DOCUMENT RESUME

ED 213 579 SE 036 045

AUTHOR	Torda, T. Paul, Ed.
TITLE	Education and Experience in Engineering, The E3 Program. Volume II, Appendices to Final Report.
INSTITUTION	Illinois Inst. of Tech., Chicago.
SPONS AGENCY	National Science Foundation, Washington, D.C.
PUB DATE	Aug 77
GRANT	NSF-SED-70-03352
NOTE	521p.; For related document, see ED 180 834. Contains occasional marginal legibility.
EDRS PRICE	MF02/PC21 Plus Postage.
DESCRIPTORS	College Science; *Engineering Education; *Group Dynamics; Higher Education; Interdisciplinary Approach; Learning Modules; Problem Solving; *Program Descriptions; Program Evaluation; *Program Implementation; *Science Course Improvement Projects
IDENTIFIERS	National Science Foundation

ABSTRACT

Volume II of the Education and Experience in Engineering E3 Program is a collection of 21 appendices related to this program which provide information on funding, participants, meetings, and communications among participants. Appendix V, an E3 Handbook for students, contains information on student advising, placement, and evaluation. Appendix VI is a manual designed for training group dynamics for students and faculty. Other appendices contain evaluation reports of the curriculum committee and subcommittee as well as results of the E3 Program Center Departmental Self-Study. Appendix IX contains sample modules. Appendix XII is a description and discussion of "Self-Paced Calculus." Other information in Volume II includes employment profiles of graduates, perspectives on the use of student project groups, case studies of typical projects, and communications related to the termination of the project. (SK)

EDUCATION AND EXPERIENCE IN ENGINEERING

THE E^3 PROGRAM

VOLUME II

APPENDICES TO FINAL REPORT

SUBMITTED TO THE
NATIONAL SCIENCE FOUNDATION

GRANT NO. GY 9300

T. Paul Torda
EDITOR

AUGUST 1977

E^3 PROGRAM CENTER
TECHNOLOGY CENTER
CHICAGO, ILLINOIS 60616

VOLUME I -- REPORT
VOLUME II -- APPENDICES

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APPENDIX I

FUNDING

Requested Dollars		Period	Actual Dollars	
NSF	IIT Contribution		NSF	IIT Contribution
208,000	44,998	18 May 71		
		-30 Sept 72	175,000	9,616
834,186	108,000	-30 June 74	726,200	108,000
877,930	150,000	-30 June 76		123,221
		extended -30 June 77	850,000	
1,920,116	402,998		1,751,200	240,837

APPENDIX II

PARTICIPANT FACULTY DURING THE IMPLEMENTATION YEAR: 1971-72

Anderson, T.	CIRCE	III
Dix, R.	Engineering	SC
Essex, D.*	CIRCE	III
Guralnick, S.	Engineering	II
Honeyman, N.*	Sociology	II
Knepler, H.	Humanities	SC
Pandey, K.*	Engineering	I
Saletta, G.	Engineering	II
Scharf, R.	Political Science	II
Smith, S.	Engineering	II
Strauss, P.*	Engineering	II
Stawinski, A.	Humanities	II
Torda, F.	Sociology	II
Torda, P.	Engineering	I, II, III
Uzgiris, C.	Engineering	SC
Weber, E.	Engineering	II

EXPLANATION:	I	Task I
	II	Task II
	III	Task III
	SC	Steering Committee
	*	Graduate Assistant

STAFF DISTRIBUTION:

9 Engineering
3 Social Sciences
2 Humanities
2 Consultant (part-time)

APPENDIX III

MEMORANDUM TO THE CURRICULUM COMMITTEE
AND
DEPARTMENT CHAIRMEN

To: Curriculum Committee and Department Chairmen
From: T. P. Torda, Project Director-Experiment In Engineering Education
Date: November 19, 1971
Subject: Motion to be placed before the Curriculum Committee-November 23, 1971

Motion for the Granting of the BSE Degree:

It is moved that the Curriculum Committee recommend that the Faculty approve the granting of the degree Bachelor of Science in Engineering (BSE) to the students entering in the fall of 1972 who complete the program developed by the Experiment in Engineering Education staff.

Supporting Statements:

The following points are offered in support of this motion:

1) At the end of four years, the students participating in the curriculum will have studied and acquired competence in material equivalent to that included in the common mathematics and science and engineering science core programs.

2) During the program the students will develop--in depth and at a level equivalent to the other engineering disciplines programs--engineering competence in analysis and synthesis and in engineering decision making through working on engineering projects and designs which will involve several engineering disciplines. Guided self-study of "learning modules" of advanced engineering content, equivalent to pertinent discipline-oriented courses now in the IIT curriculum, will augment the project work.

3) In the curriculum, the students will have satisfied the equivalent of the general education requirements by the sequence of projects which will have societal significance and which will be performed under the joint guidance of engineering, humanities, and social science faculty. Guided self-study of social science and humanities material as well as seminars will also be provided.

4) Students who may wish to transfer from the BSE program to another degree program may do so with the approval and under conditions stated by the respective department. Since all students in the BSE program will have a "portfolio" recording both performance on projects and learning module completions, transfer will be accomplished by giving appropriate credit for the equivalent courses required by the specific Department.

5) Workshop/laboratory developed to support the BSE program provides students experience in physical phenomena as well as engineering technology.

6) Students graduating from the BSE program will have an ECPD equivalent education in all respects. After graduation of this first class, this will be an ECPD accreditable education.

7) Responsibility for enforcing high quality of educational standards rests with the 17 faculty members staffing the program (from 12 Departments: Chemistry, Civil Eng., Electr. Eng., Humanities,I.Eng., Inst. Des., Man. and Fin., Math., MMAE., Phys., Pol. Sc., Psych.) each of whom is in close contact with his Department.

8) The aim of the curriculum for the BSE degree is to give an educational opportunity which does not exist at the present time to a small number of students representing a wide spectrum of abilities: an engineering education in interdisciplinary problem solving within constraints of social needs (economic, political, legal, etc.).

9) Since this is an experimental curriculum, faculty review and approval will be sought on an annual basis.

The June, 1971, issue of the Proceedings of the IEEE is devoted to the assessment of the change in engineering education (not only in electrical engineering, but in engineering in general). J.R. Whinnery, the guest editor, states: "It will be news to none of the readers that higher education in general and engineering education in particular are undergoing the most sweeping set of changes of our generation."

Eric A. Walker, in the article The Major Problems Facing Engineering Education states that: "Now, in addition to these dilemmas" (distribution of time available for teaching science or engineering practice, how much design, how much theory and how much analysis, how broad the curriculum, how much hamanities) "we find ourselves confronted with the problem of finding sufficient time to cover the material considered necessary. It is obvious that many of our constraints, schedules, credits, fifty-minute periods, lectures, laboratories, and lock-step methods must be replaced by new methods and systems designed to teach more efficiently."

Other authors write about trends in graduate education, and how education for preparation to solve problems of national priorities (ecology, bio-engineering, urban problems, power generation and distribution, etc.) is becoming of major concern. However, such trends, more and more, penetrate curricula in undergraduate engineering education and experimentation in educational methodology is becoming more and more pervasive: projects are becoming the focus instead of more conventional laboratory exercises, and "the major objective of the laboratory has become to arouse the student's curiosity and interest, and motivate his study of the theory, a reversal from the traditional order."

L. Dale Harris and Albert R. Wight write in An Extensive Experiment With The Problem Oriented Approach to Learning: "Typically, education procedures emphasize the transmission of textbook content to the mind of the student. Many persons question the merit of this approach, and believe that the problem oriented emphasis promises to be better. A four-year experience with problem oriented approaches in electrical engineering undergraduate instruction is described. Here the learner searches for principles, concepts, facts, and techniques in solving a contiguous set of problems developed by the instructor. The monologue of the lecture is deemphasized in favor of dialogue in small groups. The learner uses all resources (texts, lectures, laboratory, computer, classmates, student advisors) to find his best solution to each problem, but ultimately he must justify his solution in a small group discussion. The experience described indicates that problem-oriented approaches can be simultanously more effective and less expensive than the lecture approaches."

Some trends in engineering education in England are described by R. Spence: "Engineering education has been unduly influenced by attitudes more appropriate to the natural sciences. It should instead acknowledge the ultimate concern of the engineer for design rather than analysis, for systems rather than constituent components, and for value to the community in place of mere increase of knowledge. Advocacy of an engineering education which is consistent with engineering practice is supported by suggestions concerning curriculum structure, syllabus content, and educational methods."

Other sources also indicate recognition of need for change in engineering and scientific education. Philip H. Abelson in the editorial Training Scientists for New Jobs (Science, 12 Nov. 1971) says that "...Almost all of the major problems of society involve a component of science and technology. The discipline of a good education in science, with it emphasis on fact and on a systematic approach to problem solving, could be an important component in training for many non-research careers in the public and private sectors."

The quoted material supports some of the educational philosophy in E^3.

T. P. Torda
November 22, 1971

APPENDIX IV

NEWS RELEASES TO FACULTY AND ADMINISTRATION

Experiment in Engineering Education

Distributed by the Experiment in Engineering Education project
Illinois Institute of Technology, Room 226, E-1 Building, x. 1182.

Bulletin No. 1 September 1, 1971

This is the first report to the faculty of IIT on the activities of an experimental program in undergraduate engineering education. The program is being developed in response to the changing needs of the engineering profession and is supported by the National Science Foundation (NSF).

This first bulletin will inform you about the background and objectives of the program. We hope also that you will find its goals interesting and pertinent, and will respond with suggestions, discussions, and active participation.

About the Program

The program began in May, 1971, and will extend over a five-year period. The first year will be devoted to detailed planning of both the curriculum and the evaluation methods for program and student progress. The next four years will be devoted to implementation. Beginning with the fall of 1972, small groups of undergraduates will be enrolled each year; at the end of four years, the program will have produced its first graduates.

Educational Objectives

In our technological society, it is no longer satisfactory for the engineer to concern himself or herself with whatever is technologically and economically feasible. In decision-making, he or she must also be concerned with the social and individual values and constraints. Complex technology produces complex problems at the technology-society interface which must be solved by a technically trained professional.

The E^3 (Experiment in Engineering Education) project will attempt to develop an educational program for such a professional by integrating humanities and social sciences into the context of engineering studies. Students will be made aware that all these disciplines provide them with effective tools for professional activities.

During the last few years, an increasing number of engineering colleges have been planning, and some have actually initiated, limited programs to integrate some aspects of the socio-political sciences into engineering studies. Some colleges have done so in graduate school, but the trend, increasingly, extends to undergraduate studies. Probably the best indicator of the trend is the "Memorandum of a Workshop on Social Directions for Technology". This NSF-funded workshop was held in July, 1970, with approximately ninety participants from universities, industry, and government in both engineering and social sciences. One of the three recommendations in the memorandum is: "The social and behavioral sciences eventually must become as familiar to engineering as physics, chemistry, and mathematics."

The E^3 curriculum is being designed so that its graduates will be at least as competent, from a technological point of view, as a graduate of the traditional curriculum. That is, the socio-humanistic education of the graduate will not be obtained at the expense of the scientific-technological component of his or her education. It is hoped that this result will be achieved through the unique structuring of the E^3 educational methodology.

Methodology

The methodology of the E^3 curriculum consists primarily of two basic elements: projects and seminars. The formal classroom lecture-recitation format of the traditional curriculum will either be absent altogether, or present in a modified form. This constitutes a major departure from the traditional curriculum and requires careful planning and validation.

Since the students will be assigned to small groups consisting of freshmen, sophomores, juniors, and seniors, the project work component of the E^3 curriculum will permit students to work on real engineering problems in a master-apprentice relationship with more advanced students and faculty members. Problem-solving will provide students with a learning environment which will encourage their intellectual curiosity. It will give them an opportunity to perceive what engineering is "all about". Also, since they will be working with more advanced students and faculty, they will be able to observe attitudes and the analytical and experimental tools brought to bear on solution of problems. The student is expected to devote a major part of his learning effort to project work.

The students will be learning by solving current problems obtained from industry, local and state governments, and other organizations. The progress of each student will be monitored carefully to ensure his or her growth and professional development. Supporting the students' learning on the projects will be study activities aided by learning modules ("mini-courses" covering material relevant to the solutions of the problems). The purpose of the learning modules is to broaden the material covered by the particular project-problem the student is attempting to solve. The learning modules will take many forms, such as suggested source material for reading, audio-visual aids, reading-seminar discussions, etc.

Work in the laboratory will be an important part of the education of the students in the E^3 program. Not only will they be able to verify the results of their analytical work by measurements, but they will also be able to build and test models representing their designs.

Current Activities

The following tasks are now under way:

Classification and collection of material in retrievable form at present found in the various undergraduate curricula in engineering.

Specification of content and format of modules.

Development of a framework for the selection, administration, and execution of projects consistent with the objectives of the E^3 program.

Determination of valid monitoring and evaluation methods of both the program and the students.

During the past summer, the following faculty members and students contributed their efforts to the above tasks either on a full-time or on a part-time basis. Their contributions were fruitful and given with enthusiasm.

Thomas Anderson, CIRCE
W. D. Brennan, PHYS —
Richard Bukacek, IGT —
Rollin C. Dix, MMAE
Diane Essex, CIRCE
C. E. Gebhart, MMAE —
Sidney A. Guralnick, CE
Norman Honeyman, SOC
R. R. Huilgol, MMAE —
Henry W. Knepler, HUM
T. W. Knowles, IE —
John D. Levin, KENT —
Charles Owen, ID —
Krishna G. Pandey, MMAE
Gerald F. Saletta, EE —
Richard K. Scharf, PS
Spencer B. Smith, IE
Arthur Stawinski, HUM
E. F. Stueben, MATH
Paul Strauss, MMAE
Florence Torda, SOC
S. C. Uzgiris, MMAE
Erwin W. Weber, EE —

T. Paul Torda, MMAE
Project Director

Experiment in Engineering Education

Distributed by the Experiment in Engineering Education Project Illinois Institute of Technology, Room 226, E-1 Building, x-1182.

Bulletin No. 2 November 15, 1971

At this time it may be helpful to recall briefly the objectives of the new curriculum and the methodology to be employed to achieve the objectives.

Objectives of the New Curriculum

IIT's Experiment in Engineering Education (E^3) aims at educating engineers who will not only have at their disposal basic and applied knowledge in technological subjects, as do their counterparts graduating from the conventional curriculum, but in addition will have working knowledge in and fuller appreciation of the humano-societal fields which strongly contribute to decision making in problem solving. The graduates in E^3 will acquire such appreciation through an increased emphasis during their education of the relationship of technology to civilization and to social needs, and through integrated studies of the social sciences and humanities. Also, since methodology in E^3 is different from that in the conventional curriculum, acquisition of knowledge, retention pattern and span will be different: knowledge will be acquired when the material to be learned is needed in the solution of problems, and the apprentice-tutorial relationship of the participating students and faculty will require frequent re-use of learned material thereby promoting retention. In addition, since during the four years in college the student will learn to acquire new tools (knowledge) needed for solving new problems, this ability will increase his chance of not becoming obsolete during his professionally active years.

Methodology in E^3

The key features of the methodology applied in the program are:

> Planning and execution of engineering projects through prototype testing by integrated teams of technical and non-technical students coached by faculty advisers.
>
> Grouping of students from various levels in the curriculum on teams so that the lower and upper classmen may develop an apprentice-tutorial relationship.

Replacement of traditional lecture, recitation and laboratory courses by a series of "self-paced" learning modules. These modules provide access to the technical knowledge necessary for the engineer, are supported by upperclass and graduate student tutor/proctors for assurance of mastery of the material and often require the student to use the laboratory.

Learning modules are integrated with the projects by each student's mastering a set of modules during each project in support of the portion of the work he is responsible for.

An open workshop/laboratory in whch hardware construction and test and learning module experiments are accomplished.

Administration Support

For the success of the E^3 program, strong support by the IIT Administration is necessary. Discussions have recently been conducted with the IIT Administration in the following areas:

Faculty members need to be assured that the IIT Administration places a strong value on improvement of teaching effectiveness. Specifically, faculty members need assurance that promotions and salary increases will positively reflect such effort in the E^3 program.

In addition, it is necessary that each department be assured that individual faculty participation in programs such as E^3 will not serve as a drain upon department resources so that other departmental staff would then be required to accept inequitable loads. As departmental staff become involved in these programs, it is necessary that the department receive appropriate approval for development of new staff.

These questions have been answered by the IIT Administration as follows: Such individual faculty activity is very positively regarded in terms of faculty evaluations for promotion and salary purposes. Further, faculty involvement in the E^3 program will not make it necessary for other departmental faculty to have teaching loads greater than is normally expected of them. Specifically, as additional staff become necessary as replacements for staff effort released for E^3 participation, funds made available through E^3 salary support for released time will be utilized for hiring new staff.

Enrichment of Teaching

That "teaching really matters" to the university today cannot be doubted by anyone who attended the 1971 ASEE Conference in Annapolis. That teaching and learning methods are at the beginning of a period of rapid transition is clear from both the Annapolis meeting and reports from many other universities. The keynote of the trend is a shift from the professor as teacher to the student as learner.

Through coaching project work, faculty will directly contribute to the goals of professional education as described in the 1971 position statement of the American Society of Mechanical Engineers:

> . . . to develop the student's ability to reason, to express his thoughts, to evaluate arguments and evidence in various fields, to find information, to carry out independent investigation, and to direct his self-education.

In E^3, faculty will promote student involvement in the planning and self-evaluation of their own education, in learning the value of authentic project work as opposed to faculty constructed ("academic") experiences, and of interdisciplinary study extending beyond the purely technical.

It is expected that many of the projects will serve as primers for sponsored research and the project reports may also be suitable for publication in reviewed journals.

The mutual appreciation developing between engineering and liberal arts faculty working on E^3 establishes a unifying force which is an important factor in education of students in a highly developed technological society.

Faculty participation in E^3 will be voluntary and is considered an undergraduate teaching assignment which should not interfere with research and work with graduate students.

The Students and the Faculty

The Experiment in Engineering Education will enroll approximately 35 engineering freshmen each in the Fall of 1972 and in succeeding years. In the first few years, more advanced students from the conventional curricula in engineering will be added to the E^3 group to achieve the vertical grouping. These, together with volunteering social science and humanities students, will raise the first year total to, perhaps, 50. Thereafter, the total will increase to around 140 and then remain constant.

In the course of the four years of NSF support, approximately 60 IIT faculty members will have participated directly in E^3. These faculty will coach student project teams, and organize and administer the learning modules and laboratory. For participating faculty, preparatory workshops, conferences and experimental sessions are planned for each summer.

Many more professors will have participated indirectly, perhaps serving as a consultant or co-adviser to a student group. Thus, IIT faculty will gain by being able to experiment with new techniques of teaching and by participating in a new format of education.

Independently Paced Instruction and Problem Solving at Some Other Universities

In many disciplines, independently paced instruction (IPI, SPI, etc.) is being developed at different universities across the U. S. The two major proponents in engineering are the University of Texas at Austin and the Oklahoma State University. Design based instruction, particularly in the upper classes, is also being used at various universities in engineering education and some of these employ interdisciplinary projects. Probably the three most significant efforts in this direction are the well established design program at Harvey Mudd, the one being developed at Worcester Polytechnic Institute*, and the one planned at the New University of Texas, Permian Basin Campus. To a greater or lesser degree, use of interdisciplinary design effort is quite widespread, particularly in graduate programs. Both the established Harvey Mudd College and the experimental Worcester Poly programs use external (to the university) resource persons and institutions (from industry, municipalities, hospitals, etc.) to interact with the student-faculty group working on the projects. Thus, though not as comprehensively as will be done in E^3, interdisciplinary design projects and self-paced instruction are being developed and applied in engineering curricula and this trend is spreading.

As an aid to developing the E^3 curriculum, a continuing investigation is being made into programs that are in effect or evolving elsewhere. With regard to such programs, the criteria of pertinency includes some combination of self-paced study and individualized instruction, project oriented activity, and studies relating to immediate societal priorities.

As a result of this inquiry, a curriculum program list is being tabulated, and further investigation is being made into those programs which show promise of being informative in the E^3 effort. The list continues to expand as new programs are discovered and more information is received about those of which some knowledge already exists. This list is available in the E^3 offices and will be published shortly.

*The Sloan Foundation is supporting development of interdisciplinary design projects at several other universities besides the WPI effort.

APPENDIX V

E^3 HANDBOOK

Pages 23-78 inside

E^3 HANDBOOK

FALL 1977

STUDENT ADVISING IN E^3

Student advising occurs on two levels: personal and academic. On the personal level, students--particularly newly entering ones--need help in adjusting to the E^3 mode of operation, which is much different from the ones they have been used to in high school, or, in the case of transfer students, in other curricula or colleges.

In order to help entering students to "learn the ropes" in E^3, an E^3 upperclassman is assigned as "student advisor." This arrangement has been the most successful of those tried and helps the new student to adjust (or not) to the E^3 way of life with as little anxiety and loss of time as possible. The old hand in E^3 helps the new students in establishing priorities in his/her activities and studies.

Further on the personal level, new students need to learn how to work on small teams effectively. To serve this purpose, the Counseling Center conducts small group seminars during the Fall term of each year. Continued training occurs in the project group setting through discussions of the ongoing processes conducted by the "observers" from the Counseling Center.

Advising in academic matters also occurs in various ways in E^3. In most cases, peer pressures are effective in the project activities. However, in the project team, the prime responsibility for monitoring academic progress rests with the two faculty advisors. The regular contacts with the Review Board also serve as checks in the monitoring of individual progress in academic areas.

Academic advising--independent of the project groups--is conducted by the Program Design Committee. The PDC meets with each student at least twice a semester. The first meeting, scheduled early in the term, is meant for discussing the student's study plans as these relate to the student's role in the project he/she is working on. This first session in the semester also helps determine whether the student's study plan fits longer term plans toward graduation.

The student's second meeting with the PDC is scheduled near the end of the term and serves to summarize the semester's efforts, make plans for the coming semester, and ascertain progress toward graduation.

Additional meetings between student and PDC are scheduled as needed, and may be requested by the PDC, the student, or the faculty advisor(s) in the project group.

Project team faculty advisors should plan to participate in the PDC meetings with each of the students from the project team.

STUDENT ADVANCEMENT PLAN

The following student advancement plan was accepted by the E^3 group (students and faculty) at the Monday Open on March 3, 1975.

I. Rate-of-Progress Guidelines

To provide a balanced rate of progress through the E^3 Program over a period of eight semesters and to meet Institutional requirements, the following schedule of credit accumulation is recommended for full-time students:

Semester	PP	MSES	HSS
1 through 6	6	8	3
7	9	4	3
8	13	0	3
TOTAL	58	52	24
(Required)	(52)	(52)	(24)

An additional requirement for graduation is the earning of a minimum of 16 hours of PP credit at the 400-level.

II. Prerequisites

To help ensure that an E^3 student is adequately prepared for increasing levels of study on advancing through the program, the following prerequisites will ordinarily be required. The enforcement will occur at a pre-registration meeting with the PDC late each semester at which the student's program for the following semester is planned.

E^3 Courses	Prerequisites		
	PP	MSES	HSS
200-level	8	12	4
300-level	18	28	10
400-level	30	42	16

Students not meeting those requirements and not granted waivers therefrom, will continue at the same level in PP, MSES and HSS registration. A full-time student may not register at the 100 level more than 4 times or at the 200 or 300 level more than 3 times.

CRITERIA FOR E^3 PROJECT SELECTION

The following is intended to provide assistance to faculty and students in the E^3 Program by setting some general guidelines for E^3 Projects. These criteria are distilled from four years of experience of faculty and students who have carried out a variety of projects covering a broad range of subject matters, problem-solving approaches, and organizational styles--all within the general educational goals of the E^3 Program.

A project must:

1. Begin with a problem. Problems may arise out of feelings or observations. However, they must then be clearly formulated, defined, and documented. This means that one should be able to state what the problem is, as well as where, when, for whom, and under what circumstances it is a problem. Problems which cannot be delineated in these ways usually lead to projects which are sterile or suffer from the "solution in search of a problem" syndrome.

2. Have a definable time span. Usually this is a semester, but there is no rule requiring that time period. Care must be taken to assure that a project is not so broad as to yield only a superficial treatment of the various dimensions involved. While some projects may be exploratory (such as a feasibility study, impact analysis, or technology assessment), most projects should allow the students to pursue a problem in depth, in a time span which does not delay gratifications for extremely long time periods. This is particularly important for beginning students, who need to know how they are doing on a frequent basis. More advanced students become more expert at these determinations and can usually plan and sustain inquiry over a longer period without closure.

3. Be limited by the availability of faculty, outside resources, or student expertise. Projects in any given year are limited by the human resources that are available or can be developed on short order. In the long run, these limitations are reduced by the rotation of faculty, development of new outside resource persons, and student specialization.

4. Take into account the availability of physical resources, either on or off campus. In the case of off campus facilities, care must be taken to assure that the facilities are truly available when the students need them and can get at them. In the same vein, while there are funds for student projects, such funds are limited; project design should minimize the need for highly specialized equipment and supplies. The processing of travel requests and purchase requisitions takes time; project groups must plan in advance for processing and deliveries.

5. Provide for scholarly activities at a variety of levels of competence. The grouping of freshmen, sophomores, juniors, and seniors presents a variety of levels of learning in a variety of areas of knowledge which must be meshed into the design of a successful project. While lower level students may not have the technical backgrounds necessary for all of the work the project group undertakes, they are not to be simply relegated to literature search, report writing, and "grind" work. Rather, all kinds of project work should be divided equitably among the members.

6. Provide meaningful tasks for the individuals in the project group, as well as an identifiable collective goal. As students are to be evaluated on their individual contributions to projects, as well as on the accomplishment of group goals, projects must allow for specific tasks and individual areas of inquiry and accomplishment. It is also important for students to be able to say at the conclusion of a project, "I did this, and it fits into the total effort thus." Obvious at this point may seem, it is a serious task and takes some time. Faculty assignment of tasks has not worked out in the past. The project group and each of its members must be able to understand and agree to the division of tasks that is established. Leaving this stage of project work unfinished generally results in later confusion and hard feelings all round.

7. Be centered on a theme which is shared by other projects at the same time. This not only increases the efficiency with which faculty and staff can work, but also makes it easier for the project group to learn from each other. This consideration underlies the Theme Seminar, which has as its goal an extended discussion of the various dimensions of a broad problem area which will serve as the basis of projects undertaken during the succeeding academic year.

This criteria provide a minimal framework for deciding what projects should be undertaken. They do not address requirements based on the individual student and his/her curriculum and goals. Note also that a project not suitable at one time may become so at another time, when more students or staff with needed backgrounds are available. In such circumstances, students should be encouraged to keep the project in mind and to continue background work in the meantime.

E^3 PROJECT TEAMS
COMPOSITION AND ORGANIZATION

Composition of Project Teams

Based on experience in the Program, teams consisting of 4 to 6 participants of various levels of learning and skills are optimal in terms of achieving high levels of participation and manageable patterns of communication. Teams should include two faculty members (from technical and non-technical disciplines) and four to six students. Ideally, a team should have students ranging from freshman through senior years. In cases where this cannot be done, faculty should make sure that the team is not undertaking activities inappropriate to the level of learning of the student members.

Membership on Teams

Students who have worked together successfully on a project team, especially where a strong leader has been involved, will frequently arrange their affairs so that these patterns can be maintained. To some extent, the same thing occurs among the least successful project teams. Faculty should make sure that students are learning to work with different students and faculty; engineers rarely enjoy absolute freedom in choosing their colleagues. In addition, the repetition of teams tends to discourage other students from joining what they perceive to be a closed group, or clique. Faculty should feel free to establish which members of the prospective team have worked extensively with each other, and to see that students get a chance to work with the full range of E^3 students.

Team Organization

Small groups generally choose their own form of organization in E^3, based on what works for them. Some name strong leaders, other little more than coordinators. Some develop task leadership, some general leadership. Faculty should allow a wide range of options, although a complete absence of leadership is obviously cause for concern. As project team members, faculty are expected to contribute suggestions for organization, but should keep in mind that what may appear to be a suggestion may be taken by the student members as a command. The establishment of the senior role in projects has led to more uniformity in project leadership than E^3 has had in the past, in that lower classmen recognize the legitimacy of the senior as project leader. (There are projects which have senior members who are not, however, team leaders for that project.) Again, however, the seniors differ widely in their leadership styles, and will frequently need assistance from faculty on how to improve those styles. Leadership on project teams is generally task leadership, rather than being based on personality. Successful project team leaders generally work very hard.

The responsibilities of the "senior role" in a project are spelled out on the following page.

THE SENIOR MANAGEMENT ROLE IN E^3 PROJECTS

The E^3 program plans envisioned from the start the inclusion in all project groups of students ranging from freshmen to seniors. It is also consistent with the team problem-solving approach of E^3 to call upon its most advanced students to assume management responsibilities in projects as a way of demonstrating mastery in this dimension of the curriculum. The role has come to be called the senior management role. This role carries certain responsibilities first outlined by the Steering Committee in Fall, 1974. That statement said, in part, that the senior assuming such a role would

> ...facilitate careful definition of the problem, chair meetings of the project group, ensure that the project log is kept, maintain an overview of the work being done by each member of the group, direct each member's work to assure relevance and accuracy, pace the group's work by setting a time-table for the completion of each sub-phase of the project, distribute tasks, assure that the project is in compliance with E^3 guidelines and directives that govern project work, lead the group to information sources, identify to newer students the topics they should master for the purpose of the project and provide tutorial help in these topics as needed, and supervise editing, research, and experimentation.

Credit is granted on the basis of successful discharge of the management responsibilities, and the assessment of that success will rest, as always, with the project's team members and faculty advisors.

Although the norm is one semester, the time which a senior student should devote to problem identification and the development of a proposal for a project in which he hopes to assume the management role cannot be specified. Assuming a two semester proposal-implementation sequence, the student should devote the first to the proposal, and perhaps, to the very beginnings of project work, and the second to project work and the preparation of the final report. Normally, all students are engaged in the implementation of one project while concurrently planning a proposal for the next project.

Those students who have completed their senior roles do not by that fact exempt themselves from project duties in any succeeding semesters. Such students are able to make valuable contributions to other ongoing projects. The form of their participation in such other projects will be determined jointly by the senior and the particular project team involved. There may be occasions where the senior's management roles cannot be assumed through two consecutive semsters. Plans must be made for these situations by the student concerned, and cleared with the Program Design Committee.

GROUP DYNAMICS SEMINAR
DETAILED COURSE DESCRIPTION AND SYLLABUS

ARIADEN P. BECK. THOMAS SHIEL

Counseling Center
Illinois Institute of Technology
Fall, 1977

The Group Dynamics Seminar is a specially designed fifteen-week seminar that focuses on the essential skills relevant to effective group functioning within the E^3 framework. This seminar, which is required of all E^3 students and faculty, attempts to introduce the participants to the basic skills needed in small group work, such as the E^3 project group. The format of the seminar includes the use of prepared lectures (usually given out in advance in written form) and experimental exercises focused on the development of particular skills relating to communication, leadership, and team building in the small group process.

The course is structured so that participants gain greater self knowledge and group assessment skills. Thus, experiences are built upon sequentially, providing participants with a repertoire of useful skills. The course begins with a focus on dyadic communication issues, then group communication issues, and finally, problem identification skills, group problem solving, and types of decision-making in groups.

No available text existed, so it was necessary to develop a manual with lectures and exercises that specifically met the essential objectives of the course. (A Manual of Training in Group Dynamics for E^3 Students and Faculty, Ariadne P. Beck, Editor).

The credits granted for the group seminar ranges from one to two credit hours based on the quantity and quality of the participants' growth and involvement.

Following is a detailed synopsis of the seminar:

Weeks 1 and 2: Feedback Process. Inherent problems in listening are studied as well as techniques of giving feedback which help to overcome obstacles to clear communication. Accompanying exercises are reflective of the difficulties involved in giving and receiving feedback from others.

Weeks 3 and 4: Group Role Functions. This segment is designed to stimulate awareness of the various individual roles that exist in a group and the effects of these roles on group functioning. The interdependency among the members of a group and the effect of that upon productivity and functioning of the group are observed and experienced.

Weeks 5 and 6: Leadership. The purpose here is to develop the participants' awareness of how the leader of a group affects the process and productivity of a group; and how various leadership styles affect a group in different ways.

Weeks 7 and 8: Problem Identification and Problem Resolution. Four models of problem-solving are reviewed; liabilities and assets of each are studied. Suggestions for implications of the models for E^3 project groups are discussed.

Weeks 9 and 10: Personal Problem-Solving Common Obstacles in Problem-Solving, and Principles of Decision-Making. Three topics are presented and discussed. They are useful not only for group and organizational problems, but also for personal problems. Common failures are studied.

Weeks 11 and 12: Group Problem Solving. An awareness of some of the inherent obstacles in group problem-solving are highlighted, as well as organizational and structural difficulties. Sequential phases of problem-solving in task groups are reviewed as well as certain techniques and models for problem-solving in work groups.

Weeks 13 and 14: Types of Decision-Making in Groups. Types of decision-making models in groups are discussed as well as essential areas that deserve more in-depth study. The implications of various models are explored.

Week 15: Summary, Discussion and Feedback on the seminar.

E^3 FORMS AND RECORDS

Attached are the forms currently in use in the E^3 Program. These forms may be obtained from the Program Coordinator, Pauline Guadagno, in Room 218 Engineering 1 Building.

Form 1: Staff Evaluation Form

Faculty are requested to complete a staff evaluation form for each of the faculty members with whom they have worked on projects, committees, etc. This is done at the end of each semester.

Students also complete this form for each faculty member with whom they have worked. E^3 policy provides access to this information, and that contained in other evaluations, to the Directors and person evaluated only. Summaries of the faculty evaluations are provided to the appropriate Department Chairman and Dean for salary, promotion and tenure consideration.

Completed forms should be given to the E^3 Program Director.

Form 2: Student Project Participation Evaluation Inventory

Each advisor to a project is to fill out this form for each student member of the project team. The forms become part of the student's record.

Form 3: Seminar Credit Report

Faculty who conduct seminars prepare this form for each student receiving credit. Before conducting a seminar, the faculty member should discuss details with the appropriate Associate Director and make sure the student's role is clearly defined. A written description of the goals of the seminar, its content and the student's responsibilities should be given to the Associate Director and each student participating in the seminar.

Form 4: Module Mastery Exam Record

On occasion faculty administer mastery examinations. The result of the examination should be recorded on this form. Mastery means "no conceptual errors" on the examination.

Form 5: Incomplete Course Agreement

This is the standard institute form for incompletes. All students earning incompletes must negotiate this agreement with the appropriate faculty.

Form 6: Student Log Evaluation Inventory

This form is executed by the student and documents his/her contribution to the project.

Form 7: E^3 Transcript Summary

Prepared by the student, this form describing project learning becomes part of the student's transcript. Faculty are requested to help students to be sure that these completed forms convey the student's contributions and learning in a manner meaningful to employers and graduate schools.

Form 8: Project Credit Request Form

Credit requested on this form must be approved by the project advisors as well as the Review Board. Credit for a project is "negotiated" amongst the students and faculty prior to the Review Board meeting which immediately follows the final project presentation.

Form 9: Explanation of MSES Credits Awarded

Form 10: Coverage of the Core Curriculum

Form 11: Project Report

Form 12: Summary of Academic Progress

Form 13: Explanation of Credits Reported to the Registrar

Forms #9 and #14 are maintained by the E^3 Program Center staff and clearly show each student's status in the program.

Form 14: Module Evaluation Form

This form serves as a mechanism for suggestions for revising modules. Students may fill out this form upon completion of a mastery examination. Completed forms are given to appropriate faculty.

Form 15: Senior Management Role

Review Board completes this form as a record that the student has met the Senior Management requirement.

FORM 1

STAFF EVALUATION FORM

Listed below are the activities in which various staff members may be expected to take part. Note that not all staff take part in all activities. Please evaluate staff participation in those areas of which you have knowledge.

To be evaluated by faculty and students

1. Project Participation
2. Theme Seminar
3. Administrative Work (E^3 Committees)
4. Seminars
5. Other

To be evaluated by students

6. Minicourses.
7. Student Advising

Name of evaluator ______________________________

Name of Staff member ______________________________

Date ______________________________

IN WHAT ACTIVITIES DID YOU WORK WITH THIS PERSON?

DESCRIBE THE QUALITY OF HIS/HER PARTICIPATION.
PLEASE BE SPECIFIC: GIVE EXAMPLES WHEREVER POSSIBLE.

FORM 2

STUDENT PROJECT PARTICIPATION EVALUATION INVENTORY

Student Name________________________ Project________________________________

Duration____________________ to __________ Project Faculty Advisors________________

____

	Inadequate	Fair	Good	Excellent	Not enough information
Quality of Individual Work					
1. use of faculty and student resources to advance personal knowledge	1	2	3	4	5
2. originality	1	2	3	4	5
3. integration and synthesis of material	1	2	3	4	5
4. general intellectual development and acquisition of skills	1	2	3	4	5
5. growth of person during the project	1	2	3	4	5
Quality of Team Work					
1. effort to understand all aspects of the project	1	2	3	4	5
2. assumption of leadership or initiative during project meetings	1	2	3	4	5
3. dependability/responsibility/cooperation	1	2	3	4	5
4. resourcefulness in designing, planning, and organizing project work	1	2	3	4	5
5. time devoted to project work	1	2	3	4	5
6. attendance at project meetings	1	2	3	4	5

Comments

FORM 3

SEMINAR CREDIT REPORT

Student Name____________________________________

Seminar Title________________ Seminar Period____________

Seminar Leader________________ Title & Affiliation____________

Credits Awarded____________________________________

Details of Student Participation

____
Signature of Seminar Leader

FORM 4

MODULE MASTERY EXAM RECORD

Student ______________________________

Module Number and Title ______________________________

Examiner ______________________________

Date of Exam ______________________________

Hour: From ______________ to ______________

Room ______________________________

Exam Version Number ______________________________

Result of Exam (Check one)

MASTERY ____ RESTUDY ____

____
Examiner's Signature

INCOMPLETE COURSE AGREEMENT

Subject to the following conditions a grade of I will be given to:

Date |_|_|_|_|_|_|

Name (print) ______________________ ______________________

CC |_|_|_|_|_|_|_|_|_| Social Security Number |_|_|_|_| Original Yr-Term |_|_|_|_| Course Initials |_|_|_| Number |_|_| Sect |_|_| Hrs |_|I|

Reason for Incomplete:

Requirements to be made up:

Date by which work is to be completed ______________

The earned grade will be posted to the student's transcript at the end of the semester in which the work for the course is completed and graded.

______________________ Student's signature

______________________ Instructor's signature

* * * * * * * * * * * * * * * * * * *

COURSE COMPLETION

Enter this information to give a final grade

Date |_|_|_|_|_|_|

CA/CC |_|_|_|_|_|_|_|_|_| Social Security Number |_|_|_|_| Complete Yr-Term |_|_|_|_| Course Initials |_|_|_| Number |_|_| Sect |_|_| Hrs C |_|_| Grade

Remarks:

______________________ Instructor's signature

______________________ Chairman's signature

______________________ Dean's signature

NOTE: Please see instructions and routing information on reverse side.

P form AJT 110675

It is against Institute policy for a student to satisfy an incomplete by repeating the course as an unofficial auditor.

Items to be entered on the top portion of the form.
Date on which the incomplete is given: first two digits Month, next two digits Day, last two digits Year. Example, May 9th, 1976 is 050976.
Student's Social Security Number.
Original Yr-Term: the semester in which the student originally enrolled for the course. Example, Fall 1975 is 7509; Spring 1976 is 7601.
Course Initials, Number and Sect: Example, MATH 417 01.
Hrs: the credit hours for the course. Example, 03.
Reason, Requirements and Due Date are per agreement between instructor and student.

Items to be entered on the bottom portion of the form.
Date on which completed work is accepted and a grade assigned. Same format as above.
Student's Social Security Number.
Complete Yr-Term: the semester in which the grade is to be credited. If the completion date were in April of 1976, then this Yr-Term would be 7601.
Course Initials, Number, Sect., Hrs: same as above.
Grade: the grade finally earned (right justify).
Remarks: any additional comment the instructor might care to make for clarification or the edification of the chairman or dean.
Signatures as indicated.

The incomplete course agreement form is filled out in triplicate and signed by both the student and the instructor. The instructor retains the original and gives a copy to the student; the third copy is forwarded to the dean of the college. The instructor also fills out the usual grade forms at the end of the semester, reporting an "I" for the student for that course.

When the student submits to the instructor all the work required and the instructor is satisfied, the instructor completes the entries on the bottom portion of his original copy and gives it to the chairman for approval. If the chairman approves, the countersigned original is forwarded to the dean for final approval. The dean then checks the original against the copy on file in the deanery and if all is in order gives final approval and sends the original on to the institute recorder in the registrar's office.

The recorder checks the official class list and the student's transcript to verify that the student had in fact received an "I" for that course, verifies the signatures and general validity of the form, and forwards the form to keypunching. After keypunching the data cards are sent to administrative programming to update the student's file and the original form is filed in the student's file in the records office.

The new grade earned to replace the initial "I" is then reported on the student's regular grade slip at the end of the semester in which the incomplete is made up, and is posted to the transcript along with the other grades earned during that semester. If the student is not registered for any courses during the semester in which an incomplete is finished, a grade slip showing the made up incomplete will still be issued at the end of the semester, and the transcript posting made at that time.

GAP form AJT 110675 (side two)

FORM 6

STUDENT LOG EVALUATION INVENTORY

E^3 Project 1977-78

Student's Name______________________________

Project Title______________________________

Duration of Project______________to______________

Today's Date______________________________

Please summarize your experiences to the above project by answering the following items. Use your E^3 log as a reference in organizing your responses.

a. List and describe several of the resources you found most helpful in your work on this project.

b. List and describe briefly several ideas that you generated as a result of your project work.

c. List and describe briefly several of the accomplishments that best represent your efforts on this project.

d. Rate the quality of your contributions to the project team by circling one:

Excellent Good Fair Poor

Defend your rating with data from your log and be sure to make reference to your original contract in the proposal.

e. As a result of your project work, what did you learn?

FORM 7

E^3 TRANSCRIPT SUMMARY

(attach separate sheet if necessary)

Student Name________________________________

Semester________________________________

Project Title________________________________

Duration of Project________________________________

Project Abstract

Specific Responsibilities in the Project

Summary of learning: This is a summary of what you learned beyond the core curriculum in conjunction with your project work. List specific areas and topics.

Summary of HSS Activity. (Include seminars, project related work).

FORM 8

PROJECT CREDIT REQUEST FORM

Name ____________________

Project Title ____________________

Period ____________________

Faculty Advisors ____________________

	PP	HSS	MSES	Review Board Approved
Total Credits Awarded for Project Activities				

Project Activity	Credits Requested by the student		Credits Awarded		
	Category (PP, HSS, MSES)	Hrs.	Category	Hrs.	Advisors Signature

FORM 9

EXPLANATION OF MSES CREDITS AWARDED ON THE CREDIT REQUEST FORM

Semester 1, 1977-78

Name____

Subject	Modules Mastered	Credits

FORM 10 Name of Student_______________

COVERAGE OF THE CORE CURRICULUM

PHY 103	PHY 104	PHY 203	PHY 204	CHEM 111	CHEM 113	EG 101, 102
600	605	30 *249	* 26 488	535	540	99
601	608	31 *250	* 46 489	536	541	111
602	609	32 *252	*64	537	542	112
603	610	42 *253	*65	538	549	128
604	611	43 *254	144	539	553	138
606	612	47 *255	149	543	556	140
607	613	50 *256	154	544	557	145
614	616	213 *257	156	545		151
617	619	214 285	161	546		259
618	620	215 *286	173	547		260
482	621	216 364	174	548		261
	623	219 365	209	550		~~262~~
	624	220	247	551		290
	625	245	351	552		291
	626	246		554		346
	627			555		347
	628					
	562					
	581					
	44					

MATH 103	MATH 104	MATH 203	MATH 204	MATH 303	CS 202	ES 205
06	28	57 592	420 632	531	569	450
19	37	142 597	491 490	532	570	477
23	38	258 598	492	533	152	645
34	58	312 45	583	534	153	646
35	69	367	584	563	631	647
40	70	368	585	564		648
59	72	370	586	565		649
63	78	371	587	*566		650
71	352	372	588	567		651
129	355	416	589	*568		652
16	369	418	593			653
52		419	594			654
		444	629			655
		582	630			

PHY - PHYSICS
CHEM - CHEMISTRY
EG - ENGINEERING GRAPHICS
MATH - MATHEMATICS
CS - COMPUTER SCIENCE
ES - ENGINEERING SCIENCE

NAME OF STUDENT ____________

COVERAGE OF THE CORE CURRICULUM

CONTINUED

ES 206		ES 207	ES 208		ES 310	ES 311	ES 312		ES 313	
21	298	479	300	345	401	501	263	280	358	464
25	361	480	301		402	502	264	281	396	465
49	*362	481	302		403	503	265	282	397	466
67	449	518	303		404	504	266	283	398	467
73	485	519	304		405	505	*267	284	399	468
74	558	520	305		406	506	268		400	469
75	559	521	306		407	507	269		446	470
76	560	522	307		408	508	270		447	471
287	561	523	308		409	509	271		448	472
288	637	524	309		410	510	272		456	473
296	642	525	310		411	511	273		457	
297		526	313		412	512	274		458	
		527	341		413	513	275		459	
		528	342		414	514	276		460	
		529	343		415	515	277		461	
		530	344			516	278		462	
						517	279		463	

*These modules cover material beyond the course

UPDATE RECORD

DATE										
RECORDER										

FORM 11

NAME OF PROJECT DURATION

NAME OF STUDENTS	CREDITS EARNED (PP)		HSS	LEVEL
PROJECT	SEMINAR	OTHER	PROJ. RELATED	

FORM 12

NAME OF STUDENT______________________________

SUMMARY OF ACADEMIC PROGRESS

Date	Course No.	Credits Earned								I	Notes
		PP		MSES		HSS		TOTAL			
		Sem.	Cum.	Sem.	Cum.	Sem.	Cum.	Sem.	Cum.		

FORM 13

Registration Level: E^3P____________ Name________________________

Sem. Hr.________ Semester 1, 1977-78

EXPLANATION OF CREDITS REPORTED TO THE REGISTRAR

Summary of Credits Earned

From Bank							
earned during the semester							
TOTAL							

Credits Awarded

Reported to the Registrar							
To Bank							
TOTAL							

Date____________________ Signature____________________

FORM 14

MODULE EVALUATION FORM

Date______________________________

Module No.____________________ Exam Version No.__________

Module Name______________________________

Student Evaluation

1. Would it have helped if this module were broken down into two or more modules? — Yes No
2. Are there any implied Learning Objectives that are not explicitly stated? Comments____________________ — Yes No
3. Are the stated Learning Objectives clear? Comments____________________ — Yes No
4. Was it possible to associate each procedure with a stated Learning Objective? Comments____________________ — Yes No
5. Did you consider yourself as having achieved the associated Learning Objective after having completed each procedure? Comments____________________ — Yes No
   - A. Would more elaborate explanation have helped? — Yes No
   - B. Would a different text have helped? — Yes No
   - C. Would more solved examples have helped? — Yes No
   - D. Would more self test questions have helped? — Yes No
   - E. Would more assigned problems have helped? — Yes No
6. What percentage of the assigned problems did you solve? — All 75% 50% Some None
7. Did you work out the sample mastery exam? — Yes No
8. Did the sample mastery exam test you on all stated Learning Objectives? Comments____________________ — Yes No
9. Was the mastery exam similar to the sample mastery exam? Comments____________________ — Yes No
10. Was the mastery exam: Lengthy, Difficult, Appropriate Trivial
11. How much study time did the module require? — ____Hrs.
12. Over what length of time did you study the module? — ____Days
13. Other Comments____________________

FORM 14

MODULE EVALUATION FORM

Date____

Module No.____________________ Exam Version No.__________

Module Name____

Student Evaluation

1. Would it have helped if this module were broken down into two or more modules? — Yes No
2. Are there any implied Learning Objectives that are not explicitly stated? Comments__________________ — Yes No
3. Are the stated Learning Objectives clear? Comments________ — Yes No
4. Was it possible to associate each procedure with a stated Learning Objective? Comments__________________ — Yes No
5. Did you consider yourself as having achieved the associated Learning Objective after having completed each procedure? Comments________________________ — Yes No
   - A. Would more elaborate explanation have helped? — Yes No
   - B. Would a different text have helped? — Yes No
   - C. Would more solved examples have helped? — Yes No
   - D. Would more self test questions have helped? — Yes No
   - E. Would more assigned problems have helped? — Yes No
6. What percentage of the assigned problems did you solve? — All 75% 50% Some None
7. Did you work out the sample mastery exam? — Yes No
8. Did the sample mastery exam test you on all stated Learning Objectives? Comments____________________ — Yes No
9. Was the mastery exam similar to the sample mastery exam? Comments________________________ — Yes No
10. Was the mastery exam: Lengthy, Difficult, Appropriate Trivial
11. How much study time did the module require? — ____Hrs.
12. Over what length of time did you study the module? — ____Days
13. Other Comments________________________________

FORM 15

Date____________________

To Whom It May Concern:

____________________________has successfully completed the Senior Management Role in the______________________Project, and has therefore satisfied this requirement for graduation with the BSE degree.

Signed____________________

____

Review Board

CLERICAL OPERATIONS AND PROCEDURES

Program Coordinator -- Pauline Guadagno

Office Space

Each faculty member will be assigned office space in the Program Center, except for those having offices in the E-1 Building.

Reproduction of Materials

Since we have only Pauline to rely on, you are asked to give her adequate lead time for typing and reproduction of material to be used in projects, seminars, etc. Thermofax reproduction onto Ditto stencils is not very satisfactory (especially for small print), and should be used only in emergencies. Use of carbons and direct typing onto Ditto stencils is requested. Pauline will set priorities and will tell you when you can expect finished work.

Pauline has responsibility for the Auditron. The budget for xerox copying is more limited than in the past. The faculty is encouraged to use the library reserve system rather than making xerox copies and reproducing them for students. We also have an Auditron for Stuart. Any copies over 10 will be made in Stuart, all copies must be logged.

There is one typewriter for use by E^3 students and faculty in Room 218. Except for genuine emergencies, it should be used after 5:00 p.m. It is the machine nearer the window, and is the only machine that should be used without Pauline's permission.

Expenditures

Students and faculty should clear all expenditures with Dr. Lois Graham, Director.

Long distance phone calls for E^3 projects will be cleared with Pauline. Information needed is: date of call, to whom, account charge number, and name of caller, also who authorized the call. Only project associated calls will be authorized on E^3 accounts. All calls except campus calls will be made in Room 218 and must be logged.

Purchase orders, Petty Cash Vouchers, IDR's and Cash Disbursement Bouchers will be prepared by Pauline, who is responsible for keeping track of all purchases. No orders should be placed over the telephone. Always let Pauline know when items are received so that she can authorize payment. For Petty Cash, Cash Disbursement and IDR's, a receipt showing exact amount spent is required. IIT will not reimburse for sales taxes.

All travel requests must be approved by the Program Director and be submitted 5 days in advance of trip.

Pauline's keys to the Graphics Lab will not be used after 5:00, there are a special set of keys to be used in the evening. No keys will be given out if Pauline is not here.

Cameras: There will be a $2.00 charge for use of any camera. All graphics equipment must be signed out in Room 218 by Pauline. All cameras will be returned by 5:00, any time after you will need permission from Dr. Graham and responsibility will be yours.

E^3 LABORATORY/WORKSHOP

Barry Marks -- Lab Technician

Barry Marks is in charge of the E^3 Lab/workshop located in Room 130, E-1 Building. He is there to advise students in reference to project design, and also to instruct in the operation of machine tools and test instrumentation. All E^3 projects requiring workshop operations are to be worked out directly through Barry. He is available to arrange instructional sessions on "As needed Basis."

E^3 Workshop Rules

It is necessary that all students adhere strictly to these rules in order for the workshop to be an effective and safe venture.

1. Do not operate any machinery in the workshop without permission of shop personnel. Permission to operate a machine is dependent on the individual's ability to operate the machine. Instruction on the operation of each machine will be given to individuals as needed. Precautions and operating procedures will be covered for each machine. These must be strictly observed.

2. Report all improperly functioning equipment to shop personnel immediately. DO NOT attempt to repair any machinery or electrical equipment yourself.

3. No student will leave running equipment unattended.

4. When a student is operating a machine, he is not to be disturbed by anyone until he has completed his task.

5. Safety glasses must be worn by each student when using any machine tool. Other safety apparal necessary for special tasks must be worn by the student. Consult with shop personnel as to what is required.

6. Keep an organized work area as an asset to yourself and to others. Also clean your work area or machine after using it. The Lab Technician is not going to be your organizer, nor janitor.

7. Any tools or equipment taken out of the cabinets must be returned to their proper places when you are finished with them at the end of the day. Many man hours can be wasted in the search for equipment.

8. Do not touch other students experimental set-ups.

9. All student projects must have the proper safety signs posted on the equipment or set-up.

10. No student is permitted to work in the lab alone. There must be at least one other person present in the Lab.

11. Do not remove catalogues from the workshop, even temporarily.

12. No unauthorized personnel will be allowed in the workshop. Only shop personnel, faculty advisers, and E^3 students are considered authorized to be on the premises, others will be asked to leave. Tours of the facilities can be scheduled with the E^3 administration.

13. All projects to be constructed must be accompanied by a complete and neat set of technical drawings. No students will be allowed to start a project without any dimensional drawings. This will be checked by faculty advisors and shop personnel. Adherance to this rule will prevent needless wast of time and material.

14. Report all injuries to shop personnel.

It is necessary for everyone involved to abide by these rules, so that the workshop can operate both safely and effectively. We have a limited budget and any misuse or damage of equipment affects every student in the Program.

Individual Responsibility is the key to the successful operation of our workshop.

Above all, safety is our primary concern through mature conduct and responsible judgement.

TYPICAL DIFFICULTIES ENCOUNTERED BY E^3 STUDENTS AND FACULTY

I. Students' problems

A. Students find it quite challenging to work out a productive balance in the allocation of their time to module work, project work and seminars. Some students spread their efforts too thin, do not get as much as they should out of any one activity, and sometimes do not produce work which actually gains credit for them. Other students become confused and frightened by the apparent complexity and are unable to structure their own time so that they can focus attention where it is needed. They may then withdraw into inactivity, apparently hoping that "some how" it will all work out in the end. These problems are particularly noticeable in freshmen but, if left unsolved, can continue for several years.

Suggestions

1. Project work should be structured so that it clearly requires pertinent module work. Monitoring progress on those modules than becomes a normal part of project work reviews.

2. The project group members can be encouraged to exert influence on each other to meet deadlines for module work. (It becomes especially frustrating for the students who keep up when those who do not are allowed to flounder).

3. Faculty should take an interest in the programs and progress of the students in their project group. Individual meetings outside of group sessions can be used to get better acquainted with each student and his/her needs and problems. This will also tend to facilitate the project productivity as well. Meetings once a month are recommended.

4. When the PDC meets with each student to review progress and discuss plans for the semester's work, project faculty should attend with the students in their group.

   The agreements and plans made in these meetings should be written up as summary statements with copies for PDC, the student, and to his project faculty.

B. Faculty and student roles in E^3 differ from those roles in the traditional university department and classroom. Students coming to E^3 have rarely had experiences which prepare them for this difference. Initially, they experience some frustration and confusion in their perception of the faculty role and of their own, especially in project groups. It is initially difficult for them to give up the idea that faculty are omnipotnet or all knowing. It is equally difficult at first to recognize that they have to assume a good deal of responsibility both in guiding their own work and in sharing work and ideas in the project group.

This problem is exacerbated by two other factors. First, the students in a project group frequently seek a strong leader -- either a faculty person or senior student. Sometimes they carry this to the extreme of trying to coerce the leader into making all of the group's decisions, avoiding for themselves the important task of building a cooperative team where work and responsibility are shared. Secondly, the project groups tend to be extremely task oriented, to the point of precluding any use of group time for resolving leadership and team building issues. At its worst this problem leads to a dysfunctional team where the issues are buried and where ultimately the project work suffers.

Suggestions

1. It is important for the faculty to reflect upon their roles in E^3 projects and to become articulate in defining those roles, especially that of resource person to the students.

2. It is important for faculty to differentiate between their role as resource people and any leadership needs that the group may have. The latter should be met by student members of the group.

3. It is important for the faculty to learn how to facilitate the emergence of leadership in their groups. Generally, juniors and seniors in E^3 have learned leadership roles quite well and are prepared to cooperate with the faculty in building a viable team.

4. The project groups must take time to openly discuss these issues during the project group meetings. It is important for the faculty to encourage this and to recognize that these discussions are not a waste of time, but rather lead to successful project groups.

C. The normal format of secondary school education is one that encourages a great deal of competitiveness among students. An E^3 project group (or committee for that matter) depends on cooperative, mutually supportive, and mutually stimulating behavior. This change is often hard for students (and faculty) to make. When competitive behavior predominates, students avoid being exploratory, avoid any form of risk taking, and generally perform less creatively in a project group.

Suggestion

It is important for faculty to stimulate cooperation and to model that behavior among themselves. Competition is valuable as a stimulant to personal achievement, but, in the context of a problem solving, creative project group, competition among team members is more likely to reduce productivity than to encourage it.

II. Faculty problems

The faculty role in E^3 is a change from most student/faculty relationships that the staff have experienced previously. The primary focus in E^3 is to bring about the development of a professional attitude in the students, including the maturation of their powers of judgment regarding the social impact of their work. This is a tall order. As indicated above both students and faculty must adjust their expectations of faculty roles and responsibilities in E^3. Faculty can become frustrated by several aspects of their new roles.

A. Students are always concerned about faculty power in relation to evaluation. It becomes more confusing for the faculty themselves as they try to find a balance between their role as resource person, supportive to a team and to individual learning and productivity, and their role as evaluator of individuals. It takes time to develop comfort and grace in thie complex relationship. It helps everyone if the faculty neither pretend that evaluation is a non-issue nor perform their evaluational role with a heavy hand.

B. It becomes most pressing for the faculty member when certain students are not performing well or are holding back the project group's progress by their non-productiveness. Faculty are prone to focus a lot of thought and energy on these students and to feel personally responsible for their lack of success. As suggested earlier, meeting individually with students is helpful to them. But it can be equally helpful to the faculty, since it creates the opportunity for clarifying individual problems and allowing the faculty member to formulate more realistic expectations of each student. These meetings can also identify problems which cannot be solved within the E^3 student/faculty relationship. In these instances students can be referred elsewhere for help.

C. In developing a more relaxed and open communication style in E^3, faculty sometimes say things casually to a student which the student takes very seriously. It is important for faculty members to become sensitive to the fact that students often feel vulnerable and can be hurt in these interactions.

D. Faculty in E^3 sometimes feel that they are talking to a brick wall. E^3 is a context in which persuasion is the most common method by which one has impact on others. Neither coercion, one's personal prominance in the field, nor the normal sanctions of the traditional program are present in E^3. There will be many occasions on which students will hear but not follow faculty advice. There are often good reasons for this which that faculty member may not know. In any case patience is recommended. A learner-centered experience like E^3 is inconsistent with attitudes of simple compliance. Students learn a good deal by making decisions themselves and experiencing the consequences. It is still important to offer one's best judgement.

E. E^3 project groups may involve faculty in subject matter about which they have little expertise. Students often ask questions that faculty cannot answer. Rather than feeling inadequate or embarrassed to say "I don't know", faculty should see these incidents as opportunities to model exploratory and investigative behavior. The E^3 project group is meant to be preparation for a life time of exploring problems which do not yet have answers.

Unfortunately, some faculty find this uncomfortable and either withdraw or rush to do all the homework for the project group. It is better to guide the students to the sources of information and help them to answer their own questions. In this context, students can be referred to other faculty, both in and out of E^3 for help.

F. One of the reasons that the problem in "E" is uncomfortable for faculty is that they are "on view" to other faculty. Most faculty have had limited experience in sharing their teaching duties with others from different departments. This frequently creates discomfort until they have had the opportunity to get acquainted and to learn how to work collaboratively. Sometimes one feels on the spot to demonstrate how interesting or exciting one's special field is to others who are relatively unfamiliar with it. These are common impulses but should be restrained within the project context so that they do not create a competitive "show and tell" atmosphere. There are many advantages in the opportunity for collaborative effort with faculty from other departments. First is a broader picture of IIT as a university; second, the substantive new content one can learn; third, as relationships and trust develop many faculty have collaborated on research, writing and professional activities both in and out of E^3.

PROPOSED PEER EVALUATION ACTIVITY

One of the goals of the E^3 Program has been to foster and develop self-evaluation on the part of its students. To this end, a number of devices have been introduced into the operation of the Program -- logbooks, credit requests, study plans, and so forth. In addition, the Program has also stressed the development of social skills aimed at making it easier for students to work successfully with each other on project teams and in the Program generally. To this end, the Group Dynamics Seminar, Monday Opens, report writing, and oral presentations.

In large part, these efforts have been successful and E^3 students are able to learn many of the self-evaluation and communication and social skills they are likely to need in their careers.

There is a third kind of skill which the Program has not directly addressed, but which engineers are likely to need in professional practice. This is the ability to make intelligent comments about a proposal, plan of action, or research report, frequently without extensive exposure to the material or to the group that has produced it. Consultants are often called upon to make these sorts of comments. It has been observed that on the interteam level, communication and evaluation have been quite limited in the E^3 Program. This probably stems from the fact that the Program has not laid emphasis on this sort of activity and has devised no means by which it would routinely occur in a way that is mutually beneficial to all parties involved. As an example, student participation in final presentations has declined sharply since the Program began five years ago. Yet the Program provides a good opportunity for this sort of evaluation precisely because various teams are working on different projects simultaneously.

With these comments in mind the following proposal is made. It is our belief that the proposal creates a system which will help all E^3 students to become more accomplished in their self-evaluations. We also think that it will help project teams to better assess their own work as that work proceeds through the semester. The proposal is made for your consideration, discussion, modification, and, it is to be hoped, adoption.

PROPOSAL FOR PEER EVALUATION SYSTEM

1. Every E^3 student will be required to serve on the Review Board of one project during each of his/her sophomore, junior, and senior years. Each Review Board will consist of two faculty and two students. Obviously, no student will serve on the Review Board for any of his/her current projects.

2. The successful completion of the requirements associated with this Review Board activity will carry one credit each time, for a total of three credit hours (PP).

3. The following activities, formerly undertaken by faculty on the Review Boards, will be shared with the student members of the Boards.

    a. Review the team's written documents, including proposals (preliminary and final), weekly log summaries, interim reports, and final reports.

    b. Attend each of the biweekly meetings of the Review Board and the project team.

    c. Attend the final presentation and read the final report making comments on each.

    d. Prepare the following written documents:

        1. An evaluation of the team meeting attended every two weeks. This should run about 1 typed page, recapitulate the oral comments made at the meeting, and give suggestions to the group and individual members for future activity.

        2. A review of the log summaries submitted by each student on the team, with suggestions for future improvement.

        3. Comments on the team's final document, whether a proposal or final report. Because these documents are not available until the end of the semester, these comments may be written on a copy of the document itself, as is currently done by the all-faculty Review Board.

        4. A summary sheet for the above, prepared at the end of the semester, summarizing the work of the team, again with recommendations.

e. Take part in the credit allocation session as a member of the Review Board.

4. It is recognized that students, even after a year in the Program, may not have the information or skills necessary to evaluate all dimensions of the team's work. Therefore, it is urged that the student reviewers begin with those activities of the team which are easily identified and quantifiable, or are areas in which they may be expected to have some experience. These include:

   the team members' rate of progress on modules.

   the team's performance in reaching the goals it has set for itself in its proposal.

   the degree to which the team members are applying MSES materials to their problem-solving.

   the clarity of the team's presentation of its work to the Review Board.

   the quality of the team's dynamics as a working team.

5. The role of the faculty members of the Review Board will change to reflect the student activities outlined in this proposal. Their duties lie in two areas:

   Evaluating the quality of student reviewing and evaluating. The faculty members would be asked to have the student reviewers speak first to the team. Then the faculty would evaluate the quality of that reviewing, for the benefit of both the team and the student reviewers.

   Evaluating the less quantifiable dimensions of the project team's work, including the clarity of the team's conceptualization of its problem, the problem solving methodology of the team, and the technical sophistication of the team's work (in terms of the class standing of the team members).

6. Freshmen are not asked to take part in this activity. They have not yet had the Group Dynamics Seminar, nor have they experienced E^3 for themselves. We believe that the activities outlined in this proposal cannot be carried out without the experience provided by being in the Program for one year.

BASIC REPORT/PROPOSAL OUTLINE

I. Front Matter: routine material in the front of the proposal/report, preceding the main text

A. Cover/Title Page (these two may be combined)

B. Abstract: coverage, not substance, of the proposal/report (See section on Abstracts)

C. Table of Contents

D. Table of Illustrations: diagrams, photos, graphs, charts, visual displays, etc.; only where a large number are involved

II. Introduction: this should supply the minimum background information necessary for understanding the text

A. Identification of the Reader: For whom are you writing?

B. Purpose of the proposal/report & statement of understanding of problem: Why was the proposal/report written? Indicate the importance of the subject to the reader

C. Scope of the Problem: boundaries and limitations; identification of specific phase/part of the subject

D. Historical Background Information

1. Of subject

2. Of students' experience with subject (Note: different from "G" below)

E. Technical Background Information

1. General Theory: Coherent body of ideas underlying the the general subject area of the problem.

2. Specific Theory: Coherent body of ideas in terms of which the students' work and findings on the project are to be understood.

3. State-fo-the-art before and after project (Note: only the former will be possible in a proposal)

F. Necessary definitions

G. Statement of capability (re: project team)

H. Goals: stated in terms of project outcomes (results)

I. Statement of feasibility: (re: project); an assessment based on capabilities and goals. The extent to which goals can be accomplished.

J. Rationale for proposal/report organization: How is the subject going to be discussed and why?

III. Project

A. Plan of Procedure--Reports
(Note: facilities & resources to be appended to report and not to be included here; See V & VI)

1. Literature Survey: no anyalsis, no comments, only state what was looked at

2. Background History and Analysis: literature review and analysis

3. Preparation of properties, materials, and processes

4. Special procedures and techniques

5. Testing

B. Plan of Procedure--Proposals

1. Literature Survey

2. Background History and Analysis

IV. Organization of Findings and Discussion: this section should give as concise and clear a presentation of the data as possible

A. Presentation of Findings

1. First present data in a simple form which can be readily understood

2. Then, highlight details of particular interest

B. Summary Data Table: this contains all the essential test data include graphically the data necessary for the reader to check and evaluate the accuracy of the findings, as verbally stated in the report.

C. Reliability of Data: Accuracy, Precision, and Reproducibility

1. In any paper concerned with numerical values, the accuracy, precision, and reproducibility of the data must be clearly stated.

2. Discrepancies & anomalies within the data must be clearly explained

D. Discussion of Findings: interpretation of data

1. The major findings and the conclusions resulting from the work must be clearly presented, indicating degrees of certitude.

2. Any discussion of a new or unusual finding should contain an explanation or hypothesis, if possible.

3. Sometimes the method of computation or derivation used to obtain part of the findings should be included. This is the case, when one figure is derived from another.

4. Clearly point out the exact contribution made to the existing fund of knowledge by the new data.

5. If the findings have an immediate application, point this out in the discussion. Give an example if possible.

E. Broad implications of research for this an other fields of investigation.

V. Human Resources

A. Project Organization & Description

B. Scheduling

C. Responsibility of Project Members

D. Outside Personnel

VI. Physical Resources

A. Description of facilities

B. Utilization of facilities for project

C. Review of related facilities

VII. Back Matter

A. Endnotes

B. Bibliography

C. Glossary

D. Appendicies
(Note: last appendix = study plans)

ABSTRACT

(maximum: 100 words)

REPORT

1. Purpose of project
2. Scope of project
3. Techniques, procedures, or instrumentation used or developed during the project
4. The success of these (#3), or the failure and why
5. Findings; unexpected, unique, faculty, trends or indications
6. What problem the project has solved or introduced
7. Applications to current technology

PROPOSAL

1. Indicate and understanding of the problem(s) to be solved
2. Recommend method(s) of studying the problem
3. Show E^3 capabilities to successfully handle the problem
4. List E^3 facilities or equipment required for the success of the project

FIGURES

I. Graphs

A. Should be clear and simple with as few curves and words as possible.

B. Try to avoid interlaced or unrelated curves.

C. Choose the coordinates on the basis of what they mean to the reader. Try to select coordinates that will give the reader a physical feel for the variables being presented.

D. Choose scales that will be easy to read so that interpolation is simplified.

E. When a group of similar figures is presented in separate figures, individual scales should be used.

F. Use the same type of line (e.g. solid, dashed, etc.) to represent identical conditions or tests in related figures.

G. Include completely descriptive title.

H. Have fully defined coordinates on the graphs.

I. Properly label curves and data points.

II. Drawings

A. Keep simple.

B. Include only those features of the object that are essential to the reader's understanding.

C. Avoid unnecessary detail.

III. Photographs

A. Try to include labels and leaders to indicate the most important features of the apparatus being shown.

B. Include some object or scale to help the reader judge the size of the object shown.

C. Limit the labeling and the field of view to the main items being discussed to avoid confusing the reader.

REPORT OF THE JOB PLACEMENT GROUP

This report was generated as a result of the activity of the Job Placement Group which was organized at the E^3 Conference of February 24, 1974. Included is information on:

1. graduate studies after E^3
2. professional and graduate engineering tests
3. writing resumes
4. securing the interview
5. what to get across to the interviewer about E^3

We hope that the information within will be of some use to every E^3 student concerned about his future after E^3 and anxious to prepare for it.

THE E^3 STUDENT AND GRADUATE STUDIES

This article deals with several aspects of graduate study. First the question of the compatibility of E^3 and graduate studies is discussed followed by some thoughts on preparing for graduate work. This is followed by a general discussion of admission procedures and policies and suggestions for what to include in the portfolio.

The information concerning admission policies and procedures was obtained from interviews with several faculty members of the undergraduate and graduate schools at IIT and MIT. As far as the remarks on the compatibility of E^3 and graduate studies the author, John Katrakis, is answerable for the contents.

E^3 vs. GRADUATE STUDIES

When discussing the subject of graduate studies for students graduating from the E^3 Program one inevitably hears the same questions repeatedly. Is the philosophy of E^3 compatible with the concept of graduate studies? Does the E^3 Program give a person an adequate foundation for graduate work? Shouldn't a person who is definitely going into a specific field of graduate study complete his undergraduate studies in the appropriate regular curriculum? These questions have been raised by both staunch supporters and detractors of the program.

All of the above questions can be answered by two fundamental and interelated observations. First, one should not begin to speak about the appropriateness of a course of study unless one has a specific student in mind (and knows about the student's goals, needs and abilities). One should be more concerned about whether or not graduate studies are appropriate for the student. Secondly, the philosophy of E^3 is such that each student is given the responsibility of full control over the direction of his engineering education. The E^3 student who has effectively handled this responsibility and is convinced that graduate school will contribute toward his career goals will be able to carry out his plans.

PREPARATION FOR GRADUATE SCHOOL

As far as preparing himself for graduate work the E^3 student has two basic courses of action available to him. It may be that early in his undergraduate years (by the end of the sophomore year) he has identified himself with a more traditional field of engineering. In this case, graduate programs will exist along with statements on the preparation a student must have to complete the program. The E^3 student in this situation can plan his remaining undergraduate work to fulfill these requirements.

It is forseen that the typical graduating E^3-ist may not have graduate study plans or the undergraduate background that will allow him to follow a traditional graduate program. E^3's interdisciplinary approach will result (hopefully) in students who will have the desire and initiative to take up the increasingly popular option of designing their own program of graduate studies. A student in this situation has to convince the appropriate people that his career goals are worthwhile and his proposed plan of study can realistically allow him to reach these goals.

GETTING INTO GRADUATE SCHOOL

Difficult graduate schools have varying procedures for applying for graduate work. For example, at IIT it is a two step process. First one must get into the Graduate School, say, the School of Engineering. Next, a prospective student must get into a graduate program leading to a specific type of degree, i.e., Master of Science in Mechanical Engineering.

The first step is a relatively impersonal process in which the students' ability and promise are evaluated from the application and transcript. The requirements for acceptance into the graduate school are little more than possession of an accredited degree, preferably an engineering degree and an adequate G.P.A. If a G.P.A. is not directly available, an equivalent rating should be supplied that is fully approved by the institution which sent the transcript.

Once a student is accepted into the Graduate School of Engineering at IIT he must find the department most suitable to his needs and develop a program of graduate work with the appropriate faculty. This phase is more crucial for an E^3 student. Each engineering department has its own standards describing the preparation a student should have to complete a specific graduate program.

The admission procedure at MIT is different from IIT's. At MIT you must immediately determine what Department of Engineering you will be doing your graduate work in. Your application is sent directly to and evaluated by this department.

Because of the variety in procedures it is important that one begins investigating graduate schools early enough to find out admission's policy and to give the admissions people sufficient time to "digest" your E^3 portfolio.

CONTENTS OF THE PORTFOLIO

To get into a graduate program you must effectively sell yourself. The admissions people are basically willing to look at any evidence that will allow them to determine (to their satisfaction) your ability to carry out your intended plan of study.

The E^3 student should exploit his particular situation by getting as many detailed, favorable recommendations as possible. Project reports should be available for inspection. The E^3 environment gives me a greater chance to publish results. It may be necessary to provide a grade equivalent for your work in E^3.

A personal interview, although generally not required, would be of great advantage for the E^3 student. It would allow the student to explain in greater detail the E^3 Program and his particular qualifications.

Finally, it would seem that the E^3 student should be especially interested in taking and doing well on the G.R.E. and E.I.T. tests. Some graduate schools require the G.R.E. and those that don't would probably find it a useful yardstick for comparison with "regular" students.

Again it must be emphasized that early application is especially helpful to a E^3 student.

PE -- EIT TESTS

The major purpose of these tests is to allow the engineer to become registered as a professional engineer. By registering, the engineer will gain two important benefits: 1. He receives authority to practice his profession before the public; 2. He establishes a professional standing on the basis of legal requirements.

The procedure for Illinois Professional Engineer Registration involves a sixteen hour, two part written examination. The examination is divided into two parts: Part I tests the applicant on material in the common engineering curriculum, including mathematics, chemistry, physics, electricity, strengths of materials, and thermodynamics; Part II tests the applicant on problems in professional engineering practice, which is divided into the common engineering divisions. Part one, (the EIT test) may be taken after four years of college or experience. Upon the successful completion of the test, the applicant is considered an Engineer in Training. Part two can only be takne after the EIT is passed and after having either four years of college and four years of engineering experience, or eight years of engineering experience. It is recommended that the applicant take part I directly out of college; however, it can be taken the same day as the PE if the prerequisites have been met.

If a student wishes to know what the examinations are like, there is a booklet sold in the Bookstore for $3.25 that gives previous examination questions. "Typical Questions from Illinois Examinations for Professional Engineer Registration" Seventh edition. For further information write to ISPE Headquarters, located in the Association Building, 612 South Second Street, Springfield, Illinois 62704.

WRITING RESUMES

A resume is a brief description of a person's background, education and experience. It is a necessity in applying for later employment. There is no set form for a resume, but one form is included to give a basis to being one. This resume should be updated every year. A resume that a college student still in college would write might include the following:

Alfred J. Prufrock
Phone: 432-654-9215

PERSONAL

Born: February 29, 1984 - Detroit, Mich.
Single
Excellent Health

EDUCATION

Elementary: A.J. Fofley Grade School - 1973-1984
High School: Detroil High School Upper Campus - 1969-1984
College: Illinois Institute of Technology 1973-1977

College Major: "Education and Experience in Engineering" A program designed to teach diversified problem solving engineering.

Courses Completed
- Calculus
- Art Studio
- Statics and dynamics
- Etc.

High School Scholastic Standing Upon Graduation:
- Rank in class
- G.P.A.
- (not necessary)

AWARDS & HONORS	High School Honor Roll High School MVCL
	Offices Held Etc.
EXPERIENCES:	Electricity Carpentry Drafting Design Etc.
HOBBIES:	Etc.
FUTURE PLANS:	I am presently seeking to complete my education in engineering and work etc.
PAST EMPLOYERS:	Mr. Allan 2234 Low Lane Detroil 312-425-9734
	Richard, Caldwell, Inc. Chicago, IL 522-934-6527
	Etc.

I am available at any time for further information. Please feel free to call any of my past employers for a reference.

ACQUIRING OUTSIDE INTERVIEWS

As a graduating senior from IIT, there are a lot of opportunities for interviews and employment. As an example of this, IIT published a placement manual which lists all of the interviews scheduled for the year. Any senior is eligible to sign up for an appointment with these recruiters.

After an interview with Mr. Smith at the Placement Office, the committee learned a procedure to contact a company for a job which will indicate to the company that you are more than just the average Joe. You start by first finding out a little about the company: meet some engineers perhaps, or learn the names of the personnel men. Then you write a letter to the company addressed to one or some of these men and explain who you are and the position you are seeking. A resume should be included and you might have a department head also write a litter to verify your abilities with that position. When the company first gets the letter, it will be filed and you are probably still the average Joe trying to get a job. Now, the tide turns when you give the company a call. You ask for the person that you addressed the letter to. (If you have trouble contacting the man you might call person-to-person). After you get hold of him, you ask him if he has received your letter. He won't know what you are talking about, so he will ask his secretary to dig it out of the file. He will have it in his hand and say "Yes, we did receive your letter." Well, you respond very coyly, that you just wanted to make sure that the letter got to the right person. Then, you kindly end the conversation. He now has the letter in his hand and will have to read it to see who the person on the phone was. If you don't hear from the man in a couple of days, you then call again. Try going through the secretary and learn her name and remember it. Next time you call, when you call her by name she will be somewhat impressed and might help you contact the personnel man again. You keep going through this routine until you get the response you want, the interview. You might stipulate on the phone at some time that you are available for an interview if you have any questions about the resume. If you are pushy, persistent, and confident, and they have an opening, you will usually be granted that interview; and then it is up to you to sell yourself.

Once the interview is set up, there are many questions that might be asked of you in relation to E^3. The following outline is suggested in areas to bring up in an interview (if asked). The reason this is in outline form is that each person should know the main points and what they mean. If an interviewer does ask any questions about the E^3 Program (or your curriculum) each person will have something unique to say, but the main points of E^3 will be emphasized and known to the interviewer.

I. A. E^3 has gone beyond experimental stage and funding from grant by N.S.F.
   B. Achieved status of Program Center at IIT with full financial backing from the administration.

II. E^3's Grading System

   A. Mastery Concept
   B. Constant personal evaluation of students' professional ability of project work by faculty and peers.
   C. Final Report displays the knowledge each individual has learned throughout the semester (show the interviewer some samples of your final reports.)

III. E^3 in General

   A. Problem solvers
   B. Develop leadership skills
   C. Integrating social and cultural dimensions in with engineering
   D. Self paced
   E. All knowledge learned is integrated in with the professional project work.

NOTE: Consult the E^3 Handbook for further details.

SOPHOMORE PEER EVALUATION PROPOSAL

In response to the decision that sophomores should not be required to act as a full member of the Review Board, reached at the Monday Open on 9-27-76, a committee was formed of all present sophomores and Richard Scharf, to develop a proposal for the Sophomore Review Board Activity. This is the result of that committee. It is to be seen as a step toward the role of the junior as a full Review Board member.

PROPOSED PEER EVALUATION SYSTEM FOR SOPHOMORES

1. All E^3 students will be required to serve on the Review Board of one project, other than their own, during the sophomore year, starting with the sophomore class of the Spring '77 semester.

2. The successful completion of the requirements associated with this activity will carry one (1) hour credit (PP).

3. The responsibilities of the student will be as follows:

A. Review the team's written documents-proposals, weekly log summaries, project log, interim and final reports.

B. Attend the final presentation and make comments on it at the Review Board meeting which follows.

C. During the sixth and eleventh weeks of the semester the student will submit to the project team and the faculty Review Board members a written summary with comments, based solely on the written documents in 3A. This means the student cannot attend the regular Review Board meetings until after the presentation.

D. Take part in the credit allocation as a member of the Review Board.

4. The main reason for this activity is to allow the student to gain experience in evaluating a group's progress by reading about this progress in the group's reports. The specific areas of interest for the student will be:

A. Module progress of the team in general and project related areas of study.

B. Performance in reaching the goals set by the group.

5. The faculty Review Board members will be in charge of evaluating the sophomores written reports and comments on the final presentation.

The written documents for the Spring '77 semester will be due by the project meetings the weeks of February 27 - March 5 and April 3-7.

E^3 STUDENTS AS PROCTORS

1. Approximately 30 hours of proctoring must be done to earn 1 credit.
2. Credit can be granted only in areas of sufficient activity. Degree of activity will be determined by Module Coordinator.
3. Work for credit first, then if workers are still needed, and nobody else wants the job for credit, then work for cash.
4. 1 credit hour/semester maximum
5. 3 credit hours total maximum
6. 1 credit/subject maximum
7. Must be voluntary
8. MSES for MSES subject, and PP credits for PP subjects (where applicable)

APPENDIX VI

MANUAL OF TRAINING IN GROUP DYNAMICS

Pages 81-142 inside

A Manual of Training in Group Dynamics

for Students and Faculty

Ariadne P. Beck
Editor

E^3 Program Center and the Counseling Center
Illinois Institute of Technology
1977

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Acknowledgements

This training program was developed under the direction and supervision of Ariadne P. Beck as part of the consulting services of the Counseling Center to the Education and Experience in Engineering Program Center (E^3) at the Illinois Institute of Technology. This work was supported by a National Science Foundation grant, GY9300.

The chapters and some exercises were written by: Ariadne P. Beck, Thomas Cogan, Vincent Leo[illegible], Sander Marcus, Bonnie Rudolph, Ron Ruff, Thomas Shiel, Bob Spanier and Al Underys.

The majority of exercises are from:

A Handbook of Structured Experiences for Human Relations Training, Vols. I and II, by William Pfeifer and John E. Jones, Iowa City: University Associates Press, 1970.

Introduction to Manual

This volume of readings and exercises was assembled over a period of several years for use in an introductory seminar in group dynamics offered to new students and faculty in an innovative undergraduate engineering program at IIT. This program includes a good deal of small group project work in its curriculum, and the seminar was planned to facilitate the development of awareness and understanding of small group processes in work teams. Although the material included here has been prepared in a manner which makes it useful to a college freshman, it has been readily accepted by upperclassmen and faculty as well. It is most useful, according to the seminar participants, to read the material in advance, experience the appropriate exercise and then discuss both the experience and the concepts in the readings afterwards. On the basis of several studies, we have concluded that the use of this training in this context has led to increased understanding of leadership and group process issues, to increased willingness to take risks in a work group and to the creation of a sense of cohesion amongst the seminar participants. In the hope that the material will be useful in other settings as well it has been collated into this Manual.

SECTION A

READINGS USED IN THE GROUP DYNAMICS SEMINAR

CHAPTER 1

Feedback Process

Introduction

A message is that data which one person communicates to another. A message can take the form of words, facial expressions, gestures, or body postures, and is quite often a combination of two or more of these components. When you send a message to another person, you may get a message back from them which tells how your message was received and what effect it had. This return message is called feedback. Feedback is the most effective way of finding out how others have been affected by your message. Feedback indicates whether they have received your message, whether they thought you made sense, whether or not they agree with you, and most importantly how they have interpreted what you have said. Feedback can be critical or supportive. Both types of feedback are necessary in order to keep communication lines open. Feedback enables us to improve ourselves, to grow, and to alter our abilities so that we can work more effectively.

Obstacles to Feedback

In much of our everyday communication there often are obstacles both to accepting and giving feedback. We sometimes do not hear, recognize, or accept feedback from others because we consciously or unconsciously select certain information that we wish to recognize and ignore certain other information that we wish not to recognize. This process can be thought of as a kind of "perceptual filter". Although each individual is different, we all have an inner self-image formed by the need to perceive ourselves as having status, worth, prestige, acceptance and influence. We like to believe that we are important to others and that what we say and do can have some influence on others. But whatever the specifics, we do tend to reject most data that does not conform with our image of ourselves. When confronted with an inescapably painful fact about ourselves, we often throw the resultant guilt and blame onto some other person or event.

There are a variety of reasons why we do not accept the responsibility for giving feedback information to others.

1. Many people believe that any accurate feedback they could give would be so hurtful to the receiving person that that person would react with misunderstanding or anger, and reject not only the feedback message, but also the person giving it. This fear of giving feedback is so widespread that it might be conjectured historically to have given rise to the highly organized, somewhat rigid social custom of politeness. For example, suppose you attend a house party at the invitation of Mrs. Jones. The party turns out to be dull and uninteresting. Do you express your negative opinion to Mrs. Jones with the unspoken hope that she will plan a "better" party next time? Certainly

not! You thank her for a "lovely and enjoyable evening." This "feedback", while socially acceptable, has the unfortunate result of encouraging Mrs. Jones to continue to hold the same type of party. It is difficult to know how to give feedback in such a way that Mrs. Jones will perceive it as the helpful comment it was intended to be, and thus not become hurt and closed-off from further communication with you.

2. Many people are uncomfortable when they have feelings of hostility or affection for others. Society seems to have established a norm (in English speaking countries, at least) that it is not proper to show strong emotion, whether it be at the conference table or in the living room. (This restriction, however, does not seem to apply equally to women in our culture. A member of the so-called "weaker sex" is permitted to cry in theatres, and at homecomings, and family reunions, but she must not display anger or certain other more aggressive emotions.) Exceptions to this apparent rule appear, for example, at athletic contests, especially baseball, boxing, and wrestling, where outbursts of strong emotion among the spectators are quite common. Perhaps one of the reasons that we have difficulty in handling or expressing feelings in everyday situations is that our social rules permit us very little practice in doing so. One of the unfortunate consequences of these strictures is that the accuracy of our communication is generally reduced.

Listening as a Necessary Prerequisite to Feedback

The ability to listen and hear exactly what another person means by what he or she is saying, without distorting the message, is a skill that must be learned and practiced. This skill must be learned before one can give helpful feedback because it provides a way of overriding obstacles to communication.

In order to listen to another person, we have to "tune ourselves out" and focus in on the speaker. Biases, prejudices, values, and opinions affect our listening ability. People often tune out someone who disagrees with their views on an emotion laden topic, or simply because they hear things that they do not like.

When we are listening to someone, we may not be consciously aware of what the speaker is wearing, the style of his hair, the gestures he makes with his face, hands, and body, the tone and intensity of his voice, or his style of communication. However, such information is constantly being picked up by our sensory apparatus and used in forming our subjective impression of both the speaker himself and his message.

Our mood and preoccupations also play an important role in the concerted effort needed in order to simply listen to what another person is saying. Furthermore, our ability to listen is interwoven with our feelings about ourselves and the speaker. Most often, the speaker emits messages on two levels concomitantly: (1) the content level, which conveys the idea, and (2) the tone level, which conveys the accompanying emotional attitude of the speaker. Focusing on both levels at the same time is no easy task.

Criteria for Giving Helpful Feedback

1. Giving helpful feedback should be based upon the needs of the person receiving the feedback. The person who is giving the feedback should understand his own motivation for wanting to give feedback. We can give a "bomb-sight" kind of feedback in which the message is destructive because we are reacting entirely out of our own needs to express something and are not considering the effect the feedback might have on the person receiving it. In fact, before giving a feedback message, it is usually a good idea to place oneself momentarily in the other person's position and imagine what it would be like to receive such a message.

2. Ideally, feedback should describe one's own reaction and leave the individual who is receiving the feedback free to use or not use it. A description of how the person giving the feedback feels rather than an analysis of the original speakers "suspected" motivations is most helpful because while the person receiving the feedback generally does not know why he did what he did, he will often respond when he learns how his behavior made others feel.

3. Feedback is generally most helpful when it refers to a specific incident. A person who is told only, "you are domineering," has less opportunity to find out exactly what this means than if he is told, "yesterday when the group was deciding the issue, you did not listen to what others said and people felt forced to accept your arguments or face attack from you."

4. Timing is particularly important in giving feedback. Although there are no strict rules, feedback is generally most helpful when given at the first indication (following the incident) that the person is willing to listen to feedback.

5. Feedback is best given to a person when that person is in a position to act on the feedback, as opposed to giving a person information that will increase frustration because of the inability to act on it. An extreme example of the latter is continual feedback to a person that he is too short. This could prove very disturbing if he wished he were taller and has already reached maturity.

6. Feedback is effective when it is asked for by the receiver, when that person has clearly formulated goals, and when he intends to use the feedback as an aid in attaining those goals. If we are clear in our goals and have tried to behave in ways which will carry out those goals, we are likely to make good use of feedback.

7 Feedback needs to be checked to see if there have been clear messages in order to insure that the receiver of feedback has heard what the sender intended to communicate. One way of doing this is to have the receiver try to rephrase the feedback he has received to see if it corresponds with what the sender had in mind.

Feedback Cues

There are various verbal and nonverbal cues which communicate feedback messages. It is necessary to be aware of them in order to determine the appropriateness of a remark or the affect that it will have upon others. Some of these cues are: (a) posture: The way others sit. Are they alert? Are they leaning forward or backward, or are they turning away from you? (b) gestures: The way others move. Some examples are nodding, smiling, hand-waving, sitting with folded arms, fidgeting and the like. (c) tone of voice: Is their speech agitated, loud, soft, fast, slow, or otherwise a departure from their usual style of communicating? (d) real meaning: Are they saying what they mean? (e) timing: Are interjections too soon, too late, off target, or otherwise inappropriate.

Suggestions in Giving Feedback

One of the most functional ways of giving feedback involves the problem-solving approach, as presented within this manual. When listening to others, and when considering a response to be made, keep the following scheme in mind:

1. Diagnosis: What is happening? What is he really trying to say? What kind of response is needed?

2. Action: What skills should we employ? Should our response be in the form of a question? A statement?

3. Analysis: What was the effect of our feedback attempt? Was it received by the other person? Did it help or block the person or group?

The following suggestions should be carefully considered in developing feedback skills:

A. It is generally not helpful to try to analyze the motives of others in a feedback situation. Rather, one should focus on what effect the person has had on ourselves and/or the group.

B. One should take responsibility for providing clear and consistent feedback. This may be verbal or non-verbal. Nodding, for example, does not necessarily mean agreement; it could mean, "I am listening to you and encouraging you to go on," or merely that what the person has said is being accepted. Such feedback will often en-encourage the timid person toward more involved participation. In addition, it tends to curb the person who rambles or repeats himself. People who are repetitious in speech generally fall into two categories: (1) the person who feels he is not being heard, and so repeats to make sure, or (2) the person who is unsure of his ability to communicate clearly. Either support or encouragement will often help with these types of speakers.

C. One does not have to personally reject another person in order to disagree with that person's ideas. Evaluating whether an idea is a good one or not can be done without implying anything about the person who has the idea; for example, that he or she is smart, or stupid, or silly, or not worth considering. If the group can be helped to develop the norm that ideas become "depersonalized," or detached from the person who originates them, once they are given to the group, then it is possible to disagree with the idea and still be supportive of the person. In fact, one of the reasons that the "brainstorming" method of problem-solving has become so popular is that one of the ground rules clearly restricts the evaluation of any idea until all ideas have been presented. Indeed, immediate evaluation of an idea puts a stop to further creativity. Brainstorming also keeps the originator of the idea from feeling attacked. It is the idea that is in question. Expressing all ideas before evaluating any of them makes them the property of the group, depersonalizes them, and protects the author of the idea from attack.

D. Be careful to avoid stereotyping the people in the group. Feedback should be given based on what a person presents and how they present it now, not on what they have done in the past or what you expect them to do in the future.

E. Do not evaluate too quickly. Try to see the situation as others see it before you jump in with feedback messages. Test out your understanding of what someone else has said rather than assume too quickly that you understand. No matter how experienced you become in listening and giving feedback, there always exists the possibility that you may be wrong.

F. Keep your attention on the whole group, rather than on one person, even if that person is doing most of the talking and others are silent. This focus on the whole group will help you to be aware of the need to involve the whole group in the feedback process.

G. Encourage others to look directly at and talk directly to whomever they are giving feedback.

H. Continually practice giving and receiving feedback.

Summary

Feedback is a method of enhancing communication and helping people to grow. There are techniques of giving feedback that help to overcome the obstacles to clear communication which seem to have become common in our society. Accurate listening is a prerequisite to helpful feedback.

CHAPTER 2

Group Role Functions

Introduction

In this chapter, we will look at the roles people take in groups. Helping a group to interact in a more meaningful way depends upon an understanding of the members' group roles and their relationship to one another.

There are many different definitions of the term "role". Thibaut and Kelly (1959) discuss three types of roles: (1) the prescribed role, a system of expectations assigned to a position; (2) the subjective role, how the individual perceives and defines his own position; and (3) the enacted role, the overt behavior exhibited by the individual when he interacts with others. Thus, a person's role does not exist in isolation, but rather is a combination of the group's expectations of the person, the person's expectations of himself, and the resulting interaction (the actual behavior of the person towards the group).

Nieman and Hughes (1950) defined role as "participation in a specific group, which refers to the individual's assumption of or assignment to the performance of a 'part' in a definite situation as a member of a group." He also describes a role as a set of behaviors linked to some social unit in which a set of "do and don't" rules are known and enforced.

Primary Group Membership Roles

Benne and Sheats (1948) have identified, developed, and analyzed a number of primary group membership roles, which are divided into three catagories: (1) group task roles, (2) group building and maintenance roles and (3) individual roles.

Members' roles in groups are influenced by the tasks which the group is deciding to undertake or has undertaken. The purpose of group task roles are to facilitate a coordinated group effort defining a common problem and selecting an effective solution.

Group building and maintenance roles alter or maintain the group way of working. Such roles strengthen, regulate, and perpetuate the group as a group.

Individual roles are not directly related either to the group task or to the group's training, insofar as such training is directed toward improving the group's efficiency in fulfilling its goals or helping the group members to communicate better with each other. Individual roles do not define group membership, since their purpose is to meet individual needs, regardless of the demands of a group.

Group task roles are subdivided into specific roles which members can (and often do) take on during a group meeting. The following twelve group tasks have to do with facilitation, coordination, and problem-solving.

1. The initiator-contributor proposes new ideas or changes regarding the group problem or goal. A novel proposal may be a suggestion of a new group goal, a different definition of the problem, a different solution to a group problem, or a new way of organizing the group for the task ahead.

2. The information seeker asks for reality information and facts pertinent to the problem being discussed.

3. The opinion seeker asks for clarification regarding the values pertinent to what the group is undertaking, suggestions made, or alternative proposals.

4. The information giver offers facts or generalizations which are authorative. He often relates his own pertinent experience to the group.

5. The opinion giver states his pertinent beliefs or opinions regarding suggestions and alternative suggestions made by others in the group. His emphasis is not on facts or information, but on his notion of what values the group should adopt.

6. The elaborator builds on suggestions by giving examples, offering a rationale for suggestions previously made, and exploring how an idea or suggestion would work out if adopted by the group.

7. The coordinator clarifies the relationships among various ideas and suggestions, organizes suggestions together, and oversees the activities of group members or sub-groups.

8. The orienter defines the position of the group with respect to its goals by summarizing what has occured, pointing to departures from agreed upon goals, and raising questions about the direction the group discussion is taking.

9. The evaluator-critic questions the accomplishment of the group according to some standard or set of standards of group-functioning related to the group task. Thus, he may evaluate or question the practicality, the effectiveness, the logic, the facts, or the procedure of a suggestion or of some other aspect of group discussion and performance.

10. The energizer prods the group to action, encourages the group to make relevant decisions, and attempts to stimulate or arouse the group to greater or higher activity levels.

11. The procedural technician focuses on practicalities and performs the routine tasks such as distributing materials, rearranging the seating, running the recording machine, etc.

12. The recorder writes down suggestions, makes a record of group decisions, and writes down the results of discussions. The recorder acts as the "group memory".

Group building and maintenance roles, also subdivided into specific roles, build and reinforce group attitudes, orientations, and behaviors. Any group member may and often will take on more than one of these roles during a session.

1. The encourager praises, agrees with, and accepts the contributions of others. He expresses an attitude of solidarity toward other group members, offers commendation and praise, and acknowledges other points of view, ideas, and suggestions, by demonstrating understanding and acceptance of them.

2. The harmonizer mediates the differences between other members and attempts to reconcile disagreements. He may relieve tension in conflict situations by jesting, "pouring oil on the troubled waters," or other such actions.

3. The compromiser takes a stand from within a conflict which involves his own idea or position. He may offer compromise by yielding status, admitting his error, disciplining himself to maintain group harmony, or "coming halfway" in moving along with the group.

4. The gate-keeper and expediter attempts to keep communication channels open by encouraging or facilitating the participation of others (e.g. "We haven't got the ideas of Mr. X yet" etc.) or by proposing group rules for the flow of communication (e.g. "Why don't we limit the length of our contributions so that everyone will have a chance to contribute?" etc).

5. The standard setter or ego ideal expresses standards for the group in an attempt to help the group achieve its goals, and applies standards in evaluating the quality of group processes.

6. The group-observer and commentator keeps track of various aspects of group process and gives the group feedback of such data, with proposed interpretations which contribute to the group's evaluation of its own procedures.

7. The follower more or less passively goes along with the movement of the group, accepts the ideas of others and acts as an audience in group discussion and decision.

Benne and Sheats (1948) believe that any and all roles other than group-centered roles are unrelated to the functioning of a task oriented group. Although these non-group-centered or individual roles may not be conducive to smooth group functioning, they nevertheless can be valuable in training and the enhancement of group productivity.

Berne and Sheats point out that a:

high incidence of "individual-centered" as opposed to "group-centered" participation in a group always calls for self-diagnosis which may reveal one or several of a number of conditions -- low level of skill-training among members, including the group leader; the prevalence of "authoritarian" and "laissez-faire" points of view toward group functioning in the group; a low level of group maturity, discipline and morale; an inappropriately chosen and inadequately defined group task etc. Whatever the diagnosis, it is in this setting that the training needs of the group are to be defined. The outright "suppression" of "individual roles" will deprive the group of data needed for really adequate self-diagnosis and....[training] p. 45.

Some non-group centered roles are as follows:

1. The aggressor may work in many ways deflating the status of others, by expressing disapproval of the values, acts, or feelings of others, attacking the group or the problem it is working on, joking aggressively, or showing envy toward another's contribution by trying to take credit for it.

2. The blocker tends to be negativistic and stubbornly resistant, disagreeing and opposing beyond reasonable limits and attempting to maintain or reintroduce an issue after the group has rejected or by-passed it.

3. The recognition seeker calls attention to himself through boasting, reporting on personal achievements, acting in unusual ways, or struggling to prevent his being placed in an "inferior" position.

4. The playboy makes a display of his lack of involvement in the group's processes. This may take the form of cynicism, nonchalance, horseplay, and other more or less studied forms of "out of field" behavior.

5. The dominator attempts to assert authority or superiority by manipulating the group or certain members of the group. This domination may take the form of flattery, asserting a superior status or right to attention, giving directions authoritatively, or interupting the contributions of others.

6. The help seeker looks for sympathy from other group members or from the whole group, through expressions of insecurity, personal confusion, or depreciation of himself beyond reasonable limits.

7. The special interest pleader speaks for the "small business man", the "grass roots" community, the "housewife", "labor', etc., usually cloaking his own prejudices or biases in the stereotype which best fits his individual need.

Individual-centered roles occur in all groups. When the group's problem solving and goal defining progress slows down or is blocked, such roles may have been an important contribution to the halt in group process. Conversely, individual-centered roles often aid in resolving group problems and may be an added stimulus to the constructive aspects of the group. Very often the individual behavior of just one particular group member can help the group to clarify some important aspect of its work or of the communication process, such as the need to redefine goals or take into account something previously ignored. Once the group issue and related individual-centered roles are identified, it does not automatically follow that the person involved is labelled and then "dropped". A concerted effort should be made to recognize the uniqueness and value of each person's role in the group and in his or her relationships with group members.

Summary

Awareness of various group roles and of the effect of these roles on the group and its members can be developed through observation and analysis based upon use of a category syrtem developed by Benne and Sheats (1948). Each individual, whether intending to or not, effects the productivity and process of the group no matter which role he or she may take. A sensitivity amongst group members regarding the unique contributions that each of them can make to the group's work and experience facilitates the eventual development of interdependence and a high level of productivity.

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CHAPTER 3

Leadership

Introduction

The topic of leadership is of primary importance in studying group dynamics. The purpose of this chapter is to present some of the basic concepts of leadership and to stimulate an awareness of leadership potential and style, and of the styles of those one encounters in all group situations.

Definition and Models of Leadership

English and English (1958) define leadership as comprised of "the traits or skills characteristic of leaders or of the function of leading." They also define leadership as "the initiation, direction, or control of the actions or attitudes of another person or of a group, with the more or less willing acquiescence of the followers." These definitions differentiate leadership from coercion, in which participation is accomplished in spite of the unwillingness of the followers.

Leaders do not belong to a particular class of persons who have an inherent gift. Rather, leadership, as defined in this discussion, is a particular kind of role that anyone is capable of or has the right to assume in certain situations and at specific times. Leadership will be discussed here as the role of taking responsibility for the directions taken by a group.

"A leader is a person who, at a given time and place, by his actions modifies, directs, or controls the attitudes or actions of one or more followers; especially that person in a group who most exhibits such influence (English and English, 1958)." The major criterion in indentifying a leader is the "influence" which the leader has on his fellow group members (Krech, Crutchfield, and Ballachey, 1962). There are two primary methods of identifying a group's leader. One method is to ask the members to indicate the most influential person in the group. The second approach is to ask non group members, that is, observers, to state whom they think is the most influential person in the group.

According to Krech et. al., all of the group members are, to a greater or lesser degree, leaders, in that each member in a group will influence the group in some way. The distinction between leaders and followers has to do with the amount and degree of leadership assumed by or vested in each individual. Generally, acts of leadership represent instances of interpersonal behavior in which the leader has influence on the followers. But the leader is also highly influenced by the attitudes of the members of the group.

Leadership has been the subject of conjecture, observation and theorizing probably for as long as man has lived in groups. In this century it has also become the subject of intensive investigation and research. Several summaries and collections of important studies are now available (Cartwright & Zander, 1953; Gibbard, Hartman & Mann, 1974; Hare, 1962). The most important outcome of all this work is that the current view of group process, group productivity and the relationship of leadership to both of these involves a recognition of the subtleties and complexities that are involved. It was generally believed for example, that 'good' leadership was the only ingredient needed to produce a high degree of group effectiveness. A more modern view recognizes that all of the members in the group are responsible for and directly influence the level of group effectiveness.

Early studies of leadership pursued questions about the personality, skills and other individual characteristics of leaders in an attempt to define criteria for selecting leaders. Although this approach produced some interesting ideas it did not succeed in its mission as well as had been hoped. To a great extent the effectiveness of any leader depends upon the mix of individuals that compose the group he is to lead. This fact introduces a highly variable factor or set of factors to be considered. Further, as Gouldner (1950) observed, the traits that get a person into a position of leadership may be rather different from those that make a person an effective leader once he has attained an office of leadership". As a result research turned in the direction of a more 'situational' approach to leadership and further, to a recognition of the multiplicity of leadership functions in a group. Lippitt (1949) conducted a study in which he compared people who were trained in intergroup relations either individually or in a team situation. He reasoned that, "if people were trained as members o teams they could more effectively resist "on the job regressive pressures" by giving support to one another in their post-training activities. The results of this experiment, in which some members were trained as team members while others were trained as individuals, shows that those trained as teams were in fact better able to put into practice and to maintain new leadership practices than the persons who were trained as individuals (p. 304)."

Leadership needs in a group will change with the initiation of new group tasks. One of the influences of the leader is an ability to adapt to new situations in the life of the group. Leaders must be highly perceptive of the group's needs and its changing emotional climate. They must be aware of the influence and attitudes exerted by the group members, and must be concerned about the group members' ability to react to or meet the needs of the group and to perform its functions. This need not be done entirely by the formal leader, since one leadership skill is to locate and direct those persons in the group who have the resources to fulfill the needed group function, thus facilitating the sharing of leadership and responsibility.

Leadership has to do with the acts that enable the group to attain its desired goals. These acts are termed group functions (Cartwright and Zander 1953). Examples of actions conducted by group members include setting group goals, assisting the group in attaining its goals, aiding group interaction and group cohesiveness, and providing or assisting others in finding resources for the group members.

Day to day situations and events play the major role in determining both the kinds of group functions which the group will need at a particular time and the particular group member who will initiate or assume leadership for those functions.

Cattell (1951) suggested that any member of a group exerts leadership to the extent that the important aspects of the group are modified by his presence in the group. There are at least two striking features of Cattell's conception of leadership: (1) leadership is related to group performance; and (2) leadership is a characteristic which a person may possess in varying degrees, not as an all-or-none principle. Thus any group member may possess leadership potential and if the situation permits, may actualize that potential.

C.A. Gibb stressed that leadership is a "quality of the individual's role within a particular and specified social system," and, that leadership is an aspect of the group's structure. Gibb's theory of leadership is based on the idea that the person's behavior is changed in relation to the influence of the social situation. The personality and social situation interact and leadership is a function of that interaction. Therefore, leadership is a social role.

In the interaction theory model, leadership depends on a given situation. When a problem is identified and solutions are shared among the members of the group, the opportunity for leadership emerges. It can be said from this viewpoint that it is the social circumstances which make particular attributes of personality attributes of leadership. Therefore, leadership requires a particular situation in order to occur in the group. These kinds of social circumstances occuring at a given time "determine which members will take responsibility as leader." The interaction theory model also states that the individual group member's enhancement of the leadership role is directly related to the individual's ability to aid in the achievement of the groups' goals. Also, because leaders and followers are interdependent, the leader needs to have the qualities of a good member as well when he participates in the group.

There is a direct relationship between power and leadership. Leadership requires a power base, and a study of that power base is often a factor in understanding the underlying motives of leaders, especially leaders of large groups.

If the model of leadership is one in which the functions of the group are distributed among members, it is pertinent to explore how the functions are "assigned" and to whom.

Cartwright and Zander cite other aspects of a group that are determinants of leadership initiative. These include the degree of facilitative interdependence among members, the development of channels of communication within the group, and prior experience as leader.

Styles of Leadership

Seminal research on styles of leadership was conducted by Lippitt and White (1960), who identified three basic styles of leadership: (1) laissez-faire, (2) democratic, and (3) autocratic. The laissez-faire leader gives the group complete freedom with a minimum of leader participation. The democratic leader considers all policies to be a matter of group discussion and decision which is encouraged and assisted by the leader. The autocratic (authoritarian) leader determines all policy and dictates techniques and activities to the members. Each of these styles directly affects group process and efficiency, in its own way.

It was found that the autocratic leader tends to stifle creativity, create hostility and aggression, and cause discontentment that is not generally expressed overtly but that affects work performance. Although this style of leadership fosters dependency and suppresses individuality, the quantity of work done surpasses the democratic group. The democratic group tends to be efficient, work motivation is stronger, and originality and creativity are at higher levels. In addition, there is a greater sense of group cohesion and a higher degree of comradeship and personal satisfaction. The laissez-faire group tends to be the least organized, least efficient, and least satisfying to group members. It produces the least amount of work, and the work done is of a poorer quality.

Napier and Gershenfeld (1973) outlined a continuum of behavior which relates to available styles of leadership. The continuum is defined in terms of the degree to which either the leader or the group define problems and decide on solutions.

Leader decides, announces decision	Leader decides, sells decision	Leader presents ideas, invites questions	Leader presents tentative idea subject to change	Leader presents alternatives, group decides	Leader defines boundaries, group decides	Group defines boundaries and decides

Leader-Centered — Group-Centered

The degree to which the leader retains control of problem identification and solution is determined not only by his/her style but by a number of other constraints which may be imposed by the situation and context in which the group operates.

Some of these variables which influence leader behavior and style are:

1. Time factor and decision urgency.
2. Nature of need. Is it an emergency?
3. Individual versus group knowledge.
4. Quality of group skills.
5. Expectations of leader's role by group members, by leader himself, and situational expectations placed on leader's role according to the context of group.
6. Members expectation of their own role as well as their expectations of the leaders role.
7. Degree of responsibility taken for the group performance by leader and by the individual group members.

These factors, which may be within the leader, the membership, the situation and/or the context, influence the leader. How the leader behaves depends upon his own nature, the nature of the group, and that of the situation.

Suggestions for Group Leaders

For any group leader, it is often helpful to keep in mind the following questions.

1. As leader of this group, how much (and what kind of) influence do I actually have over this group? What kind of influence do they have on me?

2. As leader of this group, which responsibilities belong to me? Which belong to the group members?

3. Am I supportive of the whole group, or do I find myself taking sides?

4. Do I dominate the discussion and interaction? Do I allow it to be dominated by someone else?

5. Is the group exerting some kind of pressure on me to behave in a certain way as leader? Am I exerting a similar pressure on them?

6. What do I expect from the group? What does it expect from me?

7. Why am I being so nice (or nasty) to this group? Why are they being nice (or nasty) to me?

8. Can I accept and value this group for what it is and for who the group members are at this moment and yet still encourage the group to change and grow?

9. Do I encourage the group to keep its objectives in mind?

Summary

Leadership is a shared experience among group members. The leader of a group needs to know how to utilize the resources of his group in accomplishing the group's goals. We all have leadership skills, whether or not we realize it. We are all potentially valuable to any group's functioning. The appropriate style of leadership is determined by the personality of the leader, the goals of the group, the skills of the members, and the context in which the group is functioning.

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CHAPTER 4

Problem Identification and Problem Resolution

Introduction

The identification of a problem and the subsequent resolution of that problem are related processes; you cannot fix a thing without first knowing what about it needs to be fixed. Quite often, however, the steps involved in identifying problems and clarifying them are neglected because of emphasis on a "quick solution". In this chapter, we will focus on the processes of problem identification and problem resolution. It is hoped that this will stimulate the reader to identify, review, and evaluate his own problem-solving methods, and in addition, introduce him to a variety of different ways of solving problems. In order to more fully experience the relationship between problem-solving methods and group process, it is suggested that the reader first familiarize himself with this overview, and then participate in the exercises in the next section of this manual.

Many types of problem-solving processes or "styles" can be observed and identified in ordinary, daily activities. In some cases problem identification and problem solution are not clearly differentiated. Fortunately, a classification scheme is available which organizes and describes several types of problem-solving behavior. In this chapter we will focus on four different methods of problem-solving:

1. popular problem-solving
2. traditional or typical management model of problem-solving
3. problem evolution and the passive model
4. the rational model of problem-solving

Popular Problem-Solving

In popular problem-solving there is a fairly rapid sequence of activities which results in a solution. This sequence consists of four basic steps:

a) acknowledging the problem
b) searching for possible solutions
c) choosing a particular solution
d) implementing that solution

This method is sometimes called "crisis management".

Although most problem-solving procedures include these basic steps, this popular type has certain distinctive attributes. It is characterized by speed and brevity. It is used either in situations where difficulties have reached such proportions that a solution is required immediately, or when the external pressure of a crisis compels the search for a quick, effective solution. The problem is acknowledged (although in the intensity of the situation it is not always clearly identified), but little time is spent in a thorough search for a wide range of possible solutions. Considerable emphasis is placed on the ease with which a solution can be implemented, with little attention paid to possible "side effects" or other drawbacks. Implementation is speedy. If sufficient relief is experienced, the problem-solving process comes to a halt without further review or evaluation.

Listed below are some possible effects of the popular problem-solving method. These effects would most likely occur if the method were used too frequently in the same setting, group or organization.

1. poor anticipation and identification of problems
2. failure to consider the whole range of possible solutions
3. failure to choose the best solution
4. failure to evaluate the implemented solution so that it can be modified if need be

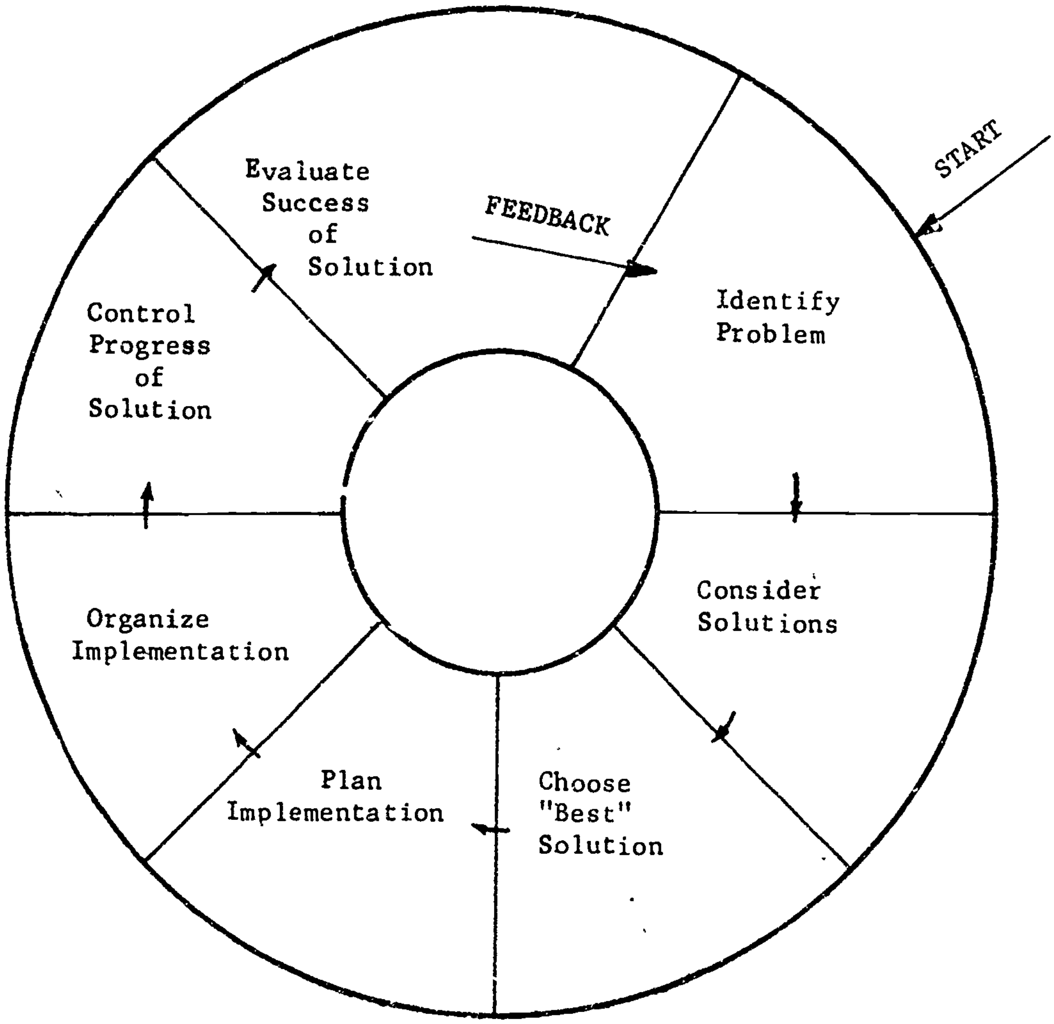
Traditional or Typical Management Model of Problem-Solving

The traditional or typical management model of problem-solving reflects the practical considerations of "big business". Management theorists such as Kepner and Tregoe (1965), have elaborated the sequence of events in the problem-solving process. Below, a fairly representative management model to problem solving is presented as a series of distinctive steps:

a) identify the "problem" (usually defined as something that went "wrong"; something not planned for)
b) consider all possible alternatives (solutions)
c) choose "best" alternative; decision-making
d) plan procedures for implementation
e) organize implementation of solution
f) control progress and success of "solution"
g) evaluate progress and success of "solution"

This model stresses planning, identification and anticipation of problems, and systematic evaluation of the success of the solution.

The process can be diagrammed as follows:



The diagram is useful in that it emphasizes the "revolving" nature of the traditional management model. It highlights one of the model's major assets: self-correcting feedback.

Problem Evolution and the Passive Model

The passive model to problem solution (evolution), though often neglected, is a commonly occurring process and takes place when there is the belief that planned control of a situation or activity will inhibit the problem-solving process. One might call it the "laissez faire model".

It consists of four rather simple steps:

a) acknowledging the problem
b) considering the alternatives
c) choosing "non-action"
d) observing the further evolution and development of the problem

Walter Kaufmann (1973), has described one such phenomenon and labeled it "decidophobia," or fear of making decisions or choosing alternatives. Kaufmann lists a number of strategies people employ to avoid making decisions, but he stresses that to not decide is itself a decision.

One should distinguish between the problem evolution model and other strategies to avoid decisions. It should also be noted that in discussing decidophobia in problem-solving, one is focusing on the social-psychological dynamics of the individual "problem-solver" more than on a model of problem-solving. Deciding by not deciding is frequently encountered, though sometimes it is only transient. Decidophobia, or fear of making decisions, seems to be frequent in large bureaucracies and may be fostered by a high overall level of anxiety, fear of failure, concern for self-acceptance, and other organizational pressures.

The Rational Model of Problem-Solving

The rational model of problem-solving is represented in the work of two management theorists, Kepner and Tregoe (1965). It consists of an even greater elaboration of a step by step process in problem-solving, and is presented here in outline form:

a) isolation of a problem area or situation
b) identification of a problem; determination of dimensions of problem

    1. when 3. how 5. what
    2. where 4. who 6. why

c) statement of problem and ordering of priorities in relation to problem
d) statement of objectives in order of priority
e) development of alternative solutions or interventions
f) evaluation of alternatives against stated priorities
g) decision on an alternative (tentative)

    1. Develop procedures for implementation
    2. Alternative must be congruent with all objectives

h) exploration of chosen alternative to determine future adverse consequences of 1) problem and 2) intervention
i) control of intervention; plan for possible adverse consequences of problem resolution
j) insurance of action on decision
k) revert to management model cycle; plan, organize-control

Steps "a" through "g" comprise identification of the problem (or "preliminary problem diagnosis"), one of the major advantages of the rational model. This overall process may be diagrammed as follows:

Preliminary Problem Diagnosis

situation
↓
problems
↓
priority problems
↓
possible causes
↓
most likely causes

Other characteristics of this model include focus on the objectives, use of the management by objectives philosophy, more direct consideration of objectives, considerable time consumption, and use of a systems or interaction framework.

A number of criticisms can be made of the rational problem-solving method. One could argue that man is basically irrational and thus would not utilize any model rationally. Another criticism is that the model is so time-consuming that it's not worth the investment of energy. A third criticism is that since the amount and quality of knowledge and information required either is lacking or is available but is too massive and complex to integrate then this approach is not feasible. A final criticism of the rational model is that it overlooks the possibility or likelihood that individual motivations, values, and loyalties will not mesh. Thus, it may not be possible to insure the evaluation or the implementation of the solution as these are conceived by the problem solver. In defense of the method, however, the emphasis on objectives addresses itself to this issue more than most of the other models presented, even though one can still question whether the emphasis is sufficient.

Summary

In this chapter, four models of problem-solving have been briefly reviewed: (1) popular problem-solving, (2) traditional or typical management model of problem-solving (3) problem evolution and the passive model and (4) the rational model of problem-solving. Some of the assets and liabilities of each have been noted.

References

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CHAPTER 5

General Principles of Problem Identification, Problem Solution and Decision-Making

Introduction

In this chapter we will discuss some problem solving methods useful for resolving not only group and organizational problems, but also private and personal problems. The common obstacles in problem-solving will be identified and investigated and three principles of decision-making will be considered.

Personal Problem Identification and Solution

Frequently, the first step in dealing with a personal problem occurs when an individual recognizes his feelings of frustration, tension or other discomfort. In many instances, he may feel only a vague sense of tension or irritability without being able to identify or acknowledge its source. This first component of problem identification on a personal level is, therefore, often characterized by vagueness, an "inward" focus, and the subjective experience of some type of emotional discomfort or disequilibrium.

Once the individual is aware of feeling uncomfortable, he can then begin to investigate and identify the specific causes of his discomfort. Often these causes focus on specific incidents or interactions.

Once these incidents are identified as being a source of the aroused feelings, then the incidents and the emotions can be analyzed for their salient features and common characteristics. The person can then move to the stage of generalization, or identification of the subjective "meaning" of the incidents. At that point the problem can be clearly stated for his own purposes and, if he wishes, can also be communicated to others. This stage is called Problem Formulation. These steps or stages in personal problem-solving are outlined in the following diagram. Once the problem is clearly formulated, the individual may then consider possible alternative solutions and choose a course of action.

experience of vague feelings of tension discomfort or frustration	→	recalls incidents related to these feelings	→	analysis of incidents	→	generalization	→	problem formulation

For most people, examples of this process are usually easy to find in daily life. Many of the activities that one participates in require both external problem identification, and personal problem identification and solution.

As a hypothetical example let us look at Dan, a student who is participating in a student/faculty planning committee. Initially, Dan felt enthusiastic about the challenges and opportunities which this project presented to him. As time went on however, he became aware of feelings of frustration and uneasiness which seemed to be associated with the days on which this committee met. Dan tried to review his associations to the feelings of frustration. In this process he recalled several incidents that had occurred during committee meetings that seemed to be particularly related to his feelings; in fact, these feelings became more intense when he remembered the events. He analyzed the events for their common characteristics and was able to see what it was that made them so intensely and personally meaningful. He was now able to identify what it was that was concerning him. He identified his problem as follows: a) he felt frustrated when faculty members of the committee either ignored his contributions or seemed to put down his suggestions without really discussing the issues with him; b) he also felt tense when the other students in the committee critized his input or altered his contributions. All the incidents he remembered had a common thread -- he felt as though his contributions were not very good and were not worth much to the committee; and, therefore, that the implication was that the other committee members didn't think much of him.

Once the problem was identified this far, it was possible for Dan to see that he was making some sweeping assumptions about his coworkers. At this point he had a number of choices available. Some of them were:

a) asking his coworkers for their evaluation of him and/or his contributions

b) telling the group in general terms that he felt some need for feedback

c) not saying anything at all to the other group members, but altering his style of interacting with them

d) reflecting on his strong sensitivity to evaluation and assessing its sources

e) seeking help or developing a plan of action to bring about some change in his attitude toward evaluation, etc., etc.

Whichever direction he might go with it, Dan was now better able to cope because he had a concept of a problem that had meaning for him and not just vague feelings of discomfort. He was better able to consider alternatives and, if necessary, to talk to others about his issues.

As indicated here, problem formulation is a very crucial step in the process leading to problem solution. Once a problem is identified however, there are a number of further steps in problem solution, each of which present their own difficulties.

Common Obstacles in Problem Solving

Difficulties in problem solving can occur in many ways but are most common at the following crucial steps in the problem solving process: 1) in attempting to identify the problem, 2) in stating one's objectives, 3) while considering alternative solutions and their possible consequences (good or bad) or 4) in choosing and implementing a particular solution. Following is an outline of some of the most common obstacles.

1) Identifying the problem

In addition to the personal components of a problem and their clarification, there are other complexities in problem identification. It is often difficult to identify a problem in its specifics because one often feels the need for a quick and easy solution. Therefore, one may not take the time to consider how the particular problem fits into a larger context, or how it is related to personal, professional, and social values. Thus the problem may be identified in a way that ignores factors relevant to an adequate solution. Once a problem is identified it is important to place it into the context of one's objectives.

2) Stating objectives

Three common problems occur in these steps: a) when there is an inadequate definition of the general objectives to be met by any solution; b) when there is an inadequate identification of the specific objectives to be met; and c) when there is a failure to relate the problem-solver, and his possible objectives to the context (i.e. group, organization etc.) within which the problem occurs, and to the possible impact on the context as well as on himself. It is most desirable when the objectives can be stated in such a way that they are not only specific, but the degree to which they are achieved can in some way be measured or assessed by those who are making the decisions.

3) Considering Alternative Solutions

In considering possible alternative solutions, certain actions or attitudes may short circuit the exploratory process. In fact most problems have inherent in them the possibility of a variety of "trade-offs" depending on the problem solver's assessment of the outcome of various choices. Some of the factors which short circuit exploration of alternatives are:

a) the fear of making mistakes may severely limit the risks one is willing to take, even in the form of mental exploration

b) premature criticism or rejection of possible alternatives; cutting short the exploration process and the examination of alternatives

c) time pressures which seem more important in the moment than the long range impact of the solution seems.

d) inadequate, incorrect, or incomplete information

Beyond the examination of alternatives, is the problem of how to assess the possible consequences of any particular solution which is chosen. In particular, the question of whose perspective to use in assessing impact is always complex. Should the criteria come from one's personal experience and judgement? From an outside expert? From those who will be effected by the solution? From an administrator's viewpoint? etc.

Implementing a Particular Solution

Common errors in this phase of the problem solution process follow.

1) neglecting the values, needs and objectives of other people who may have to be involved in the implementation phase

2) failing to gain the cooperation of others involved in implementation by first providing an orientation to the situation, the solution selected, and the reasons for selecting it

3) miscalculating the availability or quality of the resources needed to carry thru an implementation

4) failing to establish a reliable method for measuring the adequacy or effectiveness of the solution.

As can be seen from these notes there are a myriad of pitfalls on the way to a good solution. It is fortunate however, that the use of careful, thoughtful procedures in solving a problem in one area has a carryover for the problem-solver to other areas or subject matters. The basic principles are the same in most contexts even though the particular content is different for different problems.

Principles of Decision-Making

It is helpful to keep in mind certain principles when examining the processes of making decisions and choosing from among alternative solutions. Three such principles are discussed in this section:

1. the principle of identification of the relevant facts,
2. the principle of adequate evidence, and
3. the principle of adequate definition.

Identification of the "relevant facts" may, at times, seem to be simple. The problem-solver should be able to ask for the facts pertaining to a situation, and then act on those facts. However, the "facts" may be reported differently by different observers, and will vary according to the investments or the point of view of each observer, the time at which the observation was made, and any difficulties the observer has in communicating his or her observations. In practice therefore, the problem-solver should be prepared for a divergence in observers' reportings and should carefully question their observations as well as their viewpoint. This way it is more likely that the "facts" collected will not only be more "relevant" but also more "accurate".

According to the principle of adequate evidence, a decision is best made when there is accurate and complete knowledge of a well-defined problem, its etiology, and the proposed solution's probability of success. Unfortunately however, there is usually a degree of uncertaintly as to how one "knows" when the evidence is adequate, or whether one's knowledge is accurate and complete. In fact, in practice one is alwasy operating on the basis of probabilities regarding adequacy, accuracy, etc.

According to the principle of definition, the problem-solver should have clearly defined (1) the values of the organization and his own personal values as they relate to a specific decision, (2) the problem(s) to be solved, (3) the objectives of the organization, the problem-solver, and the particular solution under consideration, and (4) the priorities among problems, values and objectives, as these lead to particular solutions. The complexities involved in practicing these four steps were discussed in the previous section.

In general conclusion then, the principles involved are easier to state than to use in practice. However, the outcome is likely to be better if one follows these principles than if one does not.

Summary

Three topics were discussed in this chapter: personal problem-identification and solution, common obstacles in problem-solving, and the principles of decision making. General principles were stated as well as the complexities involved in the actual practice of trying to follow the principles.

Suggested Readings

Hill, W.F. Learning through discussion. Beverly Hills: Sage Publications, 1962.

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CHAPTER 6

Phases of Group Development and Problem Solving in Task Groups

A variety of approaches to describing the evolution of groups and their solution of task problems will be presented in this chapter. The three areas to be covered are task organization, development of group structure and leadership and stages in the decision making process.

Areas of Concern for Task Groups

In general, any group which meets regularly to accomplish a defined task will be confronted with questions of orientation, evaluation, and control. Although there are other group processes, the main focus of this section will be on these three areas.

Problems of orientation involve the rules, goals and objectives of the group members. Each group member has some knowledge and experience as well as some ignorance and uncertainty about the group and about its task. The members must somehow share as many of these perceptions as possible in order to reach a group decision on goals, objectives, and rules. The group must also make a decision on its orientation towards the task which has brought it together. In many work groups, attention is often given to the group's orientation towards the task at hand, but not to working on an agreed upon orientation towards the group itself. It is extremely important that members address the question of their functioning as a group because the interpersonal aspect of the group's process becomes the vehicle by which the task is worked on and either accomplished or left incomplete.

Problems of evaluation refer to how and by what criteria the facts of a situation and the proposed course of action are to be judged. In this area as well, both task and interpersonal dimensions are relevant. Each member of a group is likely to have criteria for evaluation that satisfy him. However, for the group to work well together some time and effort must be put into the development of a set of criteria shared by everyone in the group.

Problems of evaluation are universal. In any group, individual members rarely have similar criteria for judging a situation unless there has been a long and involved process of discussion, sharing, argument, and negotiation. Many task groups pay attention only to the task and assume that there is agreement among group members from the start. They never actually clarify the criteria for their group's operation or task approach. Preferably, however, certain questions must be asked from the start: Do the group members agree on the definition of the task? Do they agree on how the general context should be judged? Can they establish a set of criteria that all of them accept, to be used in the evaluation of their work?

The last area of concern for task groups to be considered here is that of control. Control refers both to control of individual and group performance and control of the progress on a task. Individual group members must confront the questions of how they influence each other to arrive at a unified group orientation utilizing a single set of criteria. The group must come to a collective decision as to how and when to control group interactions and progress on the external task. Unless legitimate areas and methods of control are established conflict is very likely to arise over these issues.

Sequential Phases in Problem Solving in Task Groups

The question of defining phases in group process has been addressed for some years without a final resolution being achieved regarding their exact nature or sequence. However, as the evidence mounts from many sources, the patterns are becoming more clearly defined. Among the early workers on this topic were Bales and Strodtbeck (1951) who conceived of three phases which correspond roughly to the issues of orientation, evaluation and control. Orientation concerns are usually dealt with in the beginning stages of the group. The middle phase is primarily occupied with problems of control, while evaluation characterizes the latter phases. This general division of issues is useful especially in short term group situations.

More recently, intensive observation (Beck, 1974) of group interaction has revealed a high degree of complexity in group process. In particular, the problem of forming a functional work team out of a group of strangers seems to be characterized by a unique set of communication, relationship and organizational issues. Many problems can and do develop in the formative stages of group development. For example, some groups are unable to get beyond non-constructive competitive interactions which essentially cripple a group's potential for constructive work. When certain work tasks necessitate team effort the ability to facilitate good group development becomes crucial to the accomplishment of the job to be done. For this reason an attempt has been made to specify the phases of development in greater detail.

According to Beck, the issues that are dealt with in each phase can be described for a work group or team on an abstract level as follows:

1. Each member assesses his own ability, comfort in and willingness to work with the other members in the particular group. Each member assesses the other members in terms of their potential impact on himself.

2. Forming a group identity: members work on reaching agreement about general goals, procedures for work to be done, criteria for adequate performance and leadership.

3. Exploring roles in the group: members explore what roles they can perform and what their contribution will be to the group's task (this usually involves exploration of individual ideas, viewpoints, knowledge, special skills, etc.) Important roles are determined at this time.

4. Exploring a basis for collaboration: the members seek and affirm bases for coming together on the general work plan - agreeing to direction, goal, or method.

5. Establishing mutuality about the work: the group refines its plans, spells out details, and creates space in the process for the unique contributions of all members of the team.

6. Autonomous work: sub-project tasks are developed and pursued relatively autonomously from the direction of the overall task leader of the group.

7. Confronting limits; becoming functionally collaberative: members run into their own limitations in knowledge, resources, or skill in pursuing their sub-project tasks and turn to each others' resources and skills to supplement their own; creative problem solving characterizes this phase.

8. Task completion: sub-projects are integrated, task is completed and final format is prepared.

9. Coping with termination of the task; evaluation of the job or product and possibly dissolution of the team.

These nine phases describe the development of a group's structure. They do not account for all the influences that determine group process. The personalities of the members, the context in which the group meets, the goals of the group and the communication styles of the members also greatly influence what happens.

Paralleling the phases of group development are the emergence of important group roles and functions. The reader is referred back to Chapter 2 where a broad array of group functions and roles have been outlined: gatekeeping, time keeping, clarifying, information gathering and sharing, re-stating, sponsoring and encouraging, synthesizing, summarizing, evaluating, standard setting, and tension relieving. Although these functions have some ongoing relevance to a group's process, some of them are more crucial to one phase than to others.

Decision-Making and Problem-Solution in Groups

Decision making is so important that the group experience can be thought of as dividing into two cycles with the decision-making process as a boundary separating them. The first cycle can be called the pre-decision or solution selection cycle, in which the group is involved primarily in identifying the problem, generating ideas for solutions, and forecasting the possible consequences. The second cycle can be called the post-decision or solution implementation cycle. It consists of planning solutions, acting on them, and evaluating the results. These cycles can just as easily be labelled the Investigation Cycle and the Action and Review Cycle.

The following diagram may be helpful in describing the task group experience. The diagram indicates how task groups go through a sequence of phases as they progress towards task completion.

The pre-decision and post-decision cycles have been included. The temporal order of functions, which were previously alluded to, are shown here. Some of the individual functions are predominant in particular cycles. For example, information gathering and sharing are most prevalent in cycle two, the post-decision cycle.

Pre-decision on Investigation Cycle

Problem Identification

Gathering Ideas for Solutions

Forecasting Possible Consequences to Different Solutions

Selecting Solution on Set of Solutions

Post-decision on Action and Review Cycle

Planning solution(s)

Acting on Plans to Complete Solution(s)

Evaluating the Results

Decision making operates on two levels. The most obvious example of decision making occurs when the group decides on a "solution" to be implemented to achieve task completion. Actually, the group is making various kinds of decisions throughout its existence. Possible solutions to the problem are discarded, certain kinds of information are sought, and decisions on how the group will operate are made, either explicitly or implicitly, at every phase. At this point in time the decision-making process has been insufficiently studied in task groups, yet it is clear that this is a crucial dimension of group experience.

Summary

This presentation has attempted to look at three main areas of development in task groups: task organization; development of group structure; and stages in the decision-making process. Problem-solving functions as they relate to cycles in group process and member responsibilities or functions were also discussed.

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CHAPTER 7

Styles of Decision-Making in Groups

Introduction

This chapter presents a final discussion of problem-solving and decision-making in task groups. A scheme developed by Robert Blake (1964) will be used to identify styles of decision-making processes in groups. Some areas for special focus when observing groups engaged in the decision-making process will be discussed.

Types of Decision-Making in Groups

Robert Blake (1964) has suggested that there are at least six different styles of making decisions in task groups: decision by lack of response, decision by authority rule, decision by minority rule (silence equals assent), decision by majority rule (voting and polling), decision by consensus, and decision by unanimous consent. Some of these categories are self-explanatory, such as decision by unanimous consent (in which everyone agrees on a decision), while others may need clarification or more qualification.

1. Decision by lack of response. The "plop" method, or decision by lack of response, occurs when a solution or course of action is presented but is not responded to verbally, thus the term "plop". When a group fails to respond to a suggestion or solution then, in fact, a decision has been made to ignore and thus reject the course of action or solution being offered.

2. Decision by authority rule is most common in large organizations and bureaucracies where organizational authority and responsibility are invested in certain persons, usually in the form of a power hierarchy. However, authority rule may be more prevalent in other settings, though in a less obvious way, such as when individuals with high prestige or special expertise such as doctors or college professors are deferred to or assume "authority" to make decisions.

3. Decision by minority rule is very common today. For example, many elections today are decided by minority rule; i.e., the majority of the electorate does not participate in the voting, so that the votes of the minority who do vote determine who wins the election for the majority. A striking feature of the model is that the majority remain silent and inactive, and their silence and inactivity equals agreement.

4. Decision by majority ruling; decisions reached by polling those expressing an opinion by voting. The course of action of a candidate, or idea receiving the majority (or major percentage) of the total vote prevails. Majority rule usually calls for voting. While voting is a popular and efficient means of decision making, it does have

the drawback of tending to polarize positions, which can decrease the understanding, support, and communication among subgroups in a group and thereby disrupt the cohesiveness of the total group.

5. Decision by consensus. In its pure form consensus is the most difficult and time consuming process by which decisions are made. This is true because it is dependent upon hearing every members' views, concerns, reservations and recommendations and then seeking a solution which best meets the needs of all involved. This often requires balancing a number of positive and negative consequences and arriving at a mutually satisfactory conclusion. Sometimes however, it may also require that one or several individuals give up certain goals in order that the group as a whole may move on in its task.

Each of these styles of decision-making is adequate and/or appropriate in a variety of situations or contexts. It is important to consider the appropriateness of the style to be used in each situation. It is also important that the members of a group agree about the style to be used rather than having it imposed. Unless members do agree they may not feel bound by the decisions that are made.

Questions to Consider in Observing Groups Engaged in Decision-Making

How are decisions arrived at? Which decision-making style is utilized? Does the group vote, use consensus, or minority rule?

What preceded the decision? Was there adequate information-sharing and information-gathering? Who spoke with whom? Which problem-solving functions were fulfilled; emphasized; or, ignored?

How satisfied are the members with the way the decision was reached? Do all members feel included in the decision? Have the concerns, values, and interests of group members been forgotten in the "rush" to decide? What is the "tone" of the group?

Is there a commitment to act on the decision? Who is greatly committed or who is not committed at all? Why? How can one tell?

These are just some of the questions one might ask when observing and participating in decision-making in a project group. No doubt there are many more. It is important to take the time however, to ask such questions and to observe members' reactions if efficiency, member satisfaction and success in task completion are all to be achieved in a work group.

Reference

Blake, R.R. Breakthrough in organization development. Harvard Business Review, 1964, 42, 133-155.

SECTION B

EXERCISES

USED IN THE GROUP DYNAMICS SEMINAR

INTRODUCTION TO SECTION B:

EXERCISES

The following set of exercises is designed to yield some practical group experience in working with the concepts discussed in the preceeding chapters. The exercises are organized in such a way that their specific work goals are coupled with the main concepts of a specific chapter of Section A. (See page 31 for a listing of these conjunctions.)

The directions contained in each exercise spell out the specific tasks required of the facilitator and participants, and, in addition, give the following information:

1. Goal of the exercise
2. Group Size
3. Time Required
4. Materials Utilized
5. Physical Setting
6. Process

When more detailed information is required in order to perform the exercise (e.g. charts, discussion topic lists, sign-up sheets, etc.) examples of such can be found in the pages immediately following the general directions for that exercise.

Before beginning an exercise session with a group, the facilitator should be completely familiar with all of the specific directions and process issues of that exercise. All "hand-out" materials, as required, should be completely prepared in advance of the group meeting in order to save time and avoid confusion during the practice of the exercise.

Some of the exercises require the facilitator to present brief introductory comments concerning certain key concepts discussed in the text chapters, while others require only a few short orienting remarks. In either case, the facilitator should review, in detail, his own understanding of the corresponding chapter so that he may not only "set-up" the exercise most profitably, but also aid the group in experiencing these conjunctions in the discussion periods which follows each exercise. Experience in conducting these exercises has led to the conclusion that discussions are more fruitful after the exercise has been completed.

LIST OF

EXERCISES USED IN CONJUNCTION WITH CHAPTERS

RUMOR CLINIC

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 2). Iowa City: University Associates Press, 1970, pp. 14-17.

Goal

To illustrate the distortions in communicating information as it is transmitted from the original source through several individuals to a final destination

Group Size

Six participants plus an unlimited number of process observers.

Time Required

Thirty minutes.

Materials Utilized

I. The Rumor Clinic Message

II. Rumor Clinic Observation Forms

III. Blackboard and chalk or newsprint and felt tip marker.

IV. Tape recorder (optional)

Physical Setting

I. Meeting room. All observers are seated facing platform or area where the rumor clinic is staged.

II. Room where participants can be isolated.

Process

I. The facilitator selects six members from the group to be the participants.

II. Five of the six participants are asked to go into the isolation room. One will remain with the facilitator.

III. The facilitator starts the tape recorder if he plans to replay the rumor clinic after the process is completed for clues to distortion.

IV. The facilitator reads the message to the first participant.

V. The facilitator asks the second participant to return to the room

VI. The first participant repeats what he heard from the facilitator to the second participant. It is important to keep in mind that each participant is to transmit the message in his own way, without help from other participants or observers.

VII. The third participant is asked to return, and the second participant repeats what he heard from the first participant.

VIII. The process is repeated until all but the sixth participant has has the message transmitted to him.

IX. When the sixth participant returns to the room, he becomes the policeman. The fifth participant repeats the message to the policeman, and he in turn writes the message on the blackboard or on newsprint so that the entire group can read it.

X. The facilitator then writes the original message, and it is compared with the policeman's message.

XI. The facilitator leads a short discussion with the entire group on the implications of the rumor clinic experience, utilizing the tape recorder if the rumor clinic has been taped. Observers may be asked to report, followed by reactions of participants.

Rumor Clinic Message

Accident Report

"I cannot wait to report to the police what I saw in this accident. It is imperative that I get to the hospital as soon as possible."

"The semi truck, heading south, was turning right at the intersection when the sports car, heading north, attempted to turn left. When they saw that they were turning into the same lane, they both honked their horns but proceeded to turn without slowing down. In fact, the sports car seemed to be accelerating just before the crash."

Rumor Clinic Observation Form

Message:

Accident Report

"I cannot wait to report to the police what I saw in this accident. It is imperative that I get to the hospital as soon as possible.

"The semi truck, heading south, was turning right at the intersection when the sports car, heading north, attempted to turn left. When they saw that they were turning into the same lane, they both honked their horns but proceeded to turn without slowing down. In fact, the sports car seemed to be accelerating just before the crash."

Participant	Additions	Deletions	Distortions
1			
2			
3			
4			
5			
6 (policeman)			

LISTENING TRIADS

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 1). Iowa City: University Associates Press, 1970, pp. 31-34.

Goal

To understand the necessity of listening to each other with comprehension as opposed to merely hearing words.

Group Size

Unlimited number of triads.

Time Required

Approximately forty-five minutes

Materials Utilized

I. Topics for Discussion sheets for each triad

II. Questions for Discussion sheets for each triad.

Physical Setting

Triads will separate from one another to avoid outside noise interference.

Process

I. Triads are formed

II. Participants in each triad number themselves A, B, or C.

III. The facilitator distributes Topics for Discussion sheets.

IV. In each group, one person will act as referee and the other two as participants in a discussion of one of the topics found on the sheet. One will be the speaker and the other the listener.

V. The following instructions are given by the facilitator:

A. The discussion is to be unstructured except that before each participant speaks, he must first summarize, in his own words and without notes, what has been said previously.

B. If his summary is thought to be incorrect, the speaker or the referee are free to interrupt and clear up any misunderstandings.

C. Participant A begins as speaker. He is allowed to choose his own topic from those listed.

D. Participant B will begin as listener and participant C as referee.

E. The discussion progresses as follows:

1. After about seven minutes of discussion by the speaker and the listener, participant B becomes the speaker, participant C becomes the listener, and participant A the referee. The new speaker chooses his topic.

2. After another seven minutes C becomes the speaker.

VI. After another seven minutes the discussions are halted.

VII. The facilitator distributes Questions for Discussion sheets and conducts a discussion based upon the questions.

Topics for Discussion
(from original exercise)

Choose one topic:

1. Interracial and interfaith marriages -- good or bad? Why?

2. Premarital sex relations -- acceptable or not? Why?

3. Should college students be eligible for the draft?

4. Is the U.S. right in its Vietnam policies?

5. Should the number of required credits be reduced?

6. Black Power -- good or bad for Blacks?

7. Are students activists justified in taking over college buildings?

8. (any other contemporary issue may be substituted)

Topics Offered In This Course

1. Interracial and interfaith marriages -- good or bad? Why?

2. Do professional athletes (doctors, policemen, firemen) have the right to strike?

3. Why I chose an innovative program (E^3) rather than a traditional engineering program.

4. Should tenure be abolished?

5. Should the use of marijuana be controlled?

6. Black Power -- good or bad for Blacks?

7. What do you think of laws regulating sexual behavior (e.g., for unwed couples, homosexuals, transsexuals?)

8. What could be done at this University to better the social atmosphere on campus?

9. What's your stand on abortion?

10. What do you think are the prospects of the two-party system in America?

Questions For Discussion

1. Did you find that you had difficulty in listening to others during the exercise? Why?

2. Did you find that you had difficulty in formulating your thoughts and listening at the same time?

   a. Forgetting what you were going to say

   b. Not listening to others

   c. Rehearsing your response

3. When others paraphrased your remarks, did they do it in a shorter, more concise way?

4. Did you find that you were not getting across what you wanted to say?

5. Was the manner of presentation by others affecting your listening ability?

GIVING AND RECEIVING POSITIVE AND NEGATIVE FEEDBACK

Exercise developed by:
Beck, A., Shiel, T., Spanier, R., & Underys, A. Counseling Center, Illinois Institute of Technology, 1975.

Goals

I. To focus attention on the importance, as well as the difficulties involved in accurate listening.

II. To help participants experience receiving both positive and negative feedback.

III. To help individuals examine their style of giving feedback to others as well as how they, individually, are affected by negative and positive feedback which is given to them.

IV. To provide individuals with experiential data concerning what effects positive and negative feedback have on communication in small groups.

Group Size

Unlimited number provided that they can be organized into groups of 4 or 5 each with a facilitator for each group.

Time Required

One hour to one and a half hours

Materials Utilized

I. Sign up sheets for Group Discussion with topics listed

II. Questions for Group Discussion

III. Facilitators' Instructions

Process

The members of the seminar are asked to sign up for discussion groups. Each discussion group will have 4 or 5 members. The facilitators will read the instructions to each group and will lead the post-group discussion.

Facilitators' Instructions

1. The task is for the group to conduct a discussion on the topic you all signed up for. After 15 minutes the discussion will stop and further instructions will be given.

2. Each member should take 5-10 minutes to write a few notes for himself on each other member of the group.

   List 1 positive and 1 negative aspect of each person's participation in the discussion.

   a. Did the person's style contribute or detract from the group's problem solving?

   b. Did they help or hinder other members in making their contribution to the discussion?

   c. Did they show leadership or withdraw from the discussion?

3. Now each member should take his turn as receiver of positive feedback from all the other members. He may comment if he wishes. Facilitator should make notes on how people give feedback.

4. Next each member should take his turn receiving negative feedback from all other members. Again, he should feel free to interact.

5. Discussion should follow and include feedback from facilitator on the way feedback was given.

Questions For Group Discussion

How did it feel to get feedback?

What was the difference in how you felt and what you thought about in giving positive or negative feedback?

Would it have been helpful if any of this feedback had been given during the exercise? Would it have been disruptive? Why?

Did the degree of specificity of the feedback make any difference to the receiver?

Feedback

Sigh Up Sheet

Group Discussion A

Develop a one party political system that would control the government and successfully handle national affairs.

Participants

1.

2.

3.

4.

5.

Feedback

Sign Up Sheet

Group Discussion B

Reorganize and redesign the freshman orientation for E^3 students.

Participants

1.

2.

3.

4.

5.

Feedback

Sign Up Sheet

Group Discussion C

Design a high school curriculum that would successfully prepare students for the diversity in jobs available today.

Participants

1.

2.

3.

4.

5.

ONE-WAY AND TWO-WAY COMMUNICATION

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training. (Vol. 1). Iowa City: University Associates Press, 1970, pp. 13-17.

Goals

I. To conceptualize the superior functioning of two-way communication through participatory demonstration.

II. To examine the application of communication in family, social, and occupational settings.

Group Size

Minimum of ten

Time Required

Unlimited

Materials Utilized

I. Chalkboard, chalk, and eraser

II. Two sheets of paper and a pencil for each participant.

III. Reproductions of Chart I and Chart II

Physical Setting

Participants should be facing the demonstrator and sitting in such a way that it will be difficult, if not impossible, to see each other's drawings. In the first phase of the exercise the demonstrator turns his back to the group or stands behind a screen.

Process

I. The facilitator may wish to begin with a discussion of ways of looking at communication in terms of content, direction, networks, or interference.

II. The facilitator indicates that the group will experiment with the direction aspects of communication by participating in the following exercise:

A. Preliminaries: The facilitator selects a demonstrator and one or two observers. Participants are supplied with a pencil and two sheets of paper, one labeled Chart I and the other labeled Chart II.

B. Directions: The group is told that the demonstrator will give directions to draw a series of squares. The participants are instructed to draw the squares exactly as they are told by the demonstrator. These drawings will be made on the paper labeled Chart I. Participants may neither ask questions nor give audible responses.

1. Demonstrator is asked to study the diagram of squares for a period of two minutes.

2. The facilitator instructs the observers to take notes on the behavior and reactions of the demonstrator and/or the participants.

3. The facilitator places three small tables, as follows, on the chalkboard

Table 1

MEDIANS	I	II
Time Elapsed		
Guess Accuracy		
Actual Accuracy		

Table 2

Number Correct	Guess	Actual
5		
4		
3		
2		
1		
0		

Table 3

Number Correct	Guess	Actual
5		
4		
3		
2		
1		
0		

4. The facilitator asks the demonstrator to proceed, reminding him to tell the group what to draw as quickly and accurately as he can. The facilitator will also caution the group not to ask questions and not to give audible reactions.

5. The time it takes the demonstrator to complete his instructions is recorded in Table 1.

6. Each participant is asked to estimate the number of squares he has drawn correctly in relation to the other squares.

7. Repeat the experience with the following modifications: the demonstrator uses chart II, facing the group, and is allowed to reply to questions from the group.

8. The facilitator determines the median for guessed accuracy for trials one and two based upon the individual estimations of accuracy and indicates these on Table 2 and Table 3.

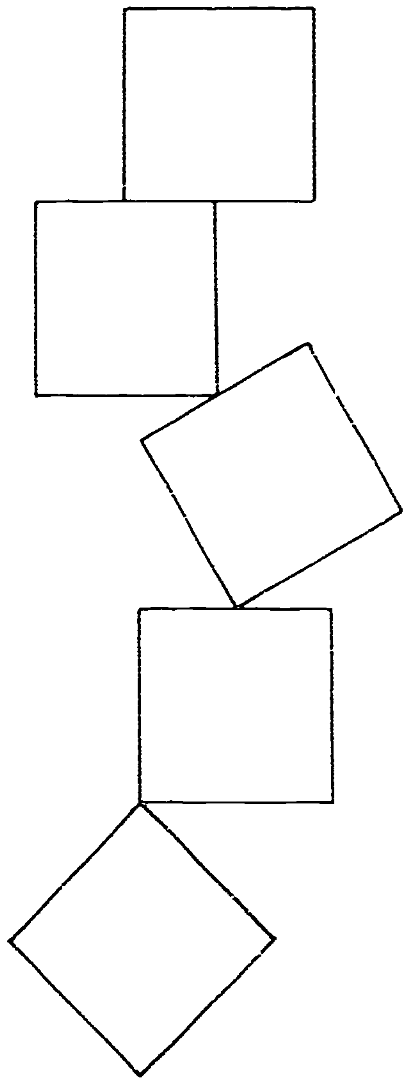
9. The group is then shown the master charts for the two sets of squares and asked to determine actual accuracy.

10. The facilitator determines the median for actual accuracy for trials one and two based upon the individual scores.

III. A discussion of the results in terms of time, accuracy, and level of confidence should follow, calling upon "backhome" experience and application.

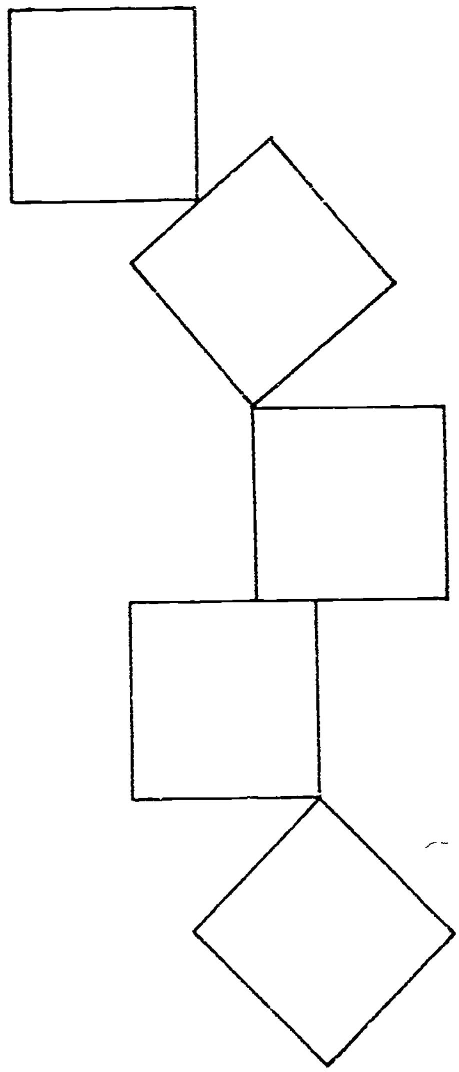
IV. The observers offer their data, and the group discusses it in relation to the data generated during the first phase of the discussion.

Master Chart I. One-Way Communication



INSTRUCTIONS: Study the figures above. With your back to the group, you are to instruct the participants how to draw them. Begin with the top square and describe each in succession, taking particular note of the relationship of each to the preceding one. No questions are allowed.

Master Chart II. Two-Way Communication



INSTRUCTIONS: Study the figures above. Facing the group, you are to instruct the participants how to draw them. Begin with the top square and describe each in succession, taking particular note of the relation of each to the preceding one. Answer all questions from participants and repeat if necessary.

GROUP MEMBER ROLES

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training. (Vol. 2). Iowa City: University Associates Press, 1970, pp. 76-78.

Goals

I. To provide feedback to the group member of the roles which his fellow members have perceived him as playing.

II. To study various types of roles in relation to group goals.

III. To demonstrate that leadership in a small group consists of several functions which should be shared among members.

Group Size

Six to twelve members

Time Required

Approximately one and a half hours

Materials Utilized

I. Role Nomination Forms

II. Pencils

Physical Setting

Participants should be seated comfortably for writing, preferably at tables or desk-chairs.

Process

I. The facilitator gives a lecturette on roles which group members often play (see Chapter 2). He explains that some roles relate to the group's task, some maintain and enhance the functioning of the group, and some detract from the group's work. He distributes the Role Nomination Forms and explains each of the fifteen roles included. (Names of members should be written in on each of the forms in the same order in advance of the meeting.)

II. Pencils are distributed, and participants follow instructions on the form.

III. When all have completed the form, a tally is made of all of the check marks. Each member calls out all of the marks he put down and each participant makes a complete tally for the entire group. Variation: the facilitator collects the forms and reads them aloud anonymously.

IV. The group has a discussion of the array of tallies. Individual members are encouraged to solicit feedback on their distributions of nominations. Attention may be given to the presence or absence of adequate numbers of persons playing various functional roles and to how disfunctional roles are to be coped with.

Role Nominations Form

Directions: For each member place check marks in the column corresponding to the roles he has played most often in the group so far. Include yourself.

Roles

Group Task Roles	A	B	C	D	E	F	G
1. Initiator contributor							
2. Information seeker							
3. Information giver							
4. Coordinator							
5. Orienter							
6. Evaluator							
Group Growing and Vitalizing Roles							
7. Encourager							
8. Harmonizer							
9. Gatekeeper and expediter							
10. Standard setter or ego ideal							
11. Follower							

OBSERVATION OF THE FORMATIVE STAGE OF PROJECT GROUP DEVELOPMENT

Exercise developed by:

Cogan, T. & Beck, A., Counseling Center, Illinois Institute of Technology, 1975.

Goals

I. To carefully observe the behavior of students and faculty in the formative stage of a project group.

II. To observe a group in relation to specific concerns and questions.

III. To facilitate a self-reflective analysis of commonly used practices in starting project groups.

IV. To heighten awareness of leadership impact on formative group process.

Group Size

Any number of groups can be formed, composed of 4-6 participants and 3-5 observers. Each should work in a separate room.

Time Required

One and a half to two hours.

Materials Utilized

I. Sign-up sheets listing project topics

II. Observation questions, pens or pencils for observers.

Process

Each person signs up for a particular project group if he wishes to participate. Those interested in observing choose the group they wish to observe. Each group has both faculty and student members as participants, simulating an actual E^3 project. Each group meets and works on developing a project group focused on the particular problem they chose. They work for 45 minutes. The observers take notes on their observations of the issues raised by the questions given to them at the start of the meeting. The observers give the participants feedback on the group process in terms of their observations. It is best if the group participants have an opportunity to discuss each question as well, taking them one at a time.

Observation Questions

1. Did the group deal with the need for "temporary" leadership just to get themselves initially organized?

    a. What method did they use to get started?

    b. If they didn't choose a temporary leader was there competition regarding that issue?

2. Did the group encourage each member to talk about why he wants to be in this project and what he needs to get done there?

3. Did the group assess the resources it already has in its members, especially resources relevant to this project?

4. How did the group deal with defining or clarifying what the project problem should be?

5. Did you observe particular people taking particular roles in this discussion? What were their characteristic inputs to the interaction?

Project A

Sign-up Sheet

Further develop the artistic/aesthetic experience and the mechanical effectiveness of kite flying.

Participants

1.

2.

3.

4.

5.

6.

Group Observation

Project B

Sign-up Sheet

Develop a recreational device to amuse and enhance a five year old child for a cost not to exceed $10.00.

Participants

1.

2.

3.

4.

5.

6.

Project C

Sign-up Sheet

Waking up and getting up in the morning is hard for most people. Develop a way to improve the experience and efficiency of doing that.

Participants

1.

2.

3.

4.

5.

6.

OBSERVING ROLE DIFFERENTIATION

Exercise developed by:

Beck, A.P. Counseling Center, Illinois Institute of Technology, 1976.

Goal

To create the opportunity to observe the process of role differentiation in a task group.

Group Size

This observational method is intended to be used by six observers, while a group of six other persons are participating in another exercise, such as the Bomb Shelter exercise.

Time Required

Depends on the exercise chosen. A minimum of forty-five minutes is needed.

Materials Utilized

I. Three lists of the roles to be observed: Task Roles; Building and Maintenance Roles; and, Individual Roles. These are taken from Chapter 2, on Group Member Roles.

II. Observation Tally Sheets

III. Blackboard or newsprint pad on which to display summary tallies.

Physical setting

Observers should be seated in an outer circle, so that they can easily see and hear the group participants whose behavior they are observing.

Process

I. The facilitator invites six persons to act as observers of six participants in another exercise.

II. The observers are taken aside and given a short description of the observation categories (they should have read Chapter 2 prior to this experience).

III. Each observer is asked to observe three participants and to categorize each of their statements in terms of the roles which he is observing.

IV. Each observer uses only one of the lists of roles (Task: Building and Maintenance; Individual) to make his observations. These assignments are made and observers read their respective lists.

V. The Observation Tally Sheets are distributed. They have three columns, one for each person being observed.

VI. The observer will categorize the participants' statements whenever they can reasonably be described by the set of categories on his particular list. The observer writes down the number of the category in the column for that participant.

VII. The participants are asked to take their seats in a circle.

VIII. The observers are asked to take their seats in an outer circle, so that they are able to see three participants clearly.

IX. Each observer is assigned to observe three specific participants at this point.

X. After forty-five minutes the exercise is ended and the observers are asked to add up the number of observations in each category for each participant. They must also get a raw total of all observations for each participant, i.e. gross member of observations made using their list.

XI. A table is written on the blackboard or newsprint pad showing the raw total for each participant on each list.

XII. The person receiving the highest number on task roles, is considered the task leader. The person receiving the highest number on building and maintenance roles is considered the emotional leader. The person receiving the highest number on individual roles is considered the scapegoat.

XIII. The entire group discusses the results of the raw total.

XIV. Each observer then gives each participant specific feedback on the way in which his behavior was categorized in each of the three areas.

Role Differentiation

TASK ROLES

Member Behavior Required for Doing Group Work

1. Initiator: Proposing tasks or goals; defining a group problem; suggesting a procedure or ideas for solving a problem...	
2. Information-seekers: Requesting facts; seeking relevant information about a group concern...	
3. Information-giver: Offering facts: providing relevant information about group concern...	
4. Opinion-seeker: Asking for expressions of feeling; requesting a statement of estimate; soliciting expressions of value; seeking suggestions and ideas...	
5. Opinion-giver: stating a belief about a matter before the group; giving suggestions and ideas...	
6. Clarifier: Interpreting ideas or suggestions; clearing up confusions; defining terms; indicating alternatives and issues before the group...	
7. Elaborator: Giving examples; developing meanings; making generalizations; indicating how a proposal might work-out, if adopted...	
8. Summarizer: Pulling together related ideas; restating suggestions after group has discussed them; offering a decision or conclusion for the group to accept or reject...	

BUILDING AND MAINTAINANCE ROLES

Member behavior required for building and maintaining the group as a working unit.

1. Encourager: Being friendly, warm and responsive to others; accepting others and their contributions; regarding others by giving them an opportunity or recognition...	
2. Feeling-expresser: Sending and expressing the feeling of the group; calling attention to reactions of group to ideas and suggestions; sharing his own feeling or affect with other members...	
3. Harmonizer: Attempting to reconcile disagreements; reducing tension through "pouring oil on troubled waters": getting people to explore their differences...	
4. Compromiser: When his own idea or status is involved in a conflict, offering compromise yielding status, admitting error disciplining himself to maintain group cohesion...	
5. Gate-keeper: Attempting to keep communication channels open; facilitating the participation of others; suggesting procedures for sharing opportunity to discuss group problems...	
6. Standard-setter: Expressing standards for group to achieve; applying standards in evaluating group functioning & production...	
7. Consensus-tester: Asking for opinions to find out if group is nearing a decision; sending up a trial balloon to test a possible group conclusion...	
8. Follower: Going along with movement of the group; accepting ideas of others; serving as an interested audience...	

"INDIVIDUAL ROLES"

Types of Non-functional Behavior

1. Aggressor: Deflates the status of others, expresses disapproval of their values, or behavior, attacks the group or the problem being worked on, shows envy of others by trying to take credit, etc....	
2. Blocker: Resists stubbornly, disagrees unreasonably, attempts to maintain or bring back an issue after the group indicates it wants to go on...	
3. Recognition-seeker: Manipulates to focus on self by boasting, reporting on personal achievements, struggling to prevent his being placed in an "Inferior" position, etc....	
4. Self-confessor: Uses the audience opportunity which the group provides to express personal, non-group oriented, "feeling", "insight" etc....	
5. Playboy: Makes a display of his lack of involvement in the group process by such forms as cynicism, nonchalance, horseplay, etc....	
6. Dominator: Tries to assert authority or superiority in manipulating the group (or certain members). May use flattery, assert a superior status or right to attention, give directions, thoughtlessly interrupt others, etc....	
7. Help-seeker: Tries to get "sympathy" from others, expresses insecurity, personal confusion or extra self depreciation...	
8. Special interest pleader: Speaks for the "small business man", the "grass roots" community, the "housewife" "Labor" etc. Cloaking his own prejudices or biases in a stereotype.	

OBSERVATION TALLY SHEETS

NAME	NAME	NAME

CHOOSING A COLOR

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 1) Iowa City: University Associates Press, 1970, pp. 59-64.

Goals

I. Learning to deal with the power vacuum created by the lack of specific directions.

II. Understanding shared leadership through role-playing.

Group Size

This exercise is designed for seven to ten participants. Several groups may be directed simultaneously.

Time Required

Thirty minutes

Materials Utilized

I. Envelope 1: Providing directions for group's task and seven to ten envelopes containing individual directions for role and position.

II. Envelope 2: Directions and group task

III. Envelope 3: Directions and group task

IV. Large envelope containing first three envelopes

V. Description of roles to be played

Physical Setting

Groups are seated in a circle.

Process

I. The participants are introduced to role-palying. The facilitator may want to use a fantasy exercise for warm-up. The following roles are explained (see Chapter 2):

A. Information-seeking

B. Tension-relieving

C. Clarifying

D. Gate-keeping

E. Initiating

F. Following

G. Information-giving

H. Harmonizing

II. The facilitator discusses the concept of shared leadership.

III. The facilitator places the large envelope containing the instruction envelopes in the center of the group with <u>no further instructions or information</u>.

Instructions written on the large envelope which contains all other envelopes:

Enclosed you will find three envelopes which contain directions for the phases of this group session. You are to open the first one (labeled I) at once. Subsequent instructions will tell you when to open the second (labeled II) and third (labeled III) envelopes.

Envelope I will contain the following directions on a separate sheet:

Directions for Envelope I

Time Allowed: 15 minutes

Special Instructions: Each member is to take one of the white envelopes and follow the individual instructions contained in it.

Task: The group is to choose a color.

DO NOT LET ANYONE ELSE SEE YOUR INSTRUCTIONS!

(After fifteen minutes go on to the next envelope)

Envelope II will contain the following directions on a separate sheet:

Directions for Envelope II

Time Allowed: 5 minutes

Task: You are to choose a group chairman.

(After five minutes go on to the next envelope)

Envelope III will contain the following directions on a separate sheet:

Time Allowed: 10 minutes

Task: You are to evaluate the first phase of this group session.

Special Instructions: The newly-selected chairman will lead this discussion.

Sample questions:

1) What behavior was effective in promoting the purposes assigned to individuals?

2) What behavior was harmful to promoting the purposes assigned to individuals?

(After ten minutes return the directions to their respective envelopes)

Individual Instruction Envelopes For Phase I

Each envelope will contain instructions for role and position. Two of the instructions will include special knowledge. The information will be given on a card in this manner:

1.
Role: Information-seeking
Position: Support Blue

The following roles, positions, and special information will be assigned in the following order:

---

1. Role: Information-seeking

   Position: support blue

---

2. Role: Tension-relieving

   Position: introduce the idea of a different color -- orange

---

3. Role: Clarifying

   Position: support red

---

4. Role: none

   Position: none

   (You have the special knowledge that the group is going to be asked to select a chairman later in the exercise; you are to conduct yourself in such a manner that they will select you as chairman.)

---

5. Role: Gate-keeping

   Position: against red

Individual Instruction Envelopes (Con't)

6. Role: Initiating

   Position: support green

---

7. Role: none

   Position: none

   (You have the special knowledge that the group is going to be asked to select a chairman later in the exercise; you are to conduct yourself in such a manner that they will select you as chairman.)

---

8. Role: Following

   Position: against red

---

9. Role: Information-giving

   Position: against blue

---

10. Role: Harmonizing

   Position: against green

If there are fewer than ten participants in the group, simply eliminate as many of the last three roles and positions as are necessary. There must be at least seven people in the room.

PERSONAL PROBLEM IDENTIFICATION

Exercise from:

Underys, A., E^3 Program, Illinois Institute of Technology, 1975.

Goals

To use the group setting to identify personal problems.

Group Size

Any number of triads

Time Required

Approximately one hour

Materials Utilized

I. Pencils and paper

II. Handout: "Roadblocks to Communication"

Physical Setting

Participants should be seated in groups of three. Size of the room, and the tolerance of the participants for noise will determine how many groups per room.

Process

I. Approximately 10 minutes. Every person will identify a vague feeling of uneasiness, tension and the specific incidents that cause these feelings. List the specific incidents.

II. Approximately 10 minutes per person (30 min. per whole triad). A member of the triad will communicate his feelings (uneasiness, tension) and the specific incidents that seem to cause these feelings. Then the other two members will attempt to find common characteristics in those specific incidents. After 10 minutes the process is repeated again with the third member.

III. Approximately 10 minutes total time. Each member will give feedback to the other two members of the triad. The feedback will relate the similarities and differences in the three persons' experiences.

IV. Approximately 5 minutes. Wrap up the exercise. Bring up the point that each individual can now formulate the problem which causes his uneasy feelings, incorporating or ignoring the feedback given to him. Each member hopefully realizes the problem as such, and not as vague feelings of uneasiness or tension, and can therefore more readily take steps to solve the problem.

ROADBLOCKS TO COMMUNICATION *

(the following are examples of statements in each category listed)

1. Ordering -

"You have to do it, and do it now."
"You're not Johnny, so you do what I say."
"Don't you ever talk to me like that again."

2. Threatening -

"If you talk to me like that again, you'll be grounded."
"If you know what's good for you, you'll stop."

3. Moralizing - (using "shoulds" or "oughts")

"You shouldn't feel that way."
"It was okay for me when I was a kid so its okay for you too."

"Do unto others as you would have them do unto you."
"Boys aren't supposed to cry."

4. Advising - (telling persons what to do to solve their problems)

"If you study harder, it will be easier."
"Why don't you find something to play with?"
"If you would share, that wouldn't happen."

5. Logical Arguments - (teaching or lecturing)

"You have to study or you won't pass."
"It's important to get good grades or you won't get a job."
"If you don't go to church, you'll go to hell."

6. Criticizing - (making negative judging or evaluation)

"You're all mixed up."
"You've got the facts confused."
"I think you're all wrong."

7. Praising - (building assets to manipulate)

"I think you're okay."
"I like you the way you are."

8. Name-calling - (putting person into category - demeaning, labeling)

"You're a snot."
"You're a delinquent."

*from Miller, Strasser, & Zent, 1974.

9. Interpreting - (reading into the motives of a person)

"You're just doing that to bother me."
"You're doing it cause your friends are."
"You're just feeling sorry for yourself."

10. Reassuring - (trying to make a person's feelings go away)

"I will be okay by tomorrow."
"Ah, it really doesn't hurt."
"You'll get over it."

11. Probing - (questioning for your own benefit not the other person's)

"What did you do to him to make him hit you?"
"What makes you feel that way?"
"Do your friends feel like that?"

12. Diverting - (getting the person away from the problem)

"Put it out of your mind."
"Let's talk about something else."
"Don't worry about it."

EFFECTS OF THESE MESSAGES*

Effects of these messages on the child:

The child may feel:

"My feelings don't count."
"Nobody listens to me."
"They think I'm doing something wrong."
"I'm not okay, I'm supposed to change."
"I'm not supposed to feel this way."

Effects of these messages on parents:

"They turn me off and make me angry."
"I want to fight back."
"I'm not about to listen to any suggestions."
"I feel bad enough without being criticized."
"I need someone to listen not preach or advise."
"I'm grown up, don't treat me like a child."

*from Gordon, 1970.

References

Gordon, T. Parent effectiveness training. New York: Peter W. Wyden, 1970.

Miller, J., Strasser, J., & Zent, K. Communication skills training. Marquette-Alger Intermediate School Districts, 1974.

PROCESS OBSERVATION GUIDES (I)

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 2) Iowa City: University Associates Press, 1970, pp. 71-74.

Goals

I. To practice observing small group process

II. To gain experience in feeding back process observation to a group

III. To provide behavioral feedback to a group concerning its own functioning

Materials Utilized

I. Self-Oriented Behavior Schedule

II. Interaction-Oriented Behavior Schedule

III. Task-Oriented Behavior Schedule

Process

Participants take turns using the three process observation guides while the group is engaged in working on tasks, such as "Consensus-Seeking", 109; and "Problem-Solving", 114. The observers do not participate in the meeting but record their observations as they make them. At the end of the work period the observers make oral reports and may lead the discussion of the functioning of the group in the task situation. The facilitator may steer the discussion toward consideration of Bass' theory of personality orientations. The Orientation Inventory (Bass, 1962) might be administered, scored, interpreted and shared within the group.

Reference:

Bass, B.M. Manual for the Orientation Inventory. Palo Alto, Cal.: Consulting Psychologists Press, Inc., 1962.

Process Observation (1)

Self-Oriented Behavior Schedule

1. What behaviors seem more oriented toward meeting individual members' needs rather than helping the group to accomplish the task? (Examples -- dominating the discussion, cutting off others, horsing around, not listening, being overly aggressive, nitpicking, smoothing over arguments, avoiding responsibility, etc.)

Who Did It?	What Did He Do?

2. What were the effects of the self-oriented behaviors which you observed?

Process Observation (I)

Interaction-Oriented Behavior Schedule

1. What behaviors appear to be aimed toward helping group members to interact with each other effectively? (Examples -- keeping members involved, harmonizing disagreements, reinforcing good contributions, relieving tension, encouraging cooperation, etc.)

Who Did It?	What Did He Do?

2. What were the effects of the interaction-oriented behaviors which you observed?

Process Observation (I)

Task-Oriented Behavior Schedule

1. What behaviors were focused on attempting to accomplish the group's task? (Examples -- getting things started, sharing information, organizing, giving opinions, clarifying, summarizing, checking-out consensus, etc.)

Who Did It?	What Did He Do?

2. What were the effects of the task-oriented behaviors which you observed?

PROCESS OBSERVATION: A GUIDE (II)

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 1) Iowa City: University Associates Press, 1970, pp. 48-50.

Goals

I. To provide feedback to a group concerning its process.

II. To provide experience for group members in observing process variables in group meetings.

Materials Utilized

Group Process Observer Report Form

Process

Participants take turns as process observers -- a different observer for each meeting. The observer does not participate in the meeting but records his impressions on the report form. At the end of the meeting the observer makes an oral report of the process he saw, and his report is disucssed. It is helpful for the first observer to have had some experience and for the participants to see a copy of the form while he is reporting.

Group Process Observer Report Form

Group Meeting____

Interpersonal Communication Skills

1. Expressing (verbal and nonverbal)

2. Listening

3. Responding

Communication Pattern

4. Directionality (one-to-one, one-to-group, all through a leader, etc.)

5. Content (cognitive, affective)

Leadership

6. Major roles (record names)

_____________Information processor   _____________Follower

_____________Coordinator   _____________Blocker

_____________Evaluator   _____________Recognition Seeker

_____________Harmonizer   _____________Dominator

_____________Gate-keeper   _____________Avoider

7. Leadership style

___________Democratic   _______Autocratic   _______Laissez-faire

8. Leadership effects

____Eager participation   ____Low commitment   ____Resisting

____Lack of enthusiasm   ____Holding back

Group Process Observer Form (Con't)

Climate

9. Feeling tone of the meeting

10. Cohesiveness

Goals

11. Explicitness

12. Commitment to agreed upon goals

Situational Variables

13. Group size

14. Time limit

15. Physical facilities

Group Development

16. Stage of development

17. Rate of development

Observer Reaction

18. Feelings experienced during the observation

19. Feelings "here and now"

20. Hunches, speculations, ideas, etc., about the process observed

PROBLEM IDENTIFICATION IN E^3 PROJECTS

Exercise developed by:

Beck, A., & Shiel, T. Counseling Center, Illinois Institute of Technology, 1975. Utilizing Kepner and Tregoe model for rational problem solving in The Rational Manager, New York: McGraw-Hill, 1965.

Goals

I. Help students become familiar with using a rational model for problem solving.

II. Relate the problems in E^3 project groups to the theoretical materials presented in the seminar.

III. Create an atmosphere conducive to bringing up E^3 project problems in order to help participants learn from each other and, also, provide possible alternative solutions.

Time Required

Approximately one to one and a half hours.

Materials

Problem Identification Worksheet

Process

The Problem Identification Worksheet is handed out along with the Problem Identification Chapter (4). Participants do the assignment prior to coming to the following seminar. Discussion at the seminar will revolve around problems and problem identification in E^3 project groups and the assignment will be the catalyst for the discussion.

Problem Identification

For next week's seminar we plan to have a discussion about problem identification as it has been pursued in the current E^3 project groups. Listed below are the steps in problem identification and resolution as outlined in Chapter 4. Please think about the current project group in which you participate and analyze the group's process of problem identification.

Write notes on your own project group in terms of the items below. You may of course find that they skipped certain steps. If you are involved in more than one group, use your proposal group as the example.

1. Isolation of a problem area of situation

2. Identification of a problem; determination of dimensions of problem

   a. when b. where c. how d. what e. why

3. Statement of problem and ordering of priorities in relation to problem

4. Statement of objectives in order of priority

5. Development of alternative solutions or interventions

6. Evaluation of alternatives against stated priorities

7. Decisions on an alternative (tentative)

   a. Develop procedures for implementation
   b. Alternative must be congruent with all objectives

8. Exploration of chosen alternative to determine future adverse consequences of a) problem and b) intervention

9. Control of intervention; plan for possible adverse consequences of problem resolution

10. Insurance of action on decision

11. Revert to management model cycle; plan, organize-control

NASA EXERCISE: SEEKING CONSENSUS

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 1). Iowa City: University Associates Press, 1970, pp. 52-57.

Goals

I. To compare the results of individual decision-making with the results of group decision making.

II. To diagnose the level of development of a task-oriented group.

Group Size

Between six and twleve participants. Several groups may be directed simultaneously.

Time Required

Approximately one hour

Materials Utilized

I. Pencils

II. Individual work sheets

III. Group work sheets

IV. Answer sheets containing rationale for decisions

V. Direction sheets for scoring

Physical Setting

Participants should be seated around a square or round table. The dynamics of a group seated at a rectangular table are such that it gives too much control to persons seated at the ends.

Process

I. Each participant is given a copy of the individual work sheet and told that he has fifteen minutes to complete the exercise.

II. One group work sheet is handed to each group.

   A. Individuals are not to change any answers on their individual sheets as a result of group discussion.

   B. A member of the group is to record group consensus on this sheet.

C. The participants will have thirty minutes in which to complete the group work sheet.

III. Each participant is given a copy of the direction sheet for scoring. This phase of the experience should take seven to ten minutes.

A. They are to score their individual work sheets.

B. They will then give their score to the recorder, who will compute the average of the individual scores.

C. The recorder will then score the group work sheet.

IV. The group will compute the average score for individuals with the group score and discuss the implications of the experience. This phase of the experience should take seven to ten minutes.

V. Results are posted according to the chart below, and the facilitator directs a discussion of the outcomes of the consensus-seeking and the experience of negotiating agreement.

	Group 1	Group 2	Group 3
Consensus Score			
Average Score			
Range of Individual Scores			

NASA Exercise Individual Worksheet

INSTRUCTIONS: You are a member of a space crew originally scheduled to rendezvous with a mother ship on the lighted surface of the moon. Due to mechanical difficulties, however, your ship was forced to land at a spot some 200 miles from the rendezvous point. During the landing, much of the equipment aboard was damaged and, since survival depends on reaching the mother ship, the most critical items available must be chosen for the 200 mile trip. Below are listed the 15 items left intact and undamaged after landing. Your task is to rank order them in terms of their importance to your crew in allowing them to reach the rendezvous point. Place the number 1 by the most important item, the number 2 by the second most important, and so on, through number 15, the lease important. You have 15 minutes to complete this phase of the exercise.

________Box of matches

________Food concentrate

________50 feet of nylon rope

________Parachute silk

________Portable heating unit

________Two .45 calibre pistols

________One case dehydrated Pet Milk

________Two 100-lb. tanks of oxygen

________Stellar map (of the moon's constellation)

________Life raft

________Magnetic compass

________5 gallons of water

________Signal flares

________First aid kit containing injection needle

________Solar-powered FM receiver-transmitter

NASA Exercise Group Worksheet

INSTRUCTIONS: This is an exercise in group decision-making. Your group is to employ the method of Group Consensus in reaching its decision. This means that the prediction for each of the 15 survival items must be agreed upon by each group member before it becomes a part of the group decision. Consensus is difficult to reach. Therefore, not every ranking will meet with everyone's complete approval. Try, as a group, to make each ranking one with which all group members can at least partially agree. Here are some guides to use in reaching consensus:

1. Avoid arguing for your own individual judgments. Approach the task on the basis of logic.

2. Avoid changing your mind only in order to reach agreement and avoid conflict. Support only solutions with which you are able to agree somewhat, at least.

3. Avoid "conflict-reducing" techniques such as majority vote, averaging, or trading in reaching your decision.

4. View differences of opinion as helpful rather than as a hindrance in decision-making.

________Box of matches

________Food concentrate

________50 feet of nylon rope

________Parachute silk

________Portable heating unit

________Two .45 calibre pistols

________One case dehydrated Pet milk

________Two 100-lb. tanks of oxygen

________Stellar map (of moon's constellation)

________Life raft

________Magnetic compass

________5 gallons of water

NASA

________Signal flares

________First aid kit containing injection needles

________Solar-powered FM receiver-transmitter

NASA Exercise Answer Sheet

RATIONALE:

No oxygen	15	Box of matches
Can live for some time without food	4	Food concentrate
For travel over rough terrain	6	50 feet of nylon rope
Carrying	8	Parachute silk
Lighted side of moon is hot	13	Portable heating unit
Some use for propulsion	11	Two .45 calibre pistols
Needs H_2O to work	12	One case dehydrated Pet Milk
No air on moon	1	Two 100-lb. tanks of oxygen
Needed for navigation	3	Stellar map (of moon's constellati[illegible]
Some value for shelter or carrying	9	Life raft
Moon's magnetic field is different from earth's	14	Magnetic Compass
You can't life long without this	2	5 gallons of water
No oxygen	10	Signal flares
First aid kit might be needed but needles are useless	7	First aid kit containing injection needles
Communication	5	Solar-powered FM receiver transmitter

NASA Exercise Direction Sheet for Scoring

The group recorder will assume the responsibility for directing the scoring. Individuals will:

1. Score the net difference between their answers and correct answers. For example, if the answer was 9, and the correct answer was 12, the net difference is 3. Three becomes the score for that particular item.

2. Total these scores for an individual score.

3. Next, total all individual scores and divide by the number of participants to arrive at an average individual score.

4. Score the net difference between group worksheet answers and the correct answers.

5. Total these scores for a group score.

6. Compare the average individual score with the group score.

Ratings:

0 -	20	Excellent
20 -	30	Good
30 -	40	Average
40 -	50	Fair
over	50	Poor

BROKEN SQUARES

Exercise from:

Pfeiffer, J. W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 1). Iowa City: University Associates Press, 1970, pp. 24-29.

Goals

I. To analyze certain aspects of cooperation in solving a group problem.

II. To sensitize the participants to some of their own behaviors which may contribute toward or obstruct the solving of a group problem.

Group Size

Any number of groups of six participants each. There will be five participants and an observer/judge.

Time Required

Fifteen minutes for the exercise and fifteen minutes for discussion.

Materials Utilized

I. Chalkboard, chalk, eraser

II. Tables that will seat five participants each

III. One set of instructions for each group of five participants and one set for the observer/judge

IV. One set of broken squares for each group of five participants.

Physical Setting

Tables should be spaced far enough apart so that the various groups cannot observe the activities of the other groups.

Process

The facilitator may wish to begin with a discussion of the meaning of cooperation; this should lead to suggestions by the groups of what is essential in successful group cooperation. These may be listed on the board, and the facilitator may introduce the exercise by indicating that the groups will conduct an experiment to test their suggestions. Basic suggestions which the facilitator may want to bring out of the groups are as follows:

1. Each individual must understand the total problem.

2. Each individual should understand how he can contribute toward solving the problem.

3. Each individual should be aware of the potential contributions of other individuals.

4. There is a need to recognize the problems of other individuals in order to aid them in making their maximum contribution.

Instructions are as follows:

A. When the preliminary discussion is finished, the facilitator chooses an observer/judge for each group of five participants. These observers are given a copy of their instructions. The facilitator then asks each group to distribute the envelopes from the prepared packets. The envelopes are to remain unopened until the signal to work is given.

B. The facilitator distributes a copy of the instructions to each group.

C. The facilitator then reads the instructions to the group, calling for questions or questioning groups as to their understanding of the instructions. It will be necessary for the facilitator or his assistants to monitor the tables during the exercise to enforce the rules which have been established during the instructions.

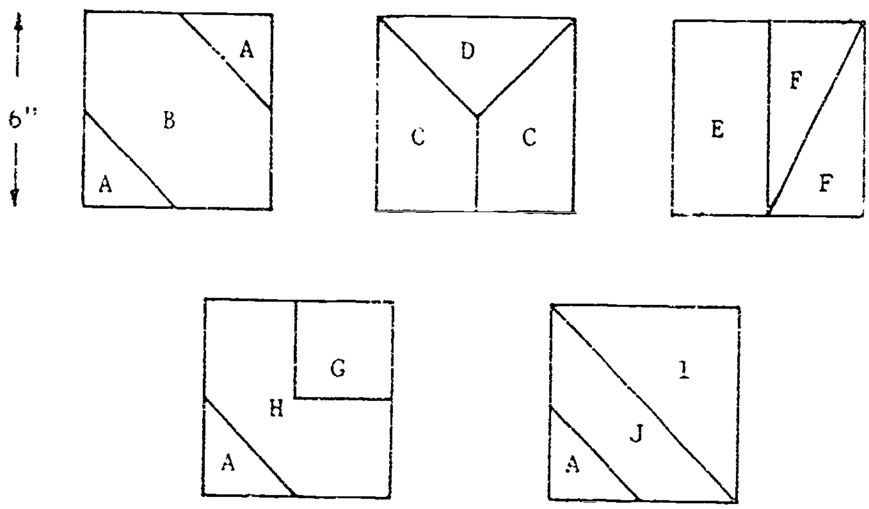
D. When all the groups have completed the task, the facilitator will engage the groups in a discussion of the experience. Discussion should focus on feelings more than merely relating experiences and general observations. Observations are solicited from the observer/judges. The facilitator may want the groups to relate this experience with their "back home" situations.

Broken Squares

Directions for Making a Set of Squares

A set consists of five envelopes containing pieces of cardboard which have been cut into different patterns and which, when properly arranged, will form five squares of equal size. One set should be provided for each group of five persons.

To prepare a set, cut out five cardboard squares of equal size, approximately six-by-six inches. Place the squares in a row and mark them as below, penciling the letters a, b, c, etc., lightly, so that they can later be erased.



The lines should be drawn so that, when cut out, all pieces marked a will be of exactly the same size, all pieces marked c of the same size, etc. By using multiples of three inches, several combinations will be possible that will enable participants to form one or two squares, but only one combination is possible that will form five squares six-by-six inches.

After drawing the lines on the six-by-six inch squares and labeling them with lower case letters, cut each square as marked into smaller pieces to make the parts of the puzzle.

Mark the five envelopes A, B, C, D, and E. Distribute the cardboard pieces in the five envelopes as follows:

Envelope	A has pieces	i, h, e
	B	a, a, a, c
	C	a, j
	D	d, f
	E	g, b, f, c

Instructions to the Group

In this packet there are five envelopes, each of which contains pieces of cardboard for forming squares. When the facilitator gives the signal to begin, the task of your group is to form five squares of equal size. The task will not be completed until each individual has before him a perfect square of the same size as that held by others.

Specific limitations are imposed upon your group during this exercise.

1. No member may speak.

2. No member may ask another member for a card or in any way signal that another person is to give him a card.

3. Members may, however, give cards to other members.

Are the instructions clear? (Questions are answered)

Facilitator gives signal, "Begin working."

Broken Squares

Instructions to the Observer/Judge

Observer:

Your job is part observer and part judge. Make sure each participant observes the rules:

1. No talking, pointing, or any other kind of communicating among the five people in your group.

2. Participants may give pieces to other participants but may not take pieces from other members.

3. Participants may not simply throw their pieces into the center for others to take; they have to give the pieces directly to one individual.

4. It is permissible for a member to give away all the pieces to his puzzle, even if he has already formed a square.

Do your best to strictly enforce these rules.

As an observer, you may want to look for some of the following:

1. Who is willing to give away pieces of the puzzle?

2. Did anyone finish his puzzle and then somewhat divorce himself from the struggles of the rest of the group?

3. Is there anyone who continually struggles with his pieces but yet is unwilling to give any or all of them away?

4. How many people are actively engaged in mentally putting the pieces together?

5. Periodically check the level of frustration and anxiety -- who's pulling his hair out?

6. Was there any critical turning point at which time the group began to cooperate?

7. Did anyone try to violate the rules by talking or pointing as a means of helping fellow members solve their puzzle?

BOMB SHELTER EXERCISE

Adapted from:

Gum, May. Exercises for High School. Mimeograph.

Goals

I. To compare and contrast individual and group problem solving issues.

II. To emphasize the relationship between group dynamics (leadership style, individual roles and communication issues) and efficient productivity in groups.

III. To review some of the inherent difficulties involved in task oriented groups.

Group Size

Class size, as long as group can be directed into smaller groups of 5 to 6 people.

Time Required

One to one and a half hours.

Materials Utilized

I. Bomb Shelter Exercise (directions for group leader)

II. Bomb Shelter - Instructions and Rating Forms (enough copies for each member)

Process

I. Facilitator gives out Bomb Shelter - Instructions and Rating form to each participant. After individual decisions have been made, the larger group will be divided into smaller groups of 5-6 people. Facilitator will give instructions to small groups.

II. Facilitator will lead discussion and follow the guidance of suggested questions.

Bomb Shelter Exercise (directions for group leader)

Give each person a copy of the instructions, rating form and role descriptions. Allow approximately five minutes for each to read roles and make individual decisions on five people to be allowed into the shelter. Have them use the instructions and individual rating column on the rating form.

When everyone has made their individual decisions, divide the group into smaller groups of 5-6 people.

Instructions to small groups:

Reach consensus on the five people to be allowed into the bomb shelter. As the radiation will reach the psychologist's home soon, you have only 20 minutes to reach your common decision. Warn the groups when 15 minutes have passed. At the end of 20 minutes ask each group to share their decisions with the rest of the group.

Suggested questions for discussion:

How did your group reach consensus?

Did your group waste much time getting organized?

Did a leader emerge in your group?

Was reaching consensus difficult?

Did the group decision differ much from individual ratings?

Bomb Shelter - Instructions and Rating Form

A psychologist is having some friends over for the evening and after they get there the radio announces that an H bomb has been dropped and that in 20 minutes the effects will reach the psychologist's home. They announce that in order to live people must spend at least 60 days in a bomb shelter. It must be remembered that bomb shelters must not be overfilled or everyone in them will die.

The psychologist happens to have a bomb shelter that will support five people for the time required, but, with any more than five, the water and air cleaning systems would break down and all would die.

The group decides to have a discussion to decide who will get to live and who will not be allowed in the shelter. They agree that they will not use violence to decide, but by discussing it and voting it will be decided in 20 minutes who will get to be in the shelter.

Rate the following with this idea in mind: Put a

1 Before the letter of the person who should most definitely be in the shelter

2 Before the person who has the next best right to be in the shelter.

3 " " " " " " " " " " " " " " .

4 " " " " " " " " " " " " " " .

5 " " " " " " " " " " " " " " .

Individual Rating	Group Rating	
__________	__________	A. Dr. Williams
__________	__________	B. Mrs. Jones
__________	__________	C. Mr. Rando
__________	__________	D. Mrs. Marsh
__________	__________	E. Rev. Winston
__________	__________	F. Miss Lewis
__________	__________	G. Mr. Jacob
__________	__________	H. Mrs. Walsh
__________	__________	I. The psychologist who owns it.

Bomb Shelter

A. DR. ROSCOE WILLIAMS is a medical doctor. He finished going to school three years ago and has been working in a surgery part of a hospital since he finished school. He is 34 years old, has been in the Marines, but was discharged when he got shot in the leg, causing him to limp.

B. MRS. JENNIFER JONES 28 years old, a married woman who has had two healthy children. Her hobby is fixing fresh foods so they will not spoil for a long time. She is also very good at sewing things.

C. MR. ADAM RANDO is a joker who is 41 years old. Everyone likes him because he is always able to be fun when someone is feeling bad. Adam can always make them feel good again. He's a fat man who gets tired sort of easy.

D. MRS. MARILYN MARSH a school teacher who has taught all of the first four grades of elementary school. Is 30 years old and in very good health. She does wear eye glasses and can't see without them.

E. REV. RALPH WINSTON pastor of the church that these people attend. Has gone to college to study about the way people live, is 35 years old, married.

F. MISS JACKIE LEWIS is a young, attractive woman, 19 years old. She finished high school but it was hard for her to do it. Since then she has learned how to fix people's hair and she is working as a beauty operator in a beauty shop. She is healthy, but she is very "picky" about what foods she eats. She refuses to eat many foods.

G. MR. JOHN JACOB is a 23 year old athlete; he is a football player, but he is also a guy who likes to build things. He's built his own home almost from the bare beginning.

H. MRS. ERNESTINE WALSH is a very unusual woman because she is a woman who knows all about science. She is 28 years old, but she never really dresses nice or fixes her hair and face so she doesn't look very good. She really knows a lot about science, though, like how to build air cleaning and water cleaning systems, not to mention all she knows about electricity.

I. MR. JOHN JOSEPH A psychologist who has invited the above people to his house for a discussion of neighborhood problems. He is the only one in the neighborhood who owns a bomb shelter, which would protect people for 2½ months. It's maximum safe capacity is five.

CONSENSUS-SEEKING: A GROUP RANKING TASK

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training (Vol. 2). Iowa City: University Associates Press, 1970, pp. 22-24.

Goals

I. To compare the results of individual decision-making with decisions made by groups.

II. To generate data to discuss decision-making patterns with task groups.

Group Size

Between six and twelve participants. Several groups may be directed simultaneously in the same room.

Time Required

Approximately one hour

Materials Utilized

I. Pencils

II. Occupational Prestige Ranking Worksheets

Physical Setting

Participants should be seated around a table. If there are no tables available, lapboards may be provided.

Process

I. Each participant is given a copy of the worksheet and is told that he has seven minutes to complete the task. He must work independently during this phase.

II. After seven minutes, the facilitator interrupts to announce that a ranking must be made by the total group, using the method of group consensus. The ranking of each occupation must be agreed upon by each member before it becomes a part of the group's decision. Members should try to make each ranking one with which all members agree at least partially. Two ground rules: no averaging, and no "majority rule" votes. The group has thirty minutes to complete its task.

III. After thirty minutes of group work (or when the group has finished, if less than thirty minutes), the facilitator should announce the "correct" ranking.* Individual group members should "score" their worksheets by adding up the differences between their ranks and the key, regardless of sign. That is, make all differences positive and sum them. Low scores, of course, are better than high ones. Someone should score the group ranking also.

The key:

1. U.S. Supreme Court Justice
2. Physician
3. Scientist
4. State governor
5. College professor
6. Lawyer
7. Dentist
8. Psychologist
9. Banker
10. Sociologist
11. Public school teacher
12. Author of novels
13. Undertaker
14. Newspaper columnist
15. Policeman

IV. The group should compute the average score of the individual members, compare this with the group's score, and discuss the implications of the experience. This processing might be focused on leadership, compromise, decision-making strategies, the feeling content of the exercise, roles members played, or other aspects of group life.

*Based on NORC prestige scores from: Hodge, R.W., Siegel, P.M. & Rossi, P.H. Occupational Prestige in the United States, 1925-1963. In R. Bendix & S. M. Lipset (Eds.), Class, Status and Power (2nd ed.). New York: The FREE Press, 1966.

Consensus-Seeking

Occupational Prestige Ranking Worksheet

Instructions: Rank the following occupations according to the prestige which is attached to them in the United States. Place a "1" in front of the occuaption which you feel to be most prestigious etc., all the way to "15", least prestigious.

_____ Author of novels

_____ Newspaper columnist

_____ Policeman

_____ Banker

_____ U.S. Supreme Court Justice

_____ Lawyer

_____ Undertaker

_____ State governor

_____ Sociologist

_____ Scientist

_____ Public school teacher

_____ Dentist

_____ Psychologist

_____ College Professor

_____ Physician

CREATING AND OBSERVING GROUP PROCESS

Exercise developed by:

Spanier, R., E^3 Program, Illinois Institute of Technology, 1975.

Goals

I. To simulate an E^3 project group and give it a task to perform

II. To help observers and participants to experience group processes and then conceptualize the relationship between orientation, evaluation and control.

Group Size

At least two groups of five to seven members each, and, two to four observers for each group

Time Required

One to one and a half hours

Materials Utilized

I. Paper and pencil

II. Questions to Guide Observation

Process

I. The group works on the task for 40 minutes

II. Observers give oral reports and group members discuss their participation in the group (20 minutes).

III. All groups come together and compare group processes that occurred in each.

Task: Develop a recreational device to muse and enhance a five year old child for a cost not to exceed $10.00

Questions to Guide Observation

1) Does each person accept the stated or implicit goals of the project? How does this affect each person in the project?

2) Did the group atmosphere encourage each member to talk about why he wants to be in this project and what each member needs to get done there? Who did this and how?

3) Did the group assess the resources it already has in its members, especially resources relevant to this project? How was this done?

4) Do the group members agree on what criteria are to be used for the evaluation of each idea? If yes, how were the criteria established?

5) Personal observations

PROBLEM-SOLVING

Exercise from:

Pfeiffer, J.W. & Jones, J.E. A Handbook of Structured Experiences for Human Relations Training. (Vol. 2). Iowa City: University Associates Press, 1970, pp. 26-30.

Goals

I. To study the sharing of information in task-oriented groups

II. To focus on cooperation in group problem-solving

III. To observe the emergence of leadership behavior in group problem-solving

Group Size

From six to twleve participants. Several groups may be directed simultaneously in the same room.

Time Required

Approximately forty-five minutes

Materials Utilized

I. Problem-Solving Task Instructions

II. Information for Individual Group Members (26 cards)

III. Problem-Solving Task Reaction Forms

IV. Pencils

Physical Setting

Group members are seated in a circle.

Process

I. Problem-solving task instruction sheets are distributed to the group members.

II. After the members have sufficient time to read the instruction sheet, the facilitator distributes the information cards randomly among the members of the group. He announces that the timing begins.

III. After twenty minutes (or less, if the group finishes early), the facilitator interrupts and distributes the Problem-Solving Task Reaction Forms, to be completed independently.

IV. The facilitator leads a discussion of the problem-solving activity, focusing on information-processing and the sharing of leadership in task situations. Group members are encouraged to share data from their reaction forms. (The solution to the problem, by the way, is 23/30 wors.)

Problem Solving Task Instructions

Pretend that lutts and mipps represent a new way of measuring distance, and that dars, wors, and mirs represent a new way of measuring time. A man drives from Town A through Town B and Town C, to Town D. The task of your group is to determine how many wors the entire trip took. You have twenty minutes for this task. Do not choose a formal leader.

You will be given cards containing information related to the task of the group. You may share this information orally, but you must keep the cards in your hands throughout.

Problem Solving

Information For Individual Group Members

Each of the following questions and answers is typed on a 3 x 5 index card (26 cards). Those are distributed randomly among group members.

How far is it from A to B?

It is 4 lutts from A to B.

How far is it from B to C?

It is 8 lutts from B to C.

How far is it from C to D?

It is 10 lutts from C to D.

What is a lutt?

A lutt is 10 mipps.

What is a mipp?

A mipp is a way of measuring distance.

How many mipps are there in a mile?

There are 2 mipps in a mile.

What is a dar?

A dar is 10 wors.

What is a wor?

A wor is 5 mirs.

What is a mir?

A mir is a way of measuring time.

How many mirs are there in an hour?

There are 2 mirs in an hour.

How fast does the man drive from A to B?

The man drives from A to B at the rate of 24 lutts per wor.

How fast does the man drive from B to C?

The man drives from B to C at the rate of 30 lutts per wor.

How fast does the man drive from C to D?

The man drives from C to D at the rate of 30 lutts per wor.

Problem-Solving Task Reactions Form

1. Whose participation was most helpful in the group's accomplishment of the task ____________________

   What did he/she do that was helpful?

2. Whose participation seemed to hinder the group's accomplishment of the task ____________________

   What did he/she do that seemed to hinder?

3. What feeling reactions did you experience during the problem-solving exercise? If possible, what behavior evoked a feeling response on your part?

4. What role(s) did you play in the group as it worked on the task?

APPENDIX VII

PACKAGING THEME SEMINAR

T. Willis, Coordinator

Seminar Objectives

The theme area for Fall 1974 is to be that of Packaging. In preparation for this, a seminar series is to be offered this semester. One objective of the seminar series will be to educate students and faculty into selected aspects of this very broad topic. Hopefully, the selection of problems to be addressed in this area will become easier and more meaningful as a result of this education. A second objective of this Seminar Series is to emphasize the interrelation which has to exist between the various disciplines involved in our society, in order that the Technologist can play a constructive and decisive role. It is for this reason that some changes have been made in the Format from previous Seminars.

Seminar Format

The Seminar Series will run for twelve (12) weeks. Eight (8) of these seminars will consist of presentations, given by faculty members, on selected topics in Packaging, which will then be followed immediately by small-group discussion periods - participation by students and faculty. For this purpose, a Faculty Theme Seminar Panel of 10 members has been formed, and joint presentations will be given by members from both the technology and liberal arts faculties. The remaining four (4) seminars will be devoted to the task of identifying project study areas for the following (Fall) semester. Corpus E^3 will be divided into 5 groups, each of which will be responsible for background research into a specific potential project area. It is probable that sub-groups will be formed within this system, so that approximately 8-10 potential project areas will be addressed. Each group (or sub-group) will be required to submit a report to the Review Board on its findings, including fairly definitive recommendations for the Fall Projects. (A sort of Preliminary Preliminary Proposal (or P^3.)

Student Participation (and Evaluation thereof)

In order that an engineer may carry out a project assignment to the best of his ability, he should be as thoroughly knowlegeable as possible in that subject area. Consequently, participation in the Theme Seminar series is as important as participation in the Projects which follow. It is simply the first phase of the Project, and all students will attend. All members of the Faculty Theme Seminar Panel will likewise be expected to attend all seminars.

Writing assignments will be given, and will involve both Liberal Arts and Technical Content. Technical content may include study of certain learning modules, and then utilization of their content in technical evaluations, etc. Thus it will be possible to accru both HSS and MSES Credits by this means. Similarly, the Preliminary Preliminary Proposals (P^3) will be evaluated for creditable content in both MSES and HSS areas, in addition to "Project and Professional" content.

E^3 PROJECT GROUPS - FACULTY ADVISOR'S PERSPECTIVE

Edwin Stueben

Mathematics and E^3

Illinois Institute of Technology

E^3 project groups consist typically of 4-6 students (representing all four undergraduate classes) and 2 faculty members, one from Engineering or Physical Science and one from Humanities or Social Science. The faculty members are not to function as project directors, but still are responsible for monitoring and evaluating the quality of the project work. On a day-to-day basis their duties, as defined in the original proposal to NSF, were to be as follows:

a) provide guidance in the search and use of resources (written material, people, laboratory equipment, etc.)

b) show perspectives to problems different from those which might be expected to arise in student discussions

c) help students develop systematic problem solving skills

d) provide assistance in technical writing and presentations

and e) assist the group in the dynamics of group activity.

Since initially there were only to be lower division students, faculty members were also expected to play the role of upperclassmen during the first two years of the program.

The projects are not contrived for educational purposes and seldom will a faculty member find himself an advisor in an area in which he is a true expert. His value to the group often rests mainly on his breadth and his experience in problem identification and problem solving. The degree and type of guidance given to students is therefore quite different than that in the typical undergraduate class. Faculty members responded to this new teaching situation in a variety of ways. Some attempted to become full and active participants in the project. This was rarely successful; typically the faculty member would develop a solution to the project problem and students were left with the task of carrying out the etails, with the faculty advisor becoming, in effect, the project di ctor. If they did not like his approach, project meetings would degenerate into bickering. In other projects, faculty remained aloof and did little except attend formal group meetings and comment on student presentations. If the faculty member did his homework (i.e., acquired the background necessary to understand in detail the project problem and the approaches being considered by the students) he could still be effective. In a number of cases, however,

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As students gained experience and more classes entered the program, the role of the faculty advisor gradually developed into that of a consultant and a critic. Much of the direct instruction of lower classmen is handled by juniors and seniors, as was intended. Weekly group meetings feature oral reports by students followed by discussions and assignment of tasks for the following week. One student is designated as group leader for the duration of the project and assumes management and coordination duties. The direction of the project thus remains in student hands, but the faculty members expect the group to continuously justify its approach and actions, and to supply evidence of understanding of both technical and non-technical underlying areas. The faculty will participate to the extent of reading the same background material as the students and, if appropriate, will hold seminars for group participants. He or she is available on demand to provide help when difficulties arise, will make contacts with experts in the field, and will arrange for the use of specialized facilities. Naturally, the precise function of the advisors varies with the project and the personnel.

Many faculty members do not feel comfortable in this teaching situation because of the significantly smaller amount of control they have on the educational process. Some disagree totally with the E^3 method and think that the function of college education is to provide tools (i.e., subject matter knowledge) which can be called upon on the job to do problem solving. Others believe that the program is too understructured and advocate faculty designed and tested projects through which the students would be carefully guided. This approach has been resisted because it would remove the dimension of reality from the problem solving process. All faculty members hold regular appointments in other departments and for most participation in the E^3 Program represents 1/3 of their teaching load, or the equivalent of one three hour per week course. In practice the time demands are much greater. In addition to coaching projects the faculty must attend meetings and seminars, write self-paced instruction modules, and serve on E^3 committees, in addition to similar activities in their regular departments. Split loyalties have led to problems in a number of cases.

During the summer preceding admittance of the first class it had been proposed to give faculty members training in group dynamics. The faculty voted against doing this, however, on the grounds that such training would not be meaningful to those (the vast majority) who had never worked on problem-solving teams and therefore were not sensitive to sources of difficulty. After the first year of the program the need for instruction in group dynamics was universally evident and, eventually, it became a required activity for faculty and students alike.

The relationship between faculty and students is quite different than in conventional engineering curricula. Because of their role as evaluators, faculty members were never accepted by students as simply more experienced and knowledgeable group members, even in the early years of the program when it had been hoped that they would play the role of upperclassmen. Students prefer to work without the presence of faculty and to handle problems with incompetent or lazy group members without faculty intervention. The tendency is to present a "united front," particularly at credit allocation time. Faculty advisors can usually spot laggards and will attempt to apply traditional pressures. This is seldom successf l -- peer group pressure is more powerful, and, if it fails, the student will also not respond to a faculty member.

Students were at first amazed to find that faculty advisors frequently disagreed with each other and would discuss their disagreement in front of the students. This, together with the fact that advisors are not "authorities" in the classroom sense, has led to students feeling comfortable in contradicting faculty members and strenuously arguing their point. Most faculty find this refreshing. Also, students are not bashful in reminding faculty of their obligations, such as meeting deadlines on report reviews.

On the social level, students and faculty interact in a friendly and relaxed fashion, but a natural distance between the two groups is evident, and, from the point of view of most, desirable.

E^3 PROJECT GROUPS-STUDENT VIEWPOINT

Mary Sue Anderson

Sangamon State University
and
Graduate of E^3 Program

The student's roles in the project groups matured as the program progressed. In the first year of the program there was no one who was experienced at molding the varied temperaments, interests, expertise and learning objectives of the faculty and students into a working team. There was a definite lack of leadership in most of the projects. This was reflected in that the projects were too broad in scope and were behind schedule. Now, that there are senior students to lead the projects and there are faculty and counselors familiar with mistakes and successes of the past the project groups function much more smoothly.

One of the most obvious difficulties which the students face is how to compare project work, to the classroom work of students in the normal engineering curricula. In the first year, the E^3 students were struggling to define what an engineering project was and how to manage it. At the same time their friends in conventional curricula were making noticeable progress in classroom work which was paced by an instructor. E^3 students were considered as rather an odd group of engineers by most other students on campus. However, once E^3 students overcame the first obstacles of learning to plan the project, they focused on learning to work together.

A project goes through various phases during the semester. There are many tasks to be performed. Generally, each student is assigned the responsibility of one major topic area in which he is interested. Then there are other tasks such as editing reports or helping with the lab work which involves the whole group. By varying the assignments and pairing of team members for different tasks the leader is more likely to ensure that everyone will know all that is happening on project work and everyone's interest and good spirits will be maintained throughout the semester.

Most of the group's decision making is accomplished at the weekly meetings. Most groups operate under a majority rule system with the group leader acting as a facilitator. Depending on the group members, the leader may have to act as initiator of ideas for the project or as the driving force behind the project work. This would tend to indicate that the majority are not interested or satisfied with the direction that the work is taking.

Another situation is one in which there is an outspoken faculty or student member who tried to lead the group down his own path or who consistently slows down project work through his objection to new ideas. Generally, all opinions are allowed for discussion and the students learn that there usually is more than one feasible solution to any project.

I believe it is the responsibility of the leader to present the concensus opinion to any member whose objections are hindering group activity. It is advisable to maintain some diplomacy so that the member will feel comfortable with the group's decision, and will continue to express ideas and work within the project.

Weekly meetings are an ideal time to question members on the past week's accomplishments. Students are encouraged to keep close records of their work. A requirement of weekly justification to the group about one's progress tends to prevent "loners" from being completely isolated from the group and it provides incentive for "lazy" students to complete a task at least a step at a time.

Much work is carried on "behind the scenes." Faculty members must take time to visit lab or work areas to discover exactly what work is being accomplished by whom and to better understand the complications and frustrations that develop during the phases of project work. It also tends to make their comments about the final report more valid.

Students do not look to the faculty for final decisions on the direction of the project work. However, they do look for aids in finding information and for new ideas or perspectives on the work. The students seem to feel easier accepting the faculty members chiefly as evaluators of project work rather than as project managers.

Some of the projects have been quite successful in utilizing experts from outside the academic world. Several projects have presented their reports to persons in governmental or industrial positions. E^3 students learn quickly not to be shy when dealing with faculty or persons in the "real" world.

The E^3 student's life is a series of meetings, seminars, and independent study modules. Peer pressure is strong to be involved in the project work. The final push at the end of the semester to produce a project report and oral presentation is very strong. Students have shown the ability to help each other out in the areas that are lagging behind schedule and have pretty good success at meeting deadlines. Each student relies heavily on other project members for not only the success of the project, but also for his own learning experiences.

Overall the students seem to enjoy project work. Many of the students have participated in workshops to introduce high school or new E^3 students to project work.

THE ROLE AND TASK OF THE E^3 COMMUNICATIONS CONSULTANT

Thomas P. Cogan

Counseling Center

Illinois Institute of Technology

The E^3 Program approach to engineering education is certainly one of the most innovative and creative approaches in the country today. The use of counseling psychologists as small group communications facilitators was one of the innovative developments in the E^3 Program. This paper will highlight the role and tasks of these consultants.

The communication facilitators were doctoral level psychology students doing internships at the IIT Counseling Center. They were seen by the E^3 students and faculty as specialists in the areas of inter-personal communication and interpersonal relationships. This point is important, for it is this author's view that without this kind of validation, their impact would have been at best minimal.

As in most consultation functions, the role of the facilitator was to provide clarification and feedback concerning various modes of communication. However, this role differed somewhat from the traditional industrial consultation model in that explicit and direct teaching often supplemented the cosulting process.

An additional aspect of the E^3 consultation that differed from a more traditional consultation model was the consultants' sense of "inbetweeness." Since all of the consultants were graduate students and were, in fact, teaching a course in group dynamics for credit in the E^3 Program, the undergraduate students viewed them as persons who, like a faculty member, had authority. They saw them as persons who had the power to give academic credit and pass judgment. The faculty on the other hand viewed the consultants as graduate students, to be respected perhaps, but nevertheless as graduate students.

An additional dilemma for the consultants was that they were seen as "psychologists," persons who could evaluate, diagnose, and categorize human emotion and behavior and therefore, a potential threat to the non-psychologist students and faculty.

It became apparent that the very first task of the consultant was to define his role as focusing on communications and to make sure that he did not stray from that role.

Having defined his role for himself and to the group, it was now possible to enable the group members to begin to define their own roles and tasks. The project group in E^3 involved a complete reversal in traditional teacher-student relationships. The faculty were not to lecture and directly teach and the students were expected to actually participate in the identification of problems and solutions. They were to rely upon their peers and their own research and reading for information concerning the varying aspects of the project and to view the faculty as consultant/advisors. On paper of course this looked good, in reality however, the early stages of project work were characterized by the students' willingness to be passive and ask the faculty for answers and the faculty willingness to provide them so as to avoid having the students fail in their work.

In order to circumvent this apparent catastrophy, it was necessary for the facilitator to pursue doggedly and point out those aspects of communication and role diffusion that were potentially disruptive to the E^3 learning model. To do this, the consultants often engaged the group members in discussions about their own roles and methods of communication, as well as how they saw the other member's roles and communication styles in relation to their own.

The areas of concern to emerge next were leadership and competition. These issues were evident in the dynamics of both the student and faculty gorup members. The student's desire not to appear incompetent contributed to leadership confusion and competition which are common occurrences in groups. The facilitator, by pointing out that each member had a role and a task in the group that was uniquely his own and that everyone else was depending on him to fulfill his role and complete his task, helped to clarify the issues and to focus the group. As the E^3 Program evolved students became freer in expressing this peer pressure and thus managing their projects more effectively.

Once the struggles over competition and leadership were reduced to an acceptable level, the issues of team work and team building could be addressed. To enable the group to become a cohesive work team the facilitator encouraged a cohesive experience and helped the project leader by pointing out areas of concern and potential disruption. By employing this method of consultation, the facilitator was able to encourage group development and at the same time avoid infringing upon the student-leader's identified role.

Consulting to a research group of this sort provided some unique and rewarding experiences for the counseling psychologist. One of the most important was the sense of accomplishment that came from helping the participants experience new ways of communicating and working productively together. Also knowing that as they move into new research teams, the students and faculty will bring with them these new skills and will be able to model them for others was a gratifying process. Another reward for the consultant, that occurs all too infrequnetly in industrial situations, is the sense of completeness that came from consulting with the project group from its formation right through to the completion of its task. This experience gave the consultant as well as the participants a sense of integrated wholeness (having collectively accomplished a task no one of them could have completed alone). Finally, consulting the research teams, like E^3 project groups, provides the consultant a setting in which he can employ his skills in an atmosphere where the participants are eager to learn. A great deal of data was gathered in the project groups both by E^3 participants and our own staff at the Counseling Center. One of the ways this was implemented in the training of our staff was through weekly meetings of all the facilitators in which these observations were discussed and mutual supervision took place regarding the various project groups and their unique issues.

CASE STUDY OF A TYPICAL PROJECT I

Kenneth Schug

Chemistry and E^3

Illinois Institute of Technology

As a faculty advisor to the Science and State Governemtn project, I will give a short chronology of its development. The seed for this project was planted in late March, 1975, when State Representative Susan Catania, who represents the district which includes IIT, participated in the E^3 theme seminar on Communication. In her talk, she emphasized the difficulties faced by state legislators in their efforts to obtain dependable scientific and technical information related to proposed or pending legislation. As a result, several faculty and students became interested in developing an E^3 project to address this issue.

After a dormant period of several months, several of these faculty and students organized a summer study group which addressed itself to the broad area of Technology Assessment, including the role of such assessments in political decision-making. As a result of this discussion, it was decided to organize a Technology Assessment project team for the Fall/1975 semester. The initial fall group consisted to two upperclassmen from the summer activity, two additional "old" E^3 students, and three entering Freshmen, and four faculty members. This group met frequently during the first few weeks of the semester to arrive at project goals; a divergence of interests was discovered which lead to the decision to form two seperate project groups (with overlapping memberships). One group, later designated the Science and State Government Project, would be a proposal-type with the objective of developing a proposal for implementation the following semester. The other group would be of the implementation-type and would carry out a specific technology assessment during the fall semester. In mid-September, the proposal group held an organizational meeting and selected a student leader and a student record keeper. At this point, the group consisted of a senior already committed to lead the technology assessment project, a sophomore with a substandard previous performance in E^3, and two freshmen, and two faculty members. The sophomore was designated student leader (although he showed little interest in the position) in part because the freshmen deferred to an older student and in part because the faculty hoped that the added responsibility might improve his performance in the E^3 program.

To aid in developing project ideas, several guests were invited to meet with the group, including a second visit from Representative Catania and a visit from Dr. John Ahlen, staff scientist with the Illinois Legislative Council, a professional agency established by the Legislative committees and commissions. At Dr. Ahlen's suggestion, four members of the project team (three students and one faculty) spent a day in Springfield, the state capitol, talking to members of the legislative staff and others with an interest in the objectives of the project group. This experience greatly increased enthusiasm among group members and probably marked the turning point in the development of the project.

At this time, about midway through the semester, an additional freshman joined the group as a refugee from another project which had disintegrated and the student leader, who had not provided effective leadership, decided to leave the E^3 program and withdrew from the group. The natural choice for his successor was the freshman student who had been serving as record keeper and who had, in fact, been supplying most of the actual leadership. With this change in structure and composition, the group moved rapidly ahead in formulating ideas, assigning tasks to individual group members, and putting together a final report.

CASE STUDY OF A TYPICAL PROJECT II

Thomas Shiel

Counseling Center

Illinois Institute of Technology

The project group, Science and State Government, investigated the process that influences legislators in their assessment of technologically oriented bills in the State Legislature of Illinois. This was a typical proposal group, composed of E^3 students and faculty advisors, whose purpose was to explore a problem area and write a proposal geared to identifying solutions. This typical E^3 proposal group encountered many of the fundamental problems and conflicts that are inherent in the life of any group. However, this group was able to effectively resolve the problems in its path in order to become a very successful E^3 proposal group. The group met twelve times prior to their final presentation and this paper will represent the point of view of the facilitator, his perceptions, in chronological order of the obstacles and conflicts in the group as well as the group's style for handling such matters.

At the first meeting, the primary issue that the group had to react to was leadership. An individual was assigned the role of a leader when in fact he clearly demonstrated that he had no desire for the position. Also, the group members seemed to be searching for ways of being part of the group as well as finding ways of controlling their anxiety particularly as they struggled with the issue of inclusion, "how do I fit into the group?"

Although the organization and structure of the group were major issues, they were ignored, denied and pushed under the table. Each time that the facilitator focused on such an issue, the group became anxious and uncomfortable and often a faculty member would feel forced to protect and defend the group. Most members of the group seemed to have their own unique understanding of the goals, focus and purpose of the group. These individual perceptions were not usually integrated into an explicit understanding of the group's goals.

During the period covering the first five meetings of this project, leadership was the focal issue which reflected the ambiguity that existed within the group about goals and procedures. The student leader's avoidance of his job and the group's implicit acceptance of the situation, as manifested by their desire to avoid and ignore the issue, only created increasingly more stress and caused the group to become fragmented. Individuals were searching for their own answers, and little group-centered communication occurred.

Meetings tended to focus on the two faculty members, and a highly regarded senior student member of the group sharing their ideas about the project. The lact of involvement and participation by the leader seemed to act as the catalyst that triggered such behaviors. In addition, this project group was similar to an open ended group, whereby some students left and other students as well as numerous visitors would join the group while meetings were in progress. Thus, the issue of inclusion was not easily resolved, rather, it was continuously recycled as the group composition changed.

The facilitator met with the assigned leader of the group who clearly stated that he was dropping out of the E^3 Program and was not concerned with the project group. However, he did not tell the rest of the group about this, nor was it the facilitator's responsibility to be his spokesman.

Complicating the situation even further was the real difficulty of breaking thru the traditional role expectations that encompass student-faculty relationships in regular curricula. Of the two faculty members, one allowed the group to grope and struggle for itself, while the other member would instantly offer the "right" or "correct" solution, thus falling into the role of lecturer. As a result, the students would withdraw, becoming obedient and passive while the faculty member was assertive and directing. On some level, there existed a desire to perpetuate a "classroom" relationship. Probably because both sides were confused and uncomfortable with their vague roles in the group, they induced the traditional faculty-student relationship, rather than pursuing a format more appropriate to the E^3 setting.

The students were leaderless and unsure of where or how to tackle the tasks of the group. In addition, it was rather difficult for the faculty members to sit by and be resource people when they saw their students struggling with problems that were vague, abstract, and relatively unidentified. In fact, all of them felt pressed by the necessity to become productive in this project.

Structural issues and organizational problems were not directly stated. Instead of identifying problematic areas and working toward a solution, the members worked harder and generated a greater output of individual work which was at times slightly unrelated to or overlapped with another person's work. Their effectiveness was limited because they were unable to cooperate as a team.

Competitive issues emerged between the two faculty members because of their differences in relating to the group. The facilitator, also, found himself in repeated conflicts with one particular faculty member who felt the need to protect the group whenever the facilitator commented on the problems.

Twice the facilitator met with this faculty member outside of the group and he confided his feelings of helplessness with the group and the fact that he could not help but offer answers and solutions to the group when he so frustrated by their lack of productivity.

Up to this time interventions by the facilitator had received varied reactions. At one extreme, he was ignored; at the other, the members released pent up frustrations by expressing irritation with him.

The anxiety level in the group seemed to be moderate and often there was a great deal of "good natured" joking such as "lets let the shrink talk" or fooling around among the members themselves. Furthermore, because of the anxiety that existed, the group did not support ideas from its' members, feedback between members was inconsistent and the resulting atmosphere in the group did not facilitate risk-taking by anyone. Inability to hear others was a major stumbling block within the group during this troubled time.

During the fifth meeting, the facilitator directly confronted the group with the issue of leadership and how it was affecting the organization of the group, which was believed to be the underlying cause of the high level of anxiety. The tremendous amount of pent-up emotion and frustration (that the group was sitting on for five weeks) was released and the facilitator was the target of it all because he broke the rule and explicitly identified the problem. He was verbally attacked, labelled callous and insensitive. The group, at that time, attempted to embarrass and intimidate him into silence and almost succeeded. This proved, however, to be a constructive release of tension because the members were then freer to explore the purpose of the project meeting and individual roles and how they related to the group task.

The inherent power of a group to demand conformity and to punish nonconformity (deviancy) is awesome. If a group member defies the rules, he or she is rapidly cast into the scapegoat role. As a result, one could easily understand why the facilitator was a threat to the group and why the group tried to control him. The major experience of the facilitator was loneliness. Each time he sought to intervene within the group process, he experienced anxiety. It would have been very easy for him to "fall in line" with the other members. It is believed that the experience of the facilitator was similar to what the other group members were experiencing and one could easily sympathize with their position.

Interestingly enough, the next meeting started in a casual manner. The faculty member who had offered immediate solutions left word that he had to leave town on business and would miss about four meetings. Two students started to organize the meeting. As ideas were offered, they were written on the black board and thru discussion they were made more specific and concrete. Individuals actually sought feedback from each other. However, although the group clearly lacked a formal student leader, they began working.

By the eighth meeting, the facilitator again focused on the leadership issue and this time the group recognized its need and elected a new leader, and the students organized themselves rapidly in an efficient manner. Members verbalized their understandings of each other's work and focused and redirected the task of the group until it became clear and each person was integrated into the total project. Organization of the project crystallized with agendas and outlines of work schedules. Deadlines were set and met.

The facilitators' interventions within the group seemed to reach their peak during the fifth meeting and slowly diminished, allowing the group to struggle and identify its own problems. It seems that this particular group reoriented itself in a more effective, productive manner after it was able to face, identify and solve its interpersonal issues. Often, the most troublesome difficulty is not problem identification (for often group members implicitly understand the issue in the group) but not explicitly dealing with it amongst the members.

It is obvious in this project group that the task development was intricately related to the interpersonal process in the group. The difficulties in communicating, organizing group structure and leadership reflected the disrupted interpersonal process which significantly hampered constructive task development. The new leadership that emerged was highly structured, though this was possibly necessitated by the great time pressures experienced at that point. It got the job done but it did not move the group closer to an understanding of how to work in a more mutually collaborative manner. The resolution of the problems encountered in its early sessions was sufficient however to allow the group to produce a product that was highly regarded in the E^3 Program's evaluation procedures.

It is essential that the conflicts and issues, which are created in the group situation, are identified explicitly by the whole group in order to allow the groups to work in a productive style. All groups have difficulties; the effectiveness of a group is based on its abilities to identify and solve its own issues which leads to a greater sense of "groupness" and a heightened sense of committment by individuals to a group process. The members of this group experienced the frustrations of groping as isolated individuals, as well as the exhilarations inherent in working as a productive effective member of a group. These experiences will, hopefully, carry over to their future group experiences and enable them to function more constructively in a shorter span of time. This learning process is an integral part of the E^3 philosophy and congruent with the concept that individuals learn and grow at their own rate and on the basis of experience and not according to some mystic time table theoretically defined by others.

APPENDIX IX

SAMPLE MODULES

Module No.:	MA 101	Analytic Geometry: The Straight Line
	MA 109	Differentials, $\frac{dy}{dx}$ and Parametric Equations
	MA 113	The Fundamental Theorem of Calculus
	SD 102	Resolution of 2 Dimensional Vectors: Unit Vectors, Use of Rectangular Components for Determining the Resultant of Several Concurrent Vectors
	SD 103	Resolution andComposition of Three Dimensional Forces

Pages 163-189

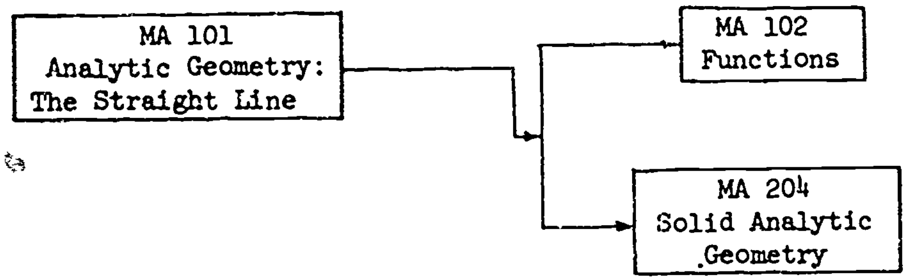
MODULE NO.: MA 101

TITLE OF MODULE: Analytic Geometry: The Straight Line

AUTHOR: E. Stueben

DATE: August 6, 1976

FLOW CHART:



ABSTRACT: Set notation and plane rectangular coordinates are introduced and simple equations are graphed. The distance formula and midpoint formula are proved. The analytic geometry of the straight line, including slope, representation as a linear equation, and the process of finding the equation from various information is covered.

LEARNING OBJECTIVES:

1. Ability to find a point with given rectangular coordinates and, conversely, to find the coordinates of a given point.

2. Ability to sketch the graph of a simple equation.

3. Ability to find the distance between two points, and the slope and midpoint of the line segment joining them.

4. Ability to find the slope of a straight line from its equation, and to be able to tell from their equations if two lines are parallel or perpendicular.

5. Ability to find the equation of a straight line given various information about it.

REFERENCE: College Calculus with Analytic Geometry
Protter & Morrey
Addison-Wesley Pub., 2nd Edition, 1970.

PROCEDURES:

1. Read pp. 18-23 of Protter and Morrey.

The open interval (a,b) is the set of all numbers which are larger than a but less than b. The closed interval [a,b] is the set of all numbers greater than or equal to a but less than or equal to b.

Note that the set of all points in the given open interval do not include the end points.

Coordinate systems are used to represent algebraic equations by geometric objects such as lines and circles. To each point in the plane a pair of numbers, called the coordinates of the points are assigned. The set of all points whose coordinates satisfy a given equation is called the graph of the equation; for example, the graph of the equation $x^2 + y^2 = 4$ is a circle with radius 2 and center at the origin.

Do problems 1, 5, 9, 10 and 16 on p. 23.

2. Read pp. 53-56 of Protter and Morrey.

What is the formula for distance between two points? Solve problems 1, 5, and 9 on p. 56.

3. Read pp. 57-63. Note that vertical lines do not have slopes.

Memorize the slope formula. Do problems 1, 5, 9, 11 and 23 on pp. 63-64.

4. Read pp. 64-69.

An important theorem in this section states that every equation of the form $Ax + By + C = 0$ represents a straight line and conversely, every straight line has such an equation.

If $B \neq 0$, then the slope of the line with equation $Ax + By + C = 0$ is $-A/B$.

As an example, we shall do problem 30 on p. 70:

Find the equation of the perpendicular bisector of the segment joining (3,-1) and (5,2).

A point on the required line is the midpoint of the segment joining (3,-1) and (5,2).

This is the point

$$\left(\frac{3+5}{2}, \frac{-1+2}{2}\right) = (4,\tfrac{1}{2}).$$

Recall the midpoint formula.

The slope of the segment is

$$\frac{2-(-1)}{5-3} = \frac{3}{2},$$

and therefore the slope of the required line is the negative reciprocal of 3/2, namely -2/3. The equation of the line through (a,b) with slope m is y-b = m(x-a); consequently, the required line has equation

Recall the formula to evaluate the slope of a line perpendicular to any other line.

$$y - \tfrac{1}{2} = -\frac{2}{3}(x-4), \text{ i.e.,}$$

$$4x + 6y - 19 = 0.$$

Do problems 1, 5, 13, 17, 19, 23 and 34 on pp. 69-70.

SAMPLE MASTERY EXAM:

1. Sketch the graph of the curve with equation $xy = 1$.

2. Let $P_1(5,-1)$ and $P_2(-2,-3)$ be two points in the plane.

   a. Make a drawing of the points, the line segment joining them, and the perpendicular bisector of the segment.
   b. Find the distance between P_1 and P_2.
   c. Find the midpoint of P_1P_2.
   d. Find the slope of P_1P_2.

3. Find the equation of the line parallel to the segment P_1P_2 (in the previous problem) which passes through the origin.

4. a. Find the slope of the line $2x - 4y + 3 = 0$.
   b. Find the equation of the line perpendicular to $2x - 4y + 3 = 0$ and which passes through P_1 $(5,-1)$.

MODULE NO.: MA 113

TITLE OF MODULE: The Fundamental Theorem of Calculus

AUTHOR: E. Stueben

DATE: July 12, 1976

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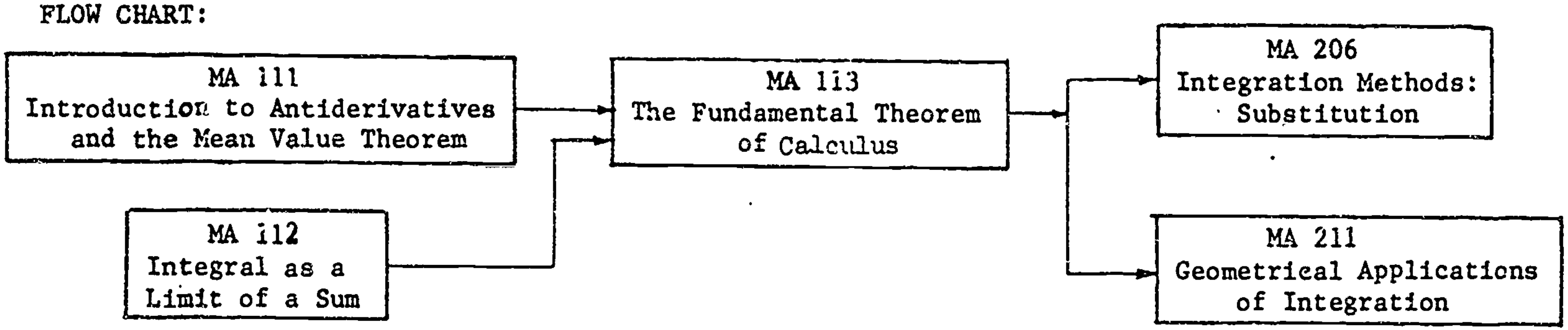

ABSTRACT: The Fundamental Theorem of Calculus states that $\int_a^b f(x)dx = F(b) - F(a)$, where $F' = f$. This theorem is proved in two ways: by using the Mean Value Theorem and by considering the integral as a function of its upper limit.

LEARNING OBJECTIVES:

1. Ability to state and use the Fundamental Theorem of Calculus.
2. Ability to find the derivative of a function of the form $F(x) = \int_a^x f(t)dt$.

REFERENCE: <u>College Calculus with Analytic Geometry</u>
Protter & Morrey
Addison-Wesley Pub., 2nd Ed., 1970.

PROCEDURES:

1. Recall that, if $f(x)\geq 0$ for $x\varepsilon[a,b]$, then $\int_a^b f(x)dx$ represents the area of the region between the graph of f, the X-axis, and the lines x=a and x=b. In a previous module the problem of finding this area was solved by approximating the region with a series of rectangles and calculating the area of the rectangles by using the computer or by algebraic tricks. This module gives a more practical method of finding the integral.

We shall prove that,

$$\int_a^b f(x)dx=F(b)-F(a),$$

where F is any function which has f as derivative.

Recall from the module on antiderivatives that, if $F_1' = F_2' = f$, then
$F_1(x) = F_2(x) + \text{constant}$

Consider, $\int_1^2 x^2\, dx$.

We know $\left(\frac{x^3}{3}\right)' = x^2$.

If

$F_1(x) = \frac{x^3}{3}$

then

$$\int_1^2 x^2dx = F_1(2) - F_1(1) = \frac{2^3}{3} - \frac{1^3}{3}.$$

Recall if $F_2'(x)=x^2$, then $F_2(x)=x^3/3 + c$.

Show that same answer results for

$F_2(x) = \frac{x^3}{3} + C$, where C is a constant.

2. Read pp. 210-211 of the text.

It is shown that, if $F(x) = \int_a^x f(t)dt$, then $F'(x)=f(x)$, i.e., $F(x) = \int_a^x f(t)dt$ is an antiderivative of f. (The argument in the text implicitly assumes that f is continuous). Therefore $\int_a^b f(x)dx=F(b)-F(a)$ (since $F(a) = \int_a^a f(x)dx=0$), where $F'=f$. Since any two antiderivatives of f differ by only a constant, any derivative G of f is of the form $G(x) = F(x)+c$. Hence

$$G(b) - G(a)=(F(b)+c)-(F(a)+c)$$
$$= F(b)-F(a)$$
$$= \int_a^b f(x)dx.$$

Suppose $G(x) = \int_0^x f(t)dt$. Then $G'(x) = f(x)$ (why?), whence $G(x) = F(x)+c$. What is c in this case?

3. The theorem $\int_a^b f(x)dx=F(b)-F(a)$ where $F'=f$ is called The Fundamental Theorem of Calculus, and is valid whenever f if integrable and has an antiderivative.

Read pp. 242-245 for a proof and for some examples.

Solve odd numbered problems 1-13 on pp. 246-247 of the text.

4. Read pp. 252-253.

State both forms of the Fundamental Theorem of Calculus.

SAMPLE MASTERY EXAM:

1. Use the Fundamental Theorem of Calculus to find the following integrals:

   a) $\int_0^2 (x^3 + 1)dx$

   b) $\int_1^3 \frac{t^2 + 1}{\sqrt{t}} dt$

   c) $\int_0^1 (x^2 + x + 1)^2 dx$

   d) $\int_{-1}^1 (\sqrt{x^3+2x^2+1})(3x^2 + 4x)\, dx$

2. Find $F'(x)$ if $F(x) = \int_a^x \frac{dt}{1+t^3}$.

MODULE NO: MA 109

TITLE OF MODULE: Differentials, $\frac{dy}{dx}$ and Parametric Equations

AUTHOR: E. Stueben

DATE: September 3, 1976

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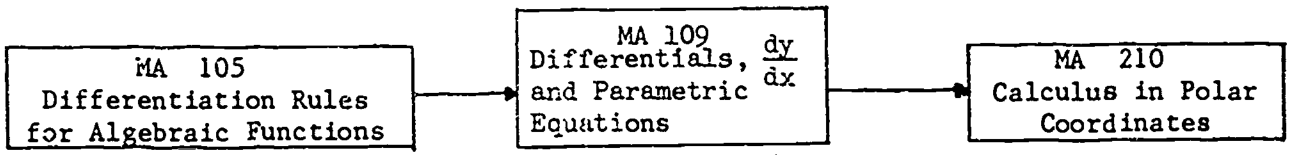

ABSTRACT: The differential of a function of one variable is defined, and is used in making approximations. The differentiation rules are recast in the dy/dx notation, and practice is provided in the use of this notation. Parametric representation of curves is introduced, and formulas are developed for dy/dx and d^2y/dx^2 when $x=f(t)$ and $y=g(t)$.

LEARNING OBJECTIVES:

1. Ability to find the differential of a function.
2. Ability to approximate functional values using differentials.
3. Ability to use the dy/dx notation, in particular the dy/dx form of the chain rule.
4. Ability to find parametric equations of a curve.
5. Ability to find dy/dx and d^2y/dx^2 for curves defined parametrically.

REFERENCES:

College Calculus with Analytic Geometry
Protter and Morrey
Addison-Wesley Pub., 2nd Ed., 1970.

PROCEDURES:

1. Read pp. 190-195 of Protter and Morrey.

The differential is sometimes convenient for making approximations and its extension to functions of several variables has considerable theoretical importance.

Define $\Delta f = f(x_0 + h) - f(x_0)$. Thus Δf is the change in f as we go from x_0 to $x_0 + h$.
Let L be any nonvertical line through the point $P(x_0, f(x_0))$ then L has the equation

$$y = m(x-x_0) + f(x_0),$$

where m is the slope of line L. The slope m can be positive or negative. One possible value for m is $f'(x_0)$ and this value occurs when the line L is tangent to the curve $y = f(x)$ at the point $P\ (x_0, f(x_0))$.
Now, let $x = x_0 + h$.
Then, with h as variable, L has the equation

$$y = L(h) = f(x_0) + m \cdot h.$$

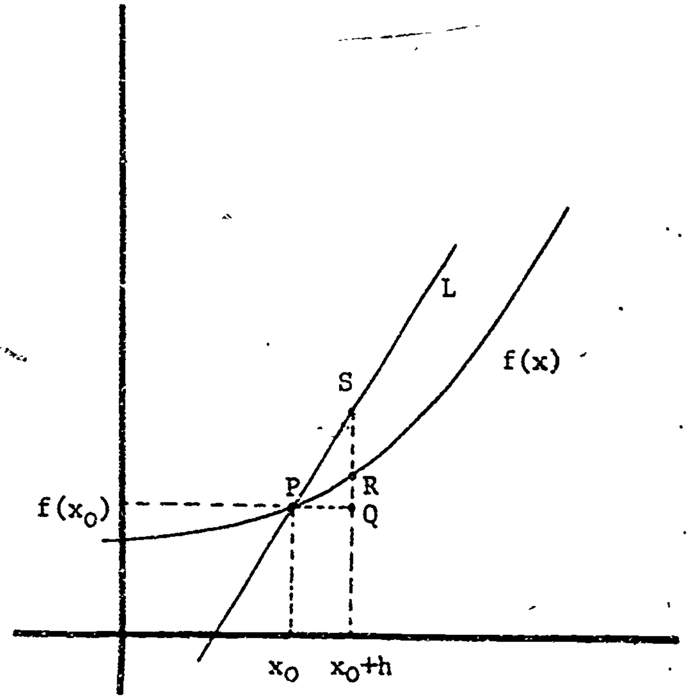

FIGURE 1

Recall equation of a straight line.

We set,

$$\delta_L f = L(h) - f(x_0) = mh.$$

Note that $\delta_L f$ is the change in L as we move from x_0 to $x_0 + h$.
Therefore in figure 1, we have

$$\overline{QR} = \Delta f \text{ and } \overline{QS} = \delta_L f.$$

Observe that when L is tangent to the function $y=f(x)$ at $P\ (x_0, f(x_0))$, we have

$$m = f'(x_0) \text{ and } \delta_L f = df.$$

Recall definition of df from the text.

We wish to show that for one such line L, $\delta_L f$ is a better approximation to Δf than any other such line for small values of h.
Now for any line L,

$$\lim_{h\to 0} (\Delta f - \delta_L f) = 0.$$

This is obviously true, since both Δf and $\delta_L f$ approach 0 as $h\to 0$.

Therefore, for every line L, $\delta_L f$ is close to Δf in some sense when h is small.
Consider

$$\lim_{h\to 0} \frac{\Delta f - \delta_L f}{h} \quad .$$

If this limit were equal to 0, a good deal more would be implied. Since the denominator itself approaches zero, the numerator will have to approach zero at a much faster rate than the denominator for the limit of the quotient to approach zero, i.e., $\delta_L f$ and Δf must be very close for small values of h.
Now,

$$\lim_{h\to 0} \frac{\Delta f - \delta_L f}{h} = \lim_{h\to 0} \frac{\Delta f - mh}{h} = \lim_{h\to 0} \left(\frac{\Delta f}{h} - m\right) = f'(x_0) - m .$$

Recall definition of $f'(x)$.

Consequently, the limit is zero if and only if $m = f'(x_0)$ or the line L is tangent to the curve $y = f(x)$ at point P.
We have proved that, of all "straight line" approximations to Δf, df is the best.
We will consider an example.
Example: Find $\sqrt{80.5}$ approximately.

Here $f(x) = \sqrt{x}$, $x_0 = 81$ and $h = -\frac{1}{2}$.

Then, $\sqrt{80.5} = f(81 + (-\frac{1}{2}))$

$= f(81) + \Delta f$
$\approx f(81) + df\ (81,-\frac{1}{2})$
$= 9 + df\ (81,-\frac{1}{2})$

Why?

Now, $df = f'(x_o) \cdot h$

$= \frac{1}{2\sqrt{x_o}}\ h$

$= \frac{1}{2\sqrt{81}} \cdot (-\frac{1}{2})$

$= \frac{-1}{36}$

Recall derivative of $\sqrt{x}$.

Therefore, $\sqrt{80.5} \approx 9 - \frac{1}{36} = 8.972.$

Approximately find the value of $\sqrt[3]{126}$.

2. Suppose $y = f(x)$.
In the formula $df = f'(x_o) \cdot h$, it is usual to write dx instead of h and dy instead of df.

Thus $dy = f'(x)\ dx$
and $\frac{dy}{dx} = f'(x)$.

If $y = f(t)$ we would write $dy = f'(t)dt$. If $z = f\ (u)$, then $dz = f'(u)du$.

$\frac{dy}{dx}$ is a notation for the derivative.
Let us rewrite the chain rule in this notation.

Given $y = f(x)$ and $x = g(t)$
then $y = f(g(t))$.
We have $\frac{dy}{dx} = f'(x)$, $\frac{dx}{dt} = g'(t)$ and

$\frac{dy}{dt} = \left[f(g(t))\right]'$.

Why?

From the chain rule,

$$\{f(g(t))\}' = f'(g(t)) \cdot g'(t)$$
$$= f'(x) \cdot g'(t)$$

Recall $x = g(t)$.

i.e.,

$$\frac{dy}{dt} = \frac{dy}{dx} \cdot \frac{dx}{dt} .$$

Consider,

Example: $y = 2\sqrt{x} + x^2$ and $x = \frac{1}{t}$.

We wish to find $\frac{dy}{dt}$.

$\frac{dy}{dx} = \frac{1}{\sqrt{x}} + 2x$ and $\frac{dx}{dt} = \frac{-1}{t^2}$.

Recall the rules for derivatives for the functions $\sqrt{x}$, x^2 and $\frac{1}{t}$.

Therefore,

$$\frac{dy}{dt} = \frac{dy}{dx} \cdot \frac{dx}{dt} = \left(\frac{1}{\sqrt{x}} + 2x\right) \cdot \left(\frac{-1}{t^2}\right) .$$

Read pp. 196-199 of the text.

Write the result in the example in terms of t. Check your answer by eliminating x to write $y = f(t)$ and finding $f'(t) = \frac{dy}{dt}$.

Solve problems 13,15,20 and 23 on p. 200.

3. Read pp. 380-386 of one text.
One reason that parametric equations are useful is that they give a way to apply the methods of calculus to curves which are not graphs of functions. Also, parametric equations for a curve can be often found simpler to work with than the usual equations in Cartesian coordinates.

Solve problems 1, 9 and 11 on p. 386.

4. Read pp. 388-390 of the text.
This section deals with how to find higher order derivatives. We will solve an example.
Example:

$$x = 3 \cos t \qquad y = 5 \sin t$$

We wish to find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$.

$$\frac{dy}{dx} = \frac{dy}{dt} \cdot \frac{dt}{dx}.$$

$$\frac{dy}{dt} = +5 \cos t \quad \text{and} \quad \frac{dx}{dt} = -3 \sin t.$$

Therefore $\frac{dy}{dx} = \frac{-5 \cos t}{3 \sin t}$.

$$\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right) = \frac{d}{dt}\left(\frac{dy}{dx}\right)\frac{dt}{dx}$$

$$= \frac{\frac{d}{dt}\left(\frac{dy}{dx}\right)}{\frac{dx}{dt}}.$$

Note: Assume $(\sin t)' = \cos t$
$(\cos t)' = -\sin t$.

$$\frac{dy}{dx} = \frac{dy}{dt} \Big/ \frac{dx}{dt}$$

Complete the problem by finding $\frac{d^2y}{dx^2}$.

Solve problems 1,3,11 and 13 on pp.390-391.

SAMPLE MASTERY EXAM:

1. Let $f(x) = x^3 + 2x^2 - x$, $x_o = 2$, $dx = \frac{1}{3}$. Find df.

2. Approximate $(81.5)^{1/3}$ using differentials.

3. Find $\frac{dy}{dr}$ if $y = (t^2 + 1)^{-1/3}$ and $t = r^3 + \frac{1}{r}$.

   Do not eliminate t between the two equations.

4. Find parametric equations for the line $y = 2x + 1$. Use as parameter the angle θ which a line segment from (0,0) to the line $y = 2x + 1$ makes with the horizontal.

5. Let $y = (t^2 + 1)^{1/3}$ and $x = 1/t$. Find $\frac{dy}{dx}$ and $\frac{d^2y}{dx^2}$

   in terms of t.

MODULE NO: SD 102

TITLE OF MODULE: Resolution of 2 Dimensional Vectors: Unit Vectors, Use of Rectangular Components for Determining the Resultant of Several Concurrent Vectors

AUTHOR: K.G. Pandey and R.J. Bonthron

DATE: July 12, 1976

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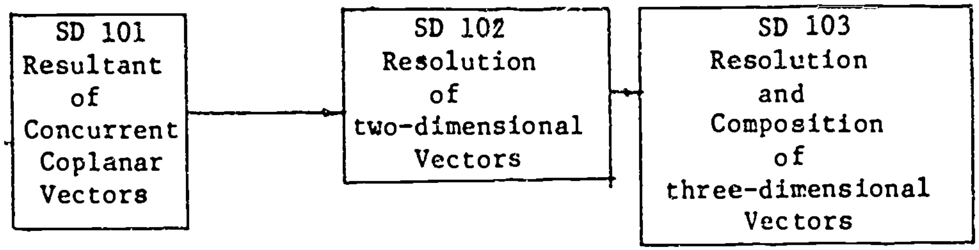


ABSTRACT: The resolution of vectors is the converse of determining the resultant of several vectors. Any given vector may be resolved in an infinite number of ways. Three cases that are of special interest in statics are discussed. The resolution of a vector into rectangular components is the most convenient and is studied in great detail. The use of rectangular components in determining the resultant of several concurrent vectors is explained.

LEARNING OBJECTIVES:

1. Given a vector (force) with one component completely specified, to be able to determine the other component.

2. Given a vector (force) to be able to determine its components along two given lines.

3. Given a vector (force) to be able to resolve it into two rectangular components in the plane.

4. To be able to use the rectangular components of several concurrent vectors to determine their resultant.

REFERENCES: Vector Mechanics for Engineers, Statics and Dynamics
Beer, F.P. and Johnston, E.R., Jr.
McGraw Hill, 1972

PROCEDURES:

1. Study Sec. 2.5, Page 14 up to the end of the first paragraph on page 15.

2. Satisfy yourself that it is indeed possible to resolve a given force in an infinite number of ways.

3. Resolving a force into two components is really a geometric problem. In order to obtain a unique (only ONE) solution, one must be able to construct only one triangle from the given data. In order to have a unique triangle construction at least three quantities must be specified.

4. Given the following data.

   (a) two sides and the included angle
   (b) three angles
   (c) three sides
   (d) two sides and an angle other than the included angle
   (e) one side and two adjacent angles.

   Is a unique triangle construction possible?

   CHECK THE ANSWER SHEET

5. Study the second paragraph on pp. 15.

   Which of the situations in item 4 is this equivalent to?

6. Solve problem 2.12 in the text.

7. Study the third paragraph on pp. 15.

   Which of the situations in item 5 is this equivalent to?

8. With respect to Fig. P2.5 in the text resolve F along a-a and b-b given $\alpha = 65^{\circ}$.

9. Read the last paragraph on page 15. Solve problems 2.6 and 2.8. In each problem identify the corresponding situation in item 4.

10. Study section 2-6, page 19. You may skip the last few sections of this section which follow the heading "Use

SAMPLE MASTERY EXAM:
(CLOSED BOOK)
30 MINUTES

1. Prob. 2-27, page 26 in the text.

2. What are the components of F along BC and along CA

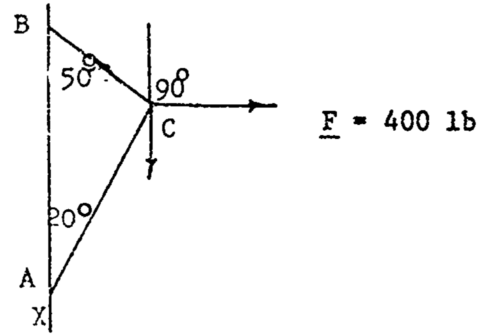
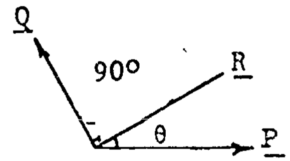


Figure 2

of the slide rule".

11. Given a force $\underline{R}$ resolve it along the two directions as shown in figure 1. Use equation (2-8) if possible



R = 30 lb
θ = 30°

Figure 1

12. Solve problem 2.14, 2.18, 2.20 on page 25 and 26.

13. Study Section 2.7 and sample problem 2.3. Note how the use of rectangular components simplifies the process of determining resultants of several concurrent coplanar forces.

14. Is it possible to apply equations (2-8) to all planar problems?

Are there any restrictions on how θ is to be measured?

15. Solve problem 2.27, 2.28 using rectangular components.

250

251

14. θ must be measured from the x-axis positive in the direction of the y-axis.

15. Answers in the text.

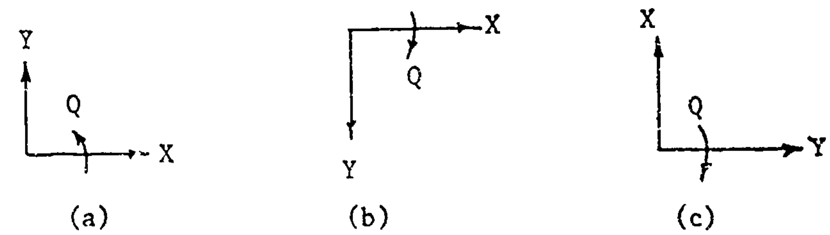


Figure 6

ANSWER SHEET

2. $\underline{F} = \underline{A} + \underline{B}$

   $\underline{F} = \underline{C} + \underline{D}$

   $\underline{F} = \underline{P} + \underline{Q} + \underline{R} + \underline{S} + \underline{T}$

4. (a) YES (b) NO (c) YES (d) NO (e) YES

5. (a) - because the magnitude and direction of $\underline{F}$ and $\underline{P}$ are known.

6. Answer in the text.

7. (e) - the magnitude and direction of $\underline{F}$ are known but only the lines of action of $\underline{P}$ and $\underline{Q}$ are specified.

8. $F_a = F_b = \dfrac{50}{\text{Cos } 65^\circ}$

9. Answers in the text.

11. If you wrote P = R Cos 30°, you blew it. Eq. (2.8) may be used for rectangular components only. The angle between $\underline{P}$ and $\underline{Q}$ is 120° so Eq. (2.8) cannot be used.

    from the force triangle,

    $$\text{Cos } 30^\circ = \frac{R}{P} \rightarrow P = \frac{R}{\text{Cos } 30^\circ} = 30\sqrt{2}$$

    $$\text{Sin } 30^\circ = \frac{Q}{R} \rightarrow Q = R\tan 30^\circ = 30\sqrt{3}$$

12. Answers in the text.

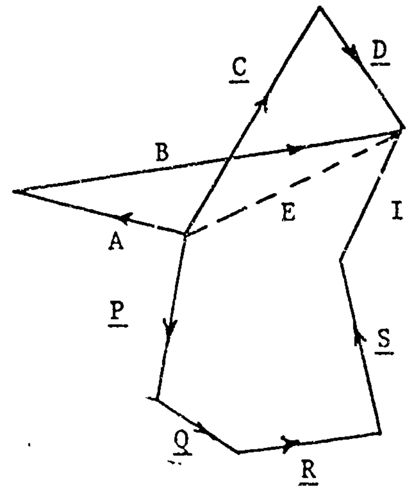


Figure 3

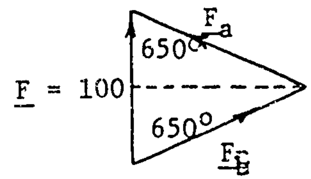


Figure 6

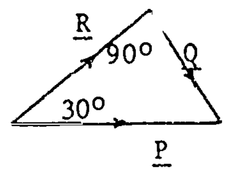


Figure 5

MODULE NO: SD 103

TITLE OF MODULE: Resolution and Composition of Three Dimensional Forces

AUTHOR: K. G. Pandey and R.J. Bonthron

DATE: July 7, 1976

FLOW CHART:

SD 102 — Resolution of Two Dimensional Vectors → SD 103 — Resolution and Composition of three Dimensional Vectors → SD 104 — Statics of Particles

ABSTRACT: This module is an extension of No. 102 to three dimensional forces. The resolution of space vectors (forces) into three orthogonal components is studied. Direction cosines are defined.

LEARNING OBJECTIVES:

1. Given a space vector (force) to be able to resolve it into three orthogonal components,
2. To learn the definition and properties of direction cosines.
3. Given a space vector (force) to be able to determine its direction cosines.
4. Given two points in space to be able to define a unit vector along the line joining the two points.
5. To be able to add concurrent forces in space, analytically.

REFERENCES:

Vector Mechanics for Engineers, Statics and Dynamics
F. P. Beer, and E. R. Johnston, Jr.
McGraw Hill, 1972

PROCEDURES:

1. Any three concurrent lines such that any one line is perpendicular to the other two constitutes a three dimensional rectangular coordinate system in space.

   Also recall that any two lines define a plane so it follows that each axis of a 3-D rectangular coordinate system is perpendicular to the plane defined by the other two axes. In a later module we will distinguish between left handed and right handed coordinate systems.

You should be familiar with three dimensional coordinate systems in space from your prerequisite math.

2. Study Sec. 2.11, page 35 to the top of page 37 in the text.

3. The most important thing to remember is that in general two lines define a plane, i.e. in general, it is not possible to define a plane containing three or more lines. In Fig. 2-30 for example it is not possible to define a plane that contains the vector F and both the x- and the y-axes. It is however possible to define one plane that contains F and the x-axis, another plane that contains F and the y-axis and a third plane that contains F and the z-axis. The second is of course what has been done in Fig. 2.31.

4. (i) Given a general three dimensional vector F.

   (ii) Express θ_x and θ_z in terms of θ_y and ϕ, if the various angles are defined as in Sec. 2.11.

What other data is needed in order to determine the three orthogonal components of F.

5 Study the rest of Sec. 2-11 (from the top of page 27) (i) Express F in terms of F, its direction cosines and the unit vectors i, j, K

   (ii) Prove that $\lambda_x^2 + \lambda_y^2 + \lambda_z^2 = 1$

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(iii) Define a unit vector parallel to the line of action of F.

(iv) Note that in Procedure 4(i) we said that two angles define the line of action of a vector. The present discussion seems to indicate that the three angles θ_x, Θ_y, Θ_t are required to define the line of action. Reconcile the two statements.

6. You should have achieved learning objectives 1, 2, and 3. Example 2 on page 38 addresses itself to objective No. 3. The solution was approached in the following manner.

The direction cosines are defined by:

$$F_x = \lambda_x F$$

$$F_y = \lambda_y F$$

$$F_z = \lambda_z F$$

In order to determine λ_x, λ_y, λ_z we must know F_x, F_y, F_z. and F.

Given F_x, F_y, F_z, however F is easily determined as

$F = \sqrt{F_x{}^2 + F_y{}^2 + F_z{}^2}$ and the problem is solved.

7. We now address ourselves to Learning Objective No. 4. To start with, we note that any two noncoinciaent points define a line. If the position of two points, M and N is specified in terms of orthogonal components (x_1, y_1, z_1) and (x_2, y_2, z_2) respectively, then the line joining the two points is the vector.

$\underline{MN} = (x_2 - x_1)\underline{i} + (y_2 - y_1)\underline{i} + (z_2 - 2_1)\underline{k}$

If $\underline{\lambda}$ be defined as a unit vector along the line MN and d be the magnitude of $\underline{MN}$, then also

$$\underline{MN} = d\underline{\lambda}$$

$\underline{\lambda}$ may be written as $\lambda_x \underline{i} + \lambda_y \underline{j} + \lambda_z \underline{k}$

$$\underline{MN} = d(\lambda_x \underline{i} + \lambda_y \underline{i} + \lambda_z \underline{k})$$

Since two vectors are identical if and only if all components are equal, it follows that

$$\lambda_x d = X_2 - X_1 \rightarrow \lambda_x = (X_2 - X_1)|d$$

$$\lambda_y d = Y_2 - Y_1 \rightarrow \lambda_y = (Y_2 - Y_1)|d$$

$$\lambda_z d = Z_2 - Z_1 \rightarrow \lambda_z = (Z_2 - Z_1)|d$$

8. In the above (i) express d in terms of $x_1, y_1, z_1 . x_2 . y_2, z_2$.

(ii) What are the direction cosines of the vector $\underline{MN}$?

9. Study Sec. 2.12, page 39-40.

10. Study Sample problem 2.7.

11. Solve problems 2.50, 2.54, 2.58

12. Study section 2.13, page 40.

13. Study sample problem 2.8 on page 42.

(i) Is it possible to define a plane that will contain the vectors $\underline{R}$, $\underline{T}_{AB}$ and $\underline{T}_{AC}$?

(ii) Outline a solution using the parallelogram law for vector addition.

14. Solve problem 2.64, page 44.

SAMPLE MASTERY EXAM:

Closed Book, 30 minutes.

1. Solve problem 2.65, page 44.

2. What are the direction cosines of the tension in AB.

ANSWER SHEET

4. (i) at least two angles
   (ii) From equation (2.17) and (2.19)

$$F_x = F \sin\Theta_y \cos\phi = F \cos\Theta_x \rightarrow \cos_x = \sin\Theta_y \cos\phi$$

$$F_z = F \sin\Theta_y \sin\phi = F \cos\Theta_z \rightarrow \cos\Theta_z = \sin\Theta_y \sin\phi$$

5. (i) $\underline{F} = F (\cos\Theta_x \underline{i} + \cos\Theta_y \underline{i} + \cos\Theta_z \underline{k})$

   (ii) $\underline{F} = F \lambda_x \underline{i} + F \lambda_y \underline{i} + F \lambda_z \underline{k}$

   implies $F^2 = F^2 \lambda_x^2 + F^2 \lambda_y^2 + F^2 \lambda_z^2$

   therefore $\lambda_x^2 + \lambda_y^2 + \lambda_z^2 = 1$

   (iii) $\underline{\lambda}$ is a unit vector parallel to the line of action of $\underline{F}$

   (iv) Given any two of the three angles Θ_x, Θ_y, Θ_z, the third is easily determined from the relation

$$\cos^2\Theta_x + \cos^2\Theta_y + \cos^2\Theta_z = 1$$

8. (i) $d^2 = (X_2 - X_1)^2 + (Y_2 - Y_1)^2 + (Z_2 - Z_1)^2$

   (ii) λ_x, λ_y, λ_z, are the direction cosines of $\underline{MN}$

13. (i) Yes, indeed because the resultant of two vectors lies in the plane of the two vectors.

   (ii) Let Θ be the angle between AB and AC then the parallelogram of forces may be used to obtain the resultant $\underline{R}$ as sketched below

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APPENDIX X

PROCTOR CHECK LIST

PROCTOR CHECK LIST

Administering an Exam

1. Before the student attempts the exam, help him/her clear up any doubts about the module material.

2. Check the proctor's Student File to see whether the student has mastered the prerequisites for the module.

3. a) If the student has not mastered the prerequisites for the module, check with the appropriate faculty to see whether the student should attempt the exam. In most cases the student must master all the prerequisites for any module before attempting any exams on that module.

   b) If the student has mastered all the prerequisites for the module then check to see whether the student has ever attempted an exam on the module.

4. a) If the student has never taken an exam on this module, then let the student randomly choose any of the exam versions. (Most modules have four different exam versions).

   b) If the student has attempted some of the exam versions on this module, then let the student randomly choose from any of the exam versions he/she has not taken.

   c) If the student has attempted without success, all the exam versions on this module, then make sure there exists another exam version on this module. (As soon as there are no more exam versions for a certain student, the proctor usually asks the faculty member in that area to make up another exam as soon as possible.)

5. As soon as the student chooses the exam, mark in the proctor's Student File which student has taken which exam version from the Exam File.

6. Make sure that the student is not using any additional material (e.g. open books, tables, notes, calculators, etc.) unless this material is allowed. Also make sure that the student does not write on the exam.

7. Pull out a Module Mastery Exam Record form and fill in the necessary information. Do not sign your name nor enter the result on this form until the exam is completely graded.

8. Most exams have a suggested time limit of one hour which in many cases is sufficient time for the student to complete the exam. For those students needing more time, give them the extra time - usually not more than 50% of the original suggested time limit.

9. After the student's answers to the exam together with the exam are handed in, staple these answers (without the exam) to the Module Mastery Exam Record form and fill in the time at which the student completed the exam. If necessary, let the student fill out a Module Evaluation Form for this module and then file this form. This form is usually filled out once per module unless there is a need for correction or revision on some exam version.

10. Grade the student's exam. Most exam versions will have a solution completely worked out which is in the proctor's Solution File. Use this solution to aid you in grading the exam. Mark all answers.
    a) If the student has made a correct answer, then mark it as correct.

    b) If the student has made some small errors, then mark them as such explaining the type of errors (e.g., computational mistake, sign error, etc.)

    c) If the student has made some large conceptual errors than mark the problem as incorrect, and explicitly work the problem correctly on the student's exam.

11. Tell the student the result (Mastery or Restudy*) on his/her exam. Then on the Module Mastery Exam Record form mark the result and sign your name. Finally, enter the student's result (and date of result) into the proctor's Student File.

12. File away the student's exam, return the exam version to the Exam File, and return the exam solution to the Solution File.

NOTE: If there is any difficulty in following the above procedures, please check with other proctors and faculty members.

*Mastery - the student has all the concepts correct on the exam, and the quantity of minor mistakes (e.g., arithmetic error) is minimal.

Restudy - not mastery.

(The above terms are explained in more detail in the Proctor Manual).

REPORTS TO BE FILED BY EACH PROCTOR

1. Summary of Learning Module Study

   This report is to be handed in by each proctor at the end of each month and at the end of each semester. All the exams that each proctor has given to the students during a certain time interval are separated into Mastery and Restudy groups. The Mastery group is alphabetized according to the students' last names, some forms (explained in the Proctor Manual) are filled out, and finally the Mastery and Restudy groups together with the forms are handed in.

2. Semester and Cumulative Report on Module Pass Rate

   This report is handed in by each proctor at the end of each semester. The Pass Rate of an Exam is calculated. This pass rate is defined as

   $$\frac{\text{Total number of masteries given in this exam version}}{\text{Total number of exams attempted in this exam version}}$$

   Similarly, the Pass Rate of a Module is calculated. This pass rate is defined as

   $$\frac{\text{Total number of masteries given in this module}}{\text{Total number of exams attempted in this module}}$$

   These pass rates are calculated each semester for each existing module and exam. A cumulative calculation is made, some forms (explained in the Proctor Manual) are filled out, and finally this report is handed in.

3. Semester Report on Student Evaluation of Modules and Exams

   This report is handed in by each proctor at the end of each semester. This report is complied from the "Module Evaluation Form" which the student fills out. In this report the proctor lists all the modules and exams that need revision or correction together with what these revisions and corrections should be. This report together with all the Module Evaluation Forms are handed in.

NOTE: If you need more information, please contact the person in charge of all the records.

APPENDIX XI

SUMMARY OF LEARNING MODULE STUDY

SUMMARY OF LEARNING MODULE STUDY 12/11/76 TO 5/20/77

AREA	NUMBER OF STUDENTS WHO MASTERED ONE OR MORE LM's IN THE AREA						NUMBER OF LM's MASTERED					
	12-11-76 1-22-77	1-24 1-31	FEB.	MAR.	APR.	5-1 5-13	12-11-76 1-22-77	1-24 1-31	FEB.	MAR.	APR.	5-1 5-13
CHEMISTRY	2	2	5	3	7	2	10	2	15	13	16	2
COMPUTER SCIENCE	1	0	0	0	2	0	2	0	0	0	2	0
ELECTRICAL ENGINEERING	1	4	6	4	3	2	4	12	46	9	16	11
ENGINEERING GRAPHICS	0	0	0	1	0	1	0	0	0	4	0	1
FLUID MECHANICS	0	0	4	2	4	3	0	0	4	3	12	9
HEAT TRANSFER	0	0	0	2	1	1	0	0	0	3	3	1
MATH	4	7	10	7	6	5	12	11	34	16	23	13
METALLURGY	0	0	2	2	3	3	0	0	8	7	4	5
PHYSICS	2	3	4	6	6	9	3	4	10	22	58	18
STATICS AND DYNAMICS	0	3	6	3	5	3	0	6	11	3	8	4
STRENGTH OF MATERIALS	1	0	2	4	2	2	1	0	4	7	4	2
THERMODYNAMICS	1	2	6	6	5	4	1	3	14	9	11	5
OTHER	0	0	0	0	0	0	0	0	0	0	0	0
ALL AREAS	8	16	26	24	22	18	33	38	146	96	157	71

STUDENT'S PROGRESS IN THE MSES AREA

Dec. 11, 1976-May 20 1977

STUDENT NAME	MODULES MASTERED*					
	Winter Break (12-11-76 1-22-77)	JAN. 24 TO JAN. 31	FEB.	MAR.	APR.	5-1 TO 5-13
BENDER PT			EE-358,268,265, 266 M-532	EE-397,270, 269		
BICKLEY			EE-263,358,284, 283,282,281,280, 279,278,277,276, 275,274,273,272, 271,270,269,268, 266,265,264	EE-396		MET-501,502,505
BLACYKI PT			M-129 SD-558,559	M-16,52	C-535,536 M-23,40	
BOWER	C-550,551, 552,554,555 M-420,490, 491,629,630, 632	SD-67		TH-648	TH-649,650	TH-653
BROWN		M-71 P-31	SD-558		CS-569 C-537,545 P-605,612 SD-559	
DOMARACKI PT			TH-477,645	TH-646		
GLIM						

*C-Chemistry, CS-Computer Science, EE-Electrical Engineering, EG-Engineering Graphics, FM-Fluid Mechanics, HT-Heat Transfer, M-Math, MET-Metallurgy, P-Physics, SD-Statics & Dynamics, SM-Strength of Materials, TH-Thermodynamics, O-Other, HSS-Humanities and Social Science, PP-Professional Project

P art Time

STUDENT'S PROGRESS IN THE MSES AREA

Dec. 11, 197[illegible]-May 20, 1977

STUDENT NAME	MODULES MASTERED*						
	Winter Break (12-11-76 1-22-77)	JAN. 24 TO JAN. 31	FEB.	MAR.	APR.	5-1 TO 5-13	
MAKARA	C-540, 541, 544, 545, 546		C-547, 548, 549, 550 M-352 SD-558	C-551,552 EG-111,112, 128,138	C-542, 553, 554, 555, 556, 557 M-69,70	M-72	
MARTIN	P-622	C-550	C-535, 549 P-625, 173, 155, 604	C-554 P-174,193, 209	C-555 P-607, 621 162, 349	P-619 C-551	
METHENITIS			C-542,555, 557	M-45	M-598,419, 142,444,258, 597,57,582, 312,418	M-367,368, 370,371,372, 416	
MIKULKA			FM-301 MET-505,509	HT-411,414 MET-506,507, 508	FM-302 HT-413,412, 415 MET-504		
NELSON PT							
NIACARIS PT			M-367,368, 45,419 SM-4[illegible]0	M-370,371, 372,418 SM-481	M-416		
O'BRIEN			P-611,614, 622,625	P-30,616, 621,628, 626	EE-263,264, 265,266,268, 269,270,271, 272,273,274, 275,276	EE-277,278, 279,280,281, 282,283,284 P-613,623 M-629	
					P-31,32,42, 43,47,50,213 214, 215,216, 219,220,245, 246,249,285,		
					364,365,619 627		

STUDENT'S PROGRESS IN THE MSES AREA

Dec. 11, 1976-May 20, 1977

STUDENT NAME	MODULES MASTERED*						
	Winter Break (12-11-76 1-22-77)	JAN. 24 TO JAN. 31	FEB.	MAR.	APR.	5-1 TO 5-13	
JONES		EE-397,398 SD-73	EE-400,399 TH-477,645 SD-74,75	MET-501,502, 504,505 SD-21 TH-646	MET-506		
JUREWICZ		EE-268,274, 275	EE-284,282, 277,283,281 280,279,278 276	EE-358		P-174	
KAY		M-26,57 P-612	M-69,70,72 P-625		M-352,78, 355,37,38 SD-558,559, 560	SD-561	
KING	CS-569,570 M-418,419	M-592	FM-300 MET-501,502 505,506,507 509 TH-654		FM-343,344, 345 MET-504,508	MET-503	
LAPIO PT							
MIKE LAVENDER			TH-477,645	TH-646	SD-288 SM-479,480, 481, TH-647	SM-521	
LOCKETT PT							
HANSON		M-129,16	M-52,23,71, 63,40	M-34,59	C-535,536, 537	P-600	
							PAGE 2 OF 5

STUDENT'S PROGRESS IN THE MSES AREA

Dec. 11, 1976-May 20 1977

STUDENT NAME	MODULES MASTERED*						
	Winter Break (12-11-76 1-22-77)	JAN. 24 TO JAN. 31	FEB.	MAR.	APR.		5-1 to 5-13
OLSEN PATTIE LAVENDER		M-63	M-69,70,78, 71,352	M-72,355,58 P-604,607, 617	P-44,562, 581,605,608, 609,610,612, 614,616,618, 619,620,621	622,626,627, 628	M-369 P-41,613,623
PAGET	M-70,72,355 P-482,606	M-369,367 P-602,604	M-57,370, 312,45,368, 444,372,371 258 P-611	M-582,416 P-562,581, 609,605, 612,625		P-44,608, 610,614,617 621,618,620 622	EG-112 P-626,607
RICHTER PT						C-538	
ROWLEY PT							
SCHIFF		TH-645,646	FM-302 TH-477,450, 647	FM-301 SM-519		EE-358,399 FM-303,305 TH-648	FM-343 SD-75,76
SHWARZSTEIN							M-57,258, 444,367
SOKOL		C-537	C-538,546, 547,548, 549	C-541,542, 550,551,552 553,554,555 556,557			
							PAGE 4 OF 5

STUDENT'S PROGRESS IN THE MSES AREA

Dec. 11, 1976-May 20, 1977

STUDENT NAME	MODULES MASTERED*						
	Winter Break (12-11-76 1-22-77)	JAN. 24 TO JAN. 31	FEB.	MAR.	APR.		5-1 to 5-13
SPOHNHOLTZ PT							
STASIOSKI		EE-269,270, 271	EE-277,276, 275,274,273	EE-278,279, 280,281			
STICE	M-57	M-258,444 SD-560,561, 21,25	M-312,45, 582 SD-49,67	SM-481,479,480 M-142,597 P-30,32,31, 42,SD-287 TH-477,645	M-418,419, 598, P-43,47,50, 213 285,	SD-73 TH-646,647 450,648,649	TH-650,651 P-214,215,216, 219,364
SUTTON			C-536				
TENNER PT				P-600			
UNDERYS	EE-263,264, 265,266	EE-268,269, 270,271	EE-275,274, 273,272 M-444,597	TH-477,645, 646		EE-276 SD-67,288 TH-647,450	EE-277,278,279 FM-300,301 TH-648,649 SD-73,MET-501 P-214,215
VAZNELIS	SM-479 TH-647	TH-450	FM-300 SD-288,76,287 SM-480,481,518 TH-648,649, 650,651	FM-301,302 HT-402 SD-449 SM-521,522		CS-570 FM-303,343, 304,305,306, 344 SM-523	C-553 FM-307,309,345 313,341,342 HT-411,P-65 SM-524
VINNEDGE PT						C-535	
							PAGE 5 OF 5

APPENDIX XII

Self-Paced Calculus

Edwin Stueben

February 1977

Materials: The E^3 learning modules for Math 103 were revised during Summer 1976 and were used in the self-paced section during the first semester 1976-77. Each module contains a list of learning objectives, an abstract, and discussion material which substitutes for the lecture. The latter contains comments on the text, additional examples, questions for the student, reading and homework assignments, and a sample examination, the answers for which are available to the student. Four examinations were written for each module. The typical module covers about one week's work.

Personnel and space arrangements: A teaching assistant was assigned as a tutor-proctor, and devoted a total of about 15 hours/week to the course. This included 12 hours per week of office hours and three hours for grading and record keeping. The assistant's office was used for tutoring and exam-taking. This is a 12 x 24 office with eight desks; since most TA's use this space only rarely it was quite satisfactory.

Student Selection: Students (incoming freshmen) with SAT math's scores of 71% (or equivalent ACT score) were sent a description of the module course and were invited to a meeting to discuss it. About 40-50 students attended. A careful description of the course, grading procedures, logistics, etc. were described and sample materials distributed. Particular emphasis was placed on the dangers of procrastination, and students were warned not to try the self paced approach if they tended to need external innovation. 32 students registered for the course.

Grading: 25% of the final grade was represented by the module exams, which were graded on a mastery basis (i.e., no conceptual errors were allowed). There was no penalty for repeating a module mastery exam. In addition there was a one-hour midterm, which was given when a student completed half the modules, and a two hour exam. These counted for 25% and 50% respectively, and were not graded on a mastery basis. Thus, if a student finished all of these mastery exams that portion was worth 25 out of 100 points for the course. The 23 students who finished within two weeks of the final exam had to take the regular Math 103 exam. Seven students finished earlier and were given exams at that time and encouraged to go on to Math 104.

Results: 23 students received an A, and seven students received the grade of B. Two students did not finish the modules by the end of the semester and got Incompletes to be made up by the beginning of the following semester. This was done, but both students received C's. The student who took the final exam scored an average of 15 points higher than the average of a group taking the regular classroom lecture course, which group had similar entrance Chemistry scores, and 20 points higher than the class average.

APPENDIX XIII

THE ROLE OF THE COUNSELING CENTER ADDENDA

Pages 209-249 inside

THE ROLE OF THE COUNSELING CENTER ADDENDA

1. DETAILED COURSE DESCRIPTION AND SYLLABUS: GROUP DYNAMIC SEMINAR
   Ariadne P. Beck, Thomas Shiel

2. DETAILED DESCRIPTION OF PRACTICUM IN LEADERSHIP
   Ariadne P. Beck, Thomas Shiel

3. DETAILED COURSE DESCRIPTION AND SYLLABUS: PROJECT MANAGEMENT SEMINAR
   Thomas P. Cogan, Larry S. Wexler, Ariadne P. Beck and Earl Young

4. SUMMARY OF FEEDBACK FROM THE PROJECT MANAGEMENT SEMINAR
   Larry Wexler, Tom Cogan

5. DETAILED COURSE DESCRIPTION AND SYLLABUS: FACILITATING CREATIVITY IN INDIVIDUALS AND GROUPS
   Ariadne P. Beck, Thomas Shiel, R. Tobey and Earl Young

6. CHANGES RESULTING FROM TRAINING E^3 STUDENTS IN GROUP DYNAMICS
   Tom Cogan, Ron Ruff, Bonnie Rudolph, and Ariadne P. Beck

7. ABSTRACT - FACTORS RELATED TO SUCCESS AND FAILURE IN AN EXPERIMENTAL ENGINEERING PROGRAM Susan Feldman-Rotman

8. DETAILED COURSE DESCRIPTION: E^3 PROBLEM-SOLVING SEMINAR
   Sharon H. Poggenpohl, Mike Merzer, Barry Bickley and Tom Methenitis

9. ABSTRACT - OCCUPATIONAL COMMITMENT AMONG COLLEGE STUDENTS
   Felicia A. Dudek

DETAILED COURSE DESCRIPTION AND SYLLABUS:

GROUPS DYNAMICS SEMINAR

ARIADNE P. BECK THOMAS SHIEL

Counseling Center
Illinois Institute of Technology
Fall, 1976

The Group Dynamics Seminar is a specially designed fifteen week seminar that focuses on the essential skills relevant to effective group functioning within the E^3 framework. This seminar, which is required of all E^3 students and faculty, attempts to introduce the participants to the basic skills needed in small group work, such as the E^3 project group. The format of the seminar includes the use of prepared lectures (usually given out in advance in written form) and experimental exercises focused on the development of particular skills relating to communication, leadership, and team building in the small group process.

The course is structured so that participants gain greater self knowledge and group assessment skills. Thus, experiences are sequentially built upon, providing participants with a repertoire of useful skills. The course begins with a focus on dyadic communication issues then, group communication issues and finally, problem identification skills, group problem solving, and types of decision making in groups.

No available text existed so it was necessary to develop a manual with lectures and exercises that specifically met the essential objectives of the course. A Manual of Training in Group Dynamics for E^3 Students and Faculty, Ariadne P. Beck, Editor, is included as a separate item.

The credits granted from the group seminar ranged from one to two credit hours based on the quantity and quality of the participants' growth and involvement.

Following is a detailed synopsis of the seminar:

Weeks 1 and 2: Feedback Process. Inherent problems in listening are studied as well as techniques of giving feedback which help to overcome obstacles to clear communication. Accompanying exercises are reflective of the difficulties involved in giving and receiving feedback from others.

Weeks 3 and 4: Group Role Functions. This segment is designed to stimulate awareness of the various individual roles that exist in a group and the effects of these roles on group functioning. The interdependency among the members of a group and the effect of that upon productivity and functioning of the group are observed and experienced.

Weeks 5 and 6: Leadership. The purpose here is to develop the participants' awareness of how the leader of a group effects the process and productivity of a group; and how various leadership styles effect a group in different ways.

Weeks 7 and 8: Problem Identification and Problem Resolution. Four models of problem-solving are reviewed; liabilities and assets of each are studied. Suggestions for implications of the models for E3 project groups are discussed.

Weeks 9 and 10: Personal Problem Solving, Common Obstacles in Problem-Solving, and Principles of Decision-Making. Three topics are presented and discussed. They are useful not only for group and organizational problems, but also for personal problems. Common failures are studied.

Weeks 11 and 12: Group Problem Solving. An awareness of some of the inherent obstacles in group problem solving are highlighted, as well as organizational and structural difficulties. Sequential phases of problem solving in task groups are reviewed as well as certain techniques and models for problem-solving in work groups.

Weeks 13 and 14: Types of Decision-Making in Groups. Types of decision-making models in groups are discussed as well as essential areas that deserve more in-depth study. The implications of various models are explored.

Week 15: Summary, Discussion and Feedback on the seminar.

DETAILED DESCRIPTION OF PRACTICUM IN LEADERSHIP

Ariadne P. Beck   Thomas Shiel
Counseling Center
Illinois Institute of Technology
Fall, 1975

A Group Dynamics Seminar, which is offered by the Counseling Center Staff is required of all new students and faculty in the E^3 Program. The purpose of the seminar is to introduce new members of E^3 to the essential skills needed to function constructively and efficiently in small task group situations. In addition, the Counseling Center provides a staff of communications facilitators to work with the E^3 task groups. The facilitators utilize skills such as those taught in the Group Dynamic Seminar, to help the groups communicate and function in a productive manner.

As an adjunct to these activities, the Counseling Center Staff offered a Practicum in Leadership Training for E^3 students. This practicum was intended as an opportunity for E^3 students to assume some of the responsibilities for training others in the Group Dynamics Seminar, or for acting as a facilitator to one of the E^3 project groups. These activities were assumed under the direct supervision and guidance of the Counseling Center instructors. This experience was offered to those who were interested, in the belief that a higher level of integration and learning is achieved when one is attempting to teach others what he already knows. This practicum experience was conceptualized in two tracks. Following is a brief description of the responsibilities the student assumed in each of these tracks.

A. Track I, working with the Group Dynamics Seminar.

1. meeting weekly with Counseling Center Staff to plan and develop the Group Dynamics Seminar

2. acting as a leader when the seminar is broken down into subgroups for exercises and discussion on various topics being covered

3. taking one of the topics to be covered and preparing lecture material, planning the exercise and conducting the overall meeting

4. working closely with a supervisor on planning and then getting feedback regarding their work

5. writing a description of their experience and what they learned at the end of the semester, in a format appropriate for use in the E^3 journal.

B. Track II, participating as a communications facilitator in an E^3 project group.

1. meeting weekly with the project team for whom he is the facilitator and negotiating an appropriate role in relation to that group.

2. meeting weekly with the group of facilitators at the Counseling Center to share experiences, plan interventions, discuss ways to help their groups, and generally stay oriented to E^3 and their function as consultants. This creates the opportunity to hear other facilitators' and other groups' experiences. This group is led by the Coordinator of Counseling Center Services to E^3 with periodic consultation from the Director of the Counseling Center.

3. meeting weekly with the Coordinator for individual supervision of his work. These meetings are for both problem solving of the specific issues the student might have, or his group may have, and, for a kind of tutorial process in the analysis of group process, dynamics and problems on a more general and didactic level.

4. writing a description of their experience and what they learned at the end of the semester, in a format appropriate for use in the E^3 journal.

Three students participated in this program during the Fall of 1975. Robert Spanier and Algirdas Underys participated in Track I. Their observations about their experiences in this practicum and the exercises that each of them presented at the seminar follows this section. John Vaznelis participated in Track II. His statement concerning his practicum experiences as a facilitator in an E^3 project group are also included here.

My Personal Experience with the Practicum in Leadership Training

Robert Spanier
Fall, 1975

This past semester I participated with others, the Counseling staff and one of my fellow E^3 students, as a co-leader of the Group Dynamics Seminar. My role in the Group Dynamics Seminar had three major tasks:

1. meeting weekly with instructors and another intern to plan and prepare the material to be used at each seminar

2. acting as a leader when the seminar was broken down into subgroups for exercises and discussion on various topics that were covered

3. taking one of the topics to be covered and preparing lecture material, planning the exercise and conducting the overall meeting

My overall participation in this seminar, I thought, was very good. I was very involved in the planning of the exercises to be used each week. When the large group was separated into smaller groups I acted as a facilitator. I did this to the best of my ability. At the outset of the seminar, I was personally involved in each of the exercises, and not in facilitating the exercise the "students" were doing. However, by the end of the seminar, I was more able to encourage the students to participate and also I was much more objective in my involvement which probably helped me to become more helpful to others.

I gave a lecture on Group Role Functions and had success in stimulating participation with most of the students. I took the topic Group Problem Solving and did background research into this area. Through this research I decided to develop an exercise in the area of Group Process. I incorporated my own ideas with that of an exercise that was previously done. The original exercise had different goals, so my first task was to re-write the exercise. Although I did not conduct a lecture on the material before the exercise, the students, I felt achieved my overall objectives.

Throughout this seminar, I received feedback from the instructors and the other practicum students. Most of the feedback was positive; however, I did get negative or constructive feedback on the exercise that I conducted. It was an exciting learning experience and I would like an opportunity to follow some of the suggestions given to me by the other leaders.

My learning experiences in participating in the Practicum in Leadership Training have been:

1. I learned about the planning and preparation involved in conducting a seminar;

2. I developed better listening skills;

3. I learned procedures for giving and receiving feedback;

4. I developed a better understanding of how to help others with their problems and how to tune my problems out.

It was necessary for me to do research for my topic. Background research required the reading of Bales, R., and Strodbeck, F. - Phases in group problem solving, in the Journal of Abnormal and Social Psychology., 1951, 46, 485-495. Also Hill, W. F., Learning Through Discussion, Beverly Hills: Saga Publications, 1962.

CREATING AND OBSERVING GROUP PROCESS

Exercise developed by:

Spanier, R., E^3 Program, Illinois Institute of Technology, 1975.

Goals

I. To simulate an E^3 project group and give it a task to perform.

II. To help observers and participants to experience group process and then conceptualize the relationship between orientation, evaluation and control.

Group Size

At least two groups of five to seven group members, and two to four observers for each group is the minimum number for this task.

Time Required

One to one and a half hours

Materials Utilized

I. Paper and pencil

II. Questions to guide observations

Process

I. The group works on the task for 40 minutes.

II. Observers are selected and given a set of questions to use as a guide to their observations.

III. Observers give oral reports and group members discuss their participation in the group (20 minutes).

IV. All groups come together and compare group processes that occurred in each.

Task

Develop a recreational device to amuse and enhance a five year old child for a cost not to exceed $10.

Observation Questions

1. Does each person accept the stated or implicit goals of the project? How did this affect each person in the project?

2. Did the group atmosphere encourage each member to talk about why he wants to be in this project and what each member needs to get done there? Who did this and how?

3. Did the group assess the resources it already has in its members, especially resources relevant to this project? How was it done?

4. Do the group members agree on what criteria are to be used for evaluation of each idea? If yes, how were the criteria established?

5. Personal observations -

My Personal Experience with the Practicum in Leadership Training

Algirdas Underys
Fall, 1975

One of the goals of the E^3 Program is to become a self-sufficient unit. To meet this goal, students in the program are expected to take over some roles of the outside personnel. One program, that was hoped could be taken over by the students of the E^3 Program, is the Group Dynamics Seminar, now being administered by the Counseling Center. Before one can phase out the use of the outside resources for a program, the students who will take over the task must be trained. This training for the Group Dynamics Seminar was in the form of a Practicum in Group Dynamics. Requirements for the Practicum were that the students would participate in the preparation of each session of the seminar; and, for one session of the seminar would prepare the material and present the session alone.

I faced many problems in the Practicum. In the beginning of the Practicum, I was uneasy in a group of people. Part of this was due to the fact that I was unsure of how people accept and react to my ideas and to what I say. An important experience during the Practicum was the constructive feedback that I received. The feedback has shown me that, in general, my ideas are good and that people receive the message that I am trying to convey. This enabled me to become more open and to express my ideas more freely as the Practicum progressed. Another problem I faced was the lack of knowledge of how to present a session to a group of people in a seminar-type atmosphere. By going through the preparation sessions, week by week, and seeing what worked and what failed during the sessions, I was able to prepare an effective session of my own. This session required researching the topic, devising an exercise for the topic, and then delivering a lecture and leading an exercise in the Group Dynamics Seminar. The lecture covered the ideas summarized in the handout, Roadblocks to Communication.

The Practicum was a valuable learning experience. If there is one thing in particular that I have learned, that probably could not have been learned any other way, it was the importance of constructive feedback for personal change. I learned from what others told me and actually saw myself change in a way that I worked with others more effectively.

The following background research materials were utilized:

1. Gordon, T., Parent Effectiveness Training. New York: Peter H. Wyden Inc., 1970.

2. Hill, W. F., Learning Through Discussion. Beverly Hills: Sage Publications, 1962.

3. Jacobs, B., Training Manual for Counseling Skills. National Drug Abuse Training Center, Washington, D.C. 1973.

4. Kepner, C. and Tregue, B., The Rational Manager. New York: McGraw-Hill, 1965.

5. Miller, J., Strasser, J., and Zent, K., Communication Skills Training. Marquetts - Alger Intermediate School Districts, 1974.

PERSONAL PROBLEM IDENTIFICATION

Exercise from:

Underys, A., E^3 Program, Illinois Institute of Technology, 1975.

Goals

I. To use the group setting to identify personal problems.

Group Size

Any number of triads

Time Required

Approximately one hour

Materials Utilized

I. Pencils and paper

II. Handout: "Roadblocks to Communication"

Physical Setting

Participants should be seated in groups of three. Size of the room, and the tolerance of the participants for noise will determine how many groups per room.

Process

I. Approximately 10 minutes. Every person will identify (to himself, and in writing if he wishes) a vague feeling of uneasiness, tension and the specific incidents that cause these feelings. List the specific incidents.

II. Approximately 10 minutes per person (30 min. per whole triad). A member of the triad will communicate his feelings (uneasiness, tension) and the specific incidents that seem to cause these feelings. Then the other two members will attempt to find common characteristics in those specific incidents. After 10 minutes, the process is repeated for another member. After 10 minutes the process is repeated again with the third member.

III. Approximately 10 minutes total time. Each member will give feedback to the other two members of the triad. The feedback will relate the similarities and differences in the three persons' experiences.

IV. Approximately 5 minutes. Wrap up the exercise. Bring up the point that each individual can now formulate the problem which causes his uneasy feelings, incorporating or ignoring the feedback given to him. Each member hopefully realizes the problem as such, and not as vague feelings of uneasiness or tension, and can therefore more readily take steps to solve the problem.

ROADBLOCKS TO COMMUNICATION*

(the following are examples of statements in each category listed)

1. Ordering -

"You have to do it, and do it now."
"You're not Johnny, so you do what I say."
"Don't you ever talk to me like that again."

2. Threatening -

"If you talk to me like that again, you'll be grounded."
"If you know what's good for you, you'll stop."

3. Moralizing - (using "shoulds" or "oughts")

"You shouldn't feel that way."
"It was okay for me when I was a kid so its okay for you too."

"Do unto others as you would have them do unto you."
"Boys aren't supposed to cry."

4. Advising - (telling persons what to do to solve their problems)

"If you study harder, it will be easier."
"Why don't you find something to play with?".
"If you would share, that wouldn's happen."

5. Logical Arguments - (teaching or lecturing)

"You have to study or you won't pass."
"It's important to get good grades or you won't get a job."
"If you don't go to church, you'll go to hell."

6. Criticizing - (making negative judging or evaluation)

"You're all mixed up."
"You've got the facts confused."
"I think you're all wrong."

7. Praising - (building assets to manipulate)

"I think you're okay."
"I like you the way you are."

8. Name-calling - (putting person into category - demeaning, labeling)

"You're a snot."
"You're a delinquent."

9. Interpreting - (reading into the motives of a person)

"You're just doing that to bother me."
"You're doing it cause your friends are."
"You're just feeling sorry for yourself."

*from Miller; Strasser; Zent, 1974.

10. Reassuring - (trying to make a person's feelings go away)

"I will be okay by tomorrow."
"Ah, it really doesn't hurt."
"You'll get over it."

11. Probing - (questioning for your own benefit not the other person's)

"What did you do to him to make him hit you?"
"What makes you feel that way?"
"Do your friends feel like that?"

12. Diverting - (getting the person away from the problem)

"Put it out of your mind."
"Let's talk about something else."
"Don't worry about it."

EFFECTS OF THESE MESSAGES*

Effects of these messages on the child:

The child may feel:

"My feelings don't count."
"Nobody listens to me."
"They think I'm doing something wrong."
"I'm not okay, I'm supposed to change."
"I'm not supposed to feel this way."

Effects of these messages on parents:

"They turn me off and make me angry."
"I want to fight back."
"I'm not about to listen to any suggestions."
"I feel bad enough without being criticized."
"I need someone to listen not preach or advise."
"I'm grown up, don't treat me like a child."

* from Gordon, 1970.

My Personal Experience with the Practicum
in Leadership Training

John Vaznelis
Fall, 1975

I worked as a facilitator with an E^3 project group. I found that attendance at the first meeting of a group with which you are to work is important. It is at this first meeting that you should explain to the group what your purpose in the group is going to be. You should explain the role of the facilitator and set up the contract with the group members. This contract should include some time at the end of each meeting to react to the meeting. It should allow you to provide continuous feedback during the meeting itself.

In giving actual feedback to the group at the meeting, it is very important to consider when the feedback is given and how it is given. If the feedback is given at a time when the group is very pressed for time and the feedback is critical of the group, the reaction may be one of rejection. In giving feedback, it should usually be given indirectly. Instead of saying, "George has taken us off the topic" you should be constructive and less directive by saying "I think we have wandered off the topic and maybe we should return to the original point of discussion." In general your purpose in the meetings is to keep everyone involved in the group effort, keep them mostly on their set agenda, and bring out any issues that you feel may be shared by members of the group but which is not brought up by them.

Your final task is to discuss your group experience with the other facilitators who in this case were all Counseling Center Staff members. At this meeting, I was able to ask for help and guidance from the more experienced facilitators. Also from listening to the reports of other facilitators, I was able to learn what to look out for in my own project group.

Throughout my role as facilitator, especially as a student facilitator, there are numerous anxieties that I felt. First and foremost is the fact that you have to explain to your fellow students that this is a serious effort on your part and that you are qualified to perform this task. Secondly, if you are too strong in any of your feedback, the reaction from other students and the faculty is much stronger than if it came from a Counseling Center staff member.

Another area that created further anxieties for me was with the E^3 faculty. They naturally carry the feeling that they are the teacher and you are the student, but when you as student are attempting to give them feedback, they at first do not readily accept it. This was especially noticed when one of the faculty members was involved in carrying the group off the topic. When I pointed out to the group that we have wandered off, his stare at me was a definite sign of his anger towards me and it made me feel extremely uncomfortable. Another example was a time when I brought up the subject of the Review Board. Upon asking for comments from the group members on the Review Board meeting, one of the faculty members who is sometimes on the Board himself responded with, "What do you mean by that," which completely closed down any further discussion by the students on that topic." Unfortunately, all the real problems that involved the Review Board were avoided, thus preventing any real constructive change in my group.

The least of my worries, but still a noticeable one especially at the beginning of the Practicum Experience was the awkward feeling that arose at the facilitators' weekly group meeting. My feeling was generally one of not being able to "compete" with the other facilitators who have already had years of study in that general area. However, this feeling slowly dissipated as the semester went on. It seems especially helpful in this problem that the other members in our meeting valued my comments and did not consider me a lowly "student."

DETAILED COURSE DESCRIPTION AND SYLLABUS:

PROJECT MANAGEMENT SEMINAR

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ARIADNE BECK EARL YOUNG

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Spring, 1975

The Project management seminar was a fifteen week laboratory training experience for the E^3 students and faculty. The seminar consisted of both didactic and experimental exposure to a broad range of topics pertinent to project group management. Structured exercises were used to highlight each topic. The topics included self-assessment and development, motivation, planning, techniques of organizational evaluation, decision-making and its administrative impact, and conflict management and resolution.

The text, (Knudson, Woodworth and Bell, 1973) was selected because it offers a concise integration of theoretical and practical aspects of small group management.

The seminar was open to students and faculty who had participated fully in the previous Counseling Center Group Dynamics Seminar. The credit granted ranged from one to three credit hours depending on the quantity and quality of the student's work.

Following is a detailed synopsis of the seminar:

Weeks 1 and 2: Self-assessment and Development, designed to enable the participants to give some time and thought to their future professional activities; text, pp. 393-412.

Weeks 3 and 4: Motivation, designed to enable the participants to identify those internal and external motivation factors that impact upon group productivity, and to further clarify motivational factors in small group management;

text, pp. 81-108
supplemental reading: Herzberg, Mausner and Snyderman, 1959.

Weeks 5, 6, and 7: Planning, designed to enable the participants to understand aspects of the planning process and to observe performance and behavior within groups involved in the planning process as well as to acquaint them with the overall complexity of this process.
text, pp. 113-150
supplementary reading: E.H. Schein, 1969, pp. 46-52.

Weeks 8 and 9: Techniques of Organizational Evaluation, designed to enhance and develop skills in understanding complex organizational relationships and to provide an opportunity for the participants to evaluate alternative organizational arrangements and their characteristics.
text, pp. 153-219.

Weeks 10 and 11: Decision-making and its Administrative Impact, designed to enable the participants to come into contact with basic information regarding the nature of decision-making process in organizations and, further, to enable the participants to experience alternate decision-making methods.
text, pp. 223-260
supplementary reading: Schein, *op. cit.*, pp. 52-58, 67-69.

Weeks 12 and 13: Conflict Management and Resolution, designed to provide the participants with an opportunity to observe leadership patterns, group decision-making methods and the interactional process among competing groups.
text, pp. 261-310.

Weeks 14 and 15: Seminar Feedback and Future Planning, use of written questionnaire and group discussion to elicit participants' feelings, thoughts and suggestions regarding the value and impact of the seminar and ways to improve it.

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Summary of Feedback from
the Project Management Seminar

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Spring, 1975

At the last meeting of the Project Management Seminar a discussion was held in which the participants evaluated the seminar and made suggestions for improvement of the format and content. During that session they briefly indicated their views on a short questionnaire as well. Following is a summary of their commentary in the discussion and on the questionnaires.

Students in the seminar varied in the learning they reported from the seminar. Most students claimed to have gained a greater understanding of groups in general and a greater sensitivity to how others behave and feel in groups. In terms of learning about themselves, nearly all the students reported having learned something new about themselves. Such learning included greater understanding of personal motivation, awareness of work preference (alone vs. in a group), awareness of one's own high expectations of others, insight regarding one's intolerance of others' work styles, realization of one's withdrawal, discovery of the difference between planning and "playing it by ear."

The amount of actual behavior change which students reported was less extensive than the amount they felt they had learned. One student said he felt the seminar helped him to open up more in his project group. Another said he now seeks the opinions of others more often. A third claimed that he was able to take on more responsibility in the group.

Another said he was trying to change his counterproductive tendency to bottle up hostile feelings. The remainder were either less specific or else stated that they did not change as a result of the seminar.

There was a good deal of consistency and overlap in the students' evaluations of the design of the seminar. The experiential format was generally acknowledged as the best feature of the seminar. The lecture portions were seen as less effective in conveying the conceptual focus and it was felt that such focus was better achieved through group discussion after experiential exercises. In that regard, students felt that more time should be allowed for discussion of the exercises, after they had been completed. In the interest of time, they emphasized the importance of students reading the exercise and related material before coming to the seminar. This avoids having to make belabored explanations of instructions. Despite the need for more time, spending two weeks on an exercise was seen as disruptive, particularly when participants from the first week fail to come the second week or people absent for the first week come on the second.

The opportunity to give and receive feedback regarding one's interpersonal and work style was seen as especially valuable. Students felt that more time for such opportunities should be designed into the seminar. One student proposed having feedback sessions at the beginning and at the end of the semester as well. Students also felt it as valuable to be able to observe groups at work and be able to compare how different groups deal with a question.

There was a divergence of opinion regarding whether the seminar should focus on actual project group problems. While some felt attention to such matters would be helpful, others felt that it was valuable to get away from actual project work and have an opportunity to talk to people in a different context. Two particular problems experienced in the E^3 project groups were identified for further discussion, however; the disruptive or non-productive group member, and the lack of communication between project groups.

Finally, looking at students' interest in seeking management level positions, five students said their interest increased as a result of the seminar, one said his interest decreased (because a management position would be too much trouble) and four said they experienced no change or were not sure.

FOLLOW-UP QUESTIONNAIRE FOR E^3 PROJECT MANAGEMENT SEMINAR

1. Did your participation in the seminar help you in your project group (please explain):

   a. to function better or differently yourself
   b. to understand others or the group as a whole
   c. to contribute differently

2. Did you learn anything about yourself in terms of:

   a. your style or participating in a group
   b. your leadership style
   c. your management style

   If so, what did you learn?

3. Did you notice any change during this semester in your participation in your project group. For example did you assume more or less leadership responsibility, take more responsibility for harmonizing, collaborating or planning in your group?

4. If you were going to plan for this seminar next year what would you change or emphasize?

5. Are there any particular areas that you would spend more time on? less time on?

6. What did you like best and least in the work this seminar this semester?

7. Did your experience in this work increase or decrease your interest in seeking a management level position in your field? Why?

DETAILED COURSE DESCRIPTION AND SYLLABUS:

FACILITATING CREATIVITY IN INDIVIDUALS AND GROUPS

Beck, A., Shiel, T., Tobey, R., and Young, E.

Illinois Institute of Technology

Spring, 1976

The Creativity Seminar was a 13 week experience that was open to both students and faculty members of E^3. The seminar consisted of both didactic and experiential exposure to the realm of creativity. Its purpose was to heighten individual sensitivity to and awareness of one's own creativity, as well as learning methods for evoking creativity in individuals and groups. Other areas that were investigated were: problem-solving techniques, group techniques for creativity, group process and its relationship to both creativity and task development, creative experiences with visual thinking, envisioning organizational change and testing for creativity.

There was no text for the seminar. Four faculty members worked together to share their knowledge from different perspectives and different backgrounds concerning creativity. The bibliography they recommended follows the course description.

One credit was granted for attendance, participation in discussion and completion of assignments. In addition, individuals interested in becoming more involved in a particular area of creativity were afforded the opportunity to earn one additional credit.

Following is a detailed synopsis of the seminar:

Week 1 What's in it for Me? Individual needs, desires and expectations, were verbalized concerning what participants would like to learn from the seminar. Also, the idea and concept of creativity was discussed, getting the participants to build a definition based on their own views.

Week 2 Personal Creative Experiences. Individual experiences in the area of creativity were shared within small groups in order to acquire a "shared" history of the different forms and situations in which participants have experienced themselves able to be creative. Each member wrote a personal statement about a creative experience prior to coming to this session.

Week 3 and 4 Individual Problem-Solving Techniques. The purpose was to familiarize participants with some of the techniques utilized to facilitate individual creativity and to determine which of these techniques might be effectively implemented by each individual for developing his own creative style.

Week 5 Group Techniques for Creativity. Various techniques that stimulate creativity within a group context were presented. Exercises were used to familiarize the participants with the experiences.

Week 6 Group Process, Creativity and Task Development. The relationship between group process, creativity and task development was investigated. Also, various types of group dynamics which affect the atmosphere within a group (i.e., scapegoating, criticizing, labeling, value judgments and competition) were discussed.

Week 7 Mileage Checkup. The group re-examined its expectations, needs, desires and wishes within this time block in order to assess if participants were receiving what they desired from the seminar. The purpose was to better integrate the needs of participants with the focus of the seminar.

Week 8 Creative Experiences with Visual Thinking. The purpose was to outline models of thinking processes, demonstrate ways used to facilitate flexibility in thinking processes via experientially oriented exercises in the visual dimension.

Week 9 Envisioning Organizational Change. The senses were stimulated via slides and music in order to create an atmosphere conducive to risk taking. Charcoal and paper were used as the medium through which participants expressed themselves and worked towards a better understanding of a particular organization in which they were involved. Creative solutions and alternative approaches to problems inherent in organizations evolved from the participants' experience and interaction.

Week 10 Synthesis. This model of creative problem solving was presented and demonstrated to the group. A discussion concerning its focus, underlying assumptions and effectiveness followed.

Week 11 and 12 Testing for Creativity. A historical summary was presented of conceptualizations of intelligence and of creativity in psychology and education. The study of Getzels and Jackson on creativity and intelligence was described. The seminar participants took the tests that were used in that study to assess creative ability. Their tests were scored and their results were discussed. The results of the Getzels and Jackson study were presented and their implications were discussed.

Week 13 Discussion and Feedback. Individual and group feedback were offered. Participants received direct feedback from leaders of the seminar concerning their growth and development. Finally, credit allocation issues were discussed.

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CHANGES RESULTING FROM TRAINING E^3 STUDENTS IN GROUP DYNAMICS

Tom Cogan, Ron Ruff, Bonnie Rudolph, Ariadne P. Beck

Counseling Center

Illinois Institute of Technology

The E^3 Program invited staff of the IIT Counseling Center to conduct a seminar in group dynamics and leadership for the students in E^3. During the Fall semester, 1973, a seminar was offered by Ruff, Rudolph and Cogan which covered topics such as communication and feedback, group roles and leadership of small groups, and problem solving in small groups. The seminar included both short lectures on these topics and exercises which focused on facilitating both participation and observation of the issues being discussed.

In an effort to assess the impact of this training on attitudes toward leadership and group process in what was essentially an inexperienced population of students, a pilot study was designed and executed. It was hoped that the results of this study would tell us something about the areas in which the training had greatest impact. Of course, the student simultaneously participated in E^3 project groups and a variety of program level committees or general meetings. During this period the opportunity was also created to compare E^3 students to other IIT Engineering undergraduates. Access to this group was obtained through their participation in a required Introductory Psychology course. Dudek (1974) conducted a study comparing E^3 and other IIT students on the Occupational Preference Questionnaire (1964).

SUBJECTS

The sample consisted of two subject groups. The first group was made up of twenty-three E^3 students enrolled in the Group Dynamics Seminar conducted by the staff of the IIT Counseling Center. This group participated in the pre and post administration of the Dilemmas-of-Choice Questionnaire, the Marlow-Crowne Scale for Social Approval, the Semantic Differential, and the Group Dynamics Questionnaire.

The second subject group consisted of thirty-two volunteers enrolled in an Introductory Psychology class at IIT. All subjects in this group were majoring in engineering at IIT. This group participated in the single administration of the Occupational Preference Questionnaire, the Semantic Differential, and the Dilemmas-of-Choice Questionnaire. Subjects were matched as closely as possible on age, sex, and year in school.

INSTRUMENTS

Occupational Preference Questionnaire (OPQ) is a 23-item choice questionnaire developed by Hershenson (1964). It measures the degree to which a person perceives him or herself as fitting into his/her stated occupational choice (SOC). This instrument was designed to assess two areas:

a) The subject's perception of the fit of his/her occupation to his/her hierarchies of abilities, interests and values.

b) His/her conception of the place within his/her past, present and future life styles.

Items in the instrument include: commitment to SOC; knowledge and relevant experience regarding the SOC; the fit between the person's abilities, interests and values and those required by the SOC; anticipated potential in SOC; alternative choices and importance of the SOC in the person's life.

Group Dynamics Questionnaire. The Group Dynamics Questionnaire (GDQ) is a 25-item Likert Scale questionnaire measuring the respondent's attitudes towards groups and their processes on a 1 - 5 point scale. In addition to the twenty-five scaled items there are four questions requesting the respondent to give a subjective introspective assessment of his/her experience with groups. The GDQ is a modified form of the Opinionaire on Assumptions about Human Relations Training developed by Pfeiffer and Jones (1969).

Semantic Differential. The Semantic Differential developed by Osgood (1957) is a technique designed to measure meaning. The theoretical construct underlying the Semantic Differential is linguistic encoding, or overt response which constitutes instrumental acts and thereby serves as an index of representational mediation process.

The Semantic Differential measures or isolates the "meaning of the stimulus sign. In a combination of controlled association and scaling procedures, the subject is given a concept to be differentiated, along with a set of bi-polar adjectival scales. The subject is then asked to indicate for each item or pairing of a concept with a scale both the direction of his association and the intensity of his association on a seven-step scale.

A number of bi-polar pairs of adjectives are selected to represent in total the evaluative factor (good-bad), the potency factor, and the activity factor (active-passive). Eight concepts were rated by the subjects on the ten seven-point scales. A point of one on the scale indicated a neutral rating, while a score of seven indicated the most positive and stronger rating. A score of four indicated a neutral rating, while a score of seven indicated the most negative, weakest rating. The concepts which were rated are as follows: Me, Leadership, Professor, Communication, Student, Problem Solving, Group, and Cooperation.

Dilemmas-of-Choice Questionnaire. The Dilemmas-of-Choice Questionnaire, developed by Kogan and Wallach (1964), is a 12-item instrument in which each of the items presents a specific choice dilemma to the subject. The subject is asked to choose a course of action that represents a safe, moderately risky course of action. The items are then scored. The score represents a "relative risk factor."

Marlow-Crowne Scale for Social Approval. The Marlow-Crowne Scale developed by Crowne and Marlow (1960) is a 33-item true-false questionnaire assessing the degree to which individuals avoid self-criticism and depict themselves in improbably favorable terms. An example is "I never talk behind another's back." Item style and content indicate the scale has "lie scale" properties.

PROCEDURE

During the first session of the sixteen week Group Dynamics Seminar the following instruments were administered to the E^3 students by the Counseling Center staff:

a. Dilemmas-of-Choice Questionnaire
b. the Marlow-Crowne Social Approval Scale
c. the Group Dynamics Questionnaire
d. the Semantic Differential

On the following day the Occupational Preference Questionnaire was administered to this same group by an E^3 psychology staff member. The total testing time was 2.5 hours.

The E^3 students then participated in a sixteen week Group Dynamics Seminar, taught by the Counseling Center staff. It met once a week for one and a half hours each time.

During the sixteenth week the E^3 students were tested by the Counseling Center staff with the same set of instruments excluding the Occupational Preference Questionnaire.

Concomitant to the first testing session for the E^3 students enrolled in the Group Dynamics Seminar, the group of engineering majors enrolled in an Introductory Psychology course also participated in a testing session. The following instruments were administered by an E^3 staff member:

a. the Occupational Preference Questionnaire
b. the Dilemmas-of-Choice Questionnaire
c. the Marlow-Crowne Social Approval Scale
d. the Semantic Differential

ANALYSIS OF DATA

Two kinds of comparisons were made in the analysis of these instruments. The students' scores before and after the sixteen week training seminar were compared to assess change. In addition the scores of the pre-testing for E^3 students were compared to the scores for the non-E^3 IIT engineering students to assess whether there was a difference in the E^3 population as compared to the general IIT engineering population.

To assess the differences among the means for the various groups in this study, several statistical methods were used. The *t* test was computed to compare the scores for the pre and post administrations of the Dilemmas-of-Choice Questionnaire and the Marlow-Crowne Scale of Social Approval. The chi square was used to compare the groups on the

Occupational Preference Questionnaire and the Semantic Differential. The pre and post versions of the Group Dynamics Questionnaire were not analyzed statistically. The results from this instrument are discussed at the end of this section.

RESULTS

Dilemmas-of-Choice Questionnaire

Although an increase in the level of risk-taking was found for the mean difference scores on the pre and post administration of the Dilemmas-of-Choice Questionnaire to E^3 students, this difference was not significant, (t = 1.57, d.f. = 21, p.N.S.).

The data does indicate a significant difference between E^3 engineering students and IIT engineering students in general with regard to risk-taking. The reported significance is in the direction which indicates that E^3 engineering students have higher risk-taking level than the general IIT engineering student represented in this test group, (t = 2.32, d.f. = 23, $p < .05$).

Marlow-Crowne Scale for Social Approval

Pre and post treatment differences concerning the mean score comparisons in the Marlow-Crowne Scale failed to achieve any significance, (t = 153, d.f. 21, p.N.S.). Likewise no significance was reported on the mean differences between E^3 engineering students and IIT engineering students in this test group, (t = .446, d.f. .23, p.N.S.).

Occupational Preference Questionnaire

The data reported in Table 1 is a cross-tabulation between University class level and OPQ scores using the collective data for both E^3 engineering students and IIT engineering students. The differences in the scores reported is significant, ($X^2 = 3.51$, d.f. = 12, $p < .05$), and in the expected direction. The more senior the student, the higher the degree of occupational commitment.

(Insert Table 1)

Table 2 indicates a trend difference between E^3 engineering students and IIT engineering students in general with respect to the perception they have of their own ability to fit into the role they have chosen as an occupation: that of engineer. A trend toward a more realistic fit among E^3 engineering students was reported, ($X^2 = 5.409$, d.f. = 4, $p < .25$).

(Insert Table 2)

Semantic Differential

While no significant differences were reported between E^3 engineering students and the IIT engineering students in general, there were some interesting differences reported within the E^3 group. Table 3 shows the analysis of factor scores before and after the Group Dynamics Seminar on the Semantic Differential. Cell 1 indicates a substantial increase in the E^3 students' ability to evaluate more closely after training, ($t = 1.41$, d.f. 19, $p < .10$). Cell 2 indicates there were significant pre/post changes regarding the potency factor on the Semantic Differential, ($t = 3.13$, d.f. 19, $p < .01$). The students apparently felt more potent and impactful in group situations and in the program. Cell 3, like Cell 1, shows a strong trend toward an increase in the activity factor on the post treatment measure, ($t = 1.56$, d.f. - 19, $p < .10$, indicating increased energy in these contexts.

(Insert Table 3)

Group Dynamics Questionnaire

This instrument is not analyzed statistically. It was studied to assess changes in attitude, expressiveness or reports of behavioral change.

1. As a result of their experience in the seminar, the students generally became more interested in and curious about group processes, leadership and the coordination of individuals in team work.

2. The post test results indicated that the students became more aware of their attitudes and feelings when working in a group context and they reported a greater willingness to share these views in the work-group context itself.

3. Most students expressed greater comfort about working with others.

4. Many students reported a greater understanding of the orientation process a group goes through when beginning to work together. One might expect that this would result in less time being spent in this phase of group activity in the future.

DISCUSSION

As the results indicate, the E^3 student differs in several ways from his non-E^3 counterpart. Viewed as a group, the students engaged in the E^3 program tend to be less restricted in their choice of problem solutions. They tend to be more novel and creative in their approach to problem identification and resolution. The level of risk-taking being the key factor here, one cay say that the E^3 student is less traditional and results-oriented than the general engineering student. He seems more willing to note and reflect upon the implications of his decisions and choices.

The question of whether this kind of thinking is a function of his E^3 training or if he brought it to the program has in some ways been narrowed. It appears that while the differences in the pre and post administration of the Dilemmas-of-Choice Questionnaire were not statistically significant, there was a shift during this period. The implication is that the seminar in combination with the atmosphere of the project group have an effect on the risk-taking behavior of the E^3 student. Earlier studies concerning the risky-shift phenomenon have consistently reported that high risk-takers greatly influence the risk factor in low or medium risk-takers. It would seem that the E^3 philosophy and atmosphere are conducive to increased risk-taking therefore, whether the student entered the program with a high level or not.

Another interesting result of this study concerns the occupational choice of the E^3 student. The most statistically significant difference is reported in terms of class or university level. As expected the more mature the student and/or the longer he has been in a curriculum the more he is committed to a specific occupation. The "older" students in E^3 seemed to be more focused than the freshmen and as well focused as upper classmen in general at IIT.

Probing deeper into the concept of occupational choice, the results detail a significant trend. It appears that E^3 students perceive their occupation as a more "realistic fit" for them, than those students in the non-E^3 engineering population at IIT. Support for this may be found in the notion that the E^3 student sees himself as a more generalized engineer able to fulfill a variety of engineering functions, and, by the fact that the project work, which is the bulk of the curriculum, in many ways simulates the actual work of the engineer. The student is therefore coping more with the actual, expected demands of the engineering profession and therefore with his role in that profession. A final explanation for a more realistic occupational fit may lie in the fact that the students in E^3 have closer working relationships with their instructors, who include professional engineers, than most other IIT engineering students. This role model may play an important part in demystifying the role of the engineer.

Significant differences were reported in the E^3 group's pre and post scores on the Semantic Differential. It appears that after taking the Group Dynamics Seminar the E^3 student became more evaluative, active, and potent in terms of associative meaning. This finding was congruent with many informal observations that were made of these same students in the context of their participation in program activities, project work and other learning experiences. They generally became more assertive, organized themselves and advocated various issues and areas of change in the program and generally became more active and collaborative in their participation. This change was supported by the E^3 Program generally as well as by the impact of the seminar.

Over time E^3 students in the Group Dynamics Seminar became more integrated with the E^3 educational concept and process. They became less anxious about the professor-student dichotomy and more interested in group work, communication and leadership abilities.

While there was no instrument administered that was specifically designed to measure changes in "self concept" the stimulus concept "me" on the Semantic Differential did show a positive shift over the course of the time that the Group Dynamics Seminar was taught. It is quite possible that the fact that students were able in a variety of ways to deal with problems in E^3 may be the reason for the active shift of interest in both the topics being taught in the Group Dynamics Seminar and the work in E^3 itself.

In conclusion, the results of this study indicate that the seminar did have a meaningful impact upon the E^3 students in ways that were seen as valuable by the instructional staff, the faculty in E^3, and the students themselves.

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Table 1

OPQ Discrimination by Class Level

for Entire Subject Population

Year	Number of Subjects	Score Range	Raw Total
Freshman	29	40 - 89	51.8
Sophomore	16	50 - 89	28.6
Junior	6	60 - 89	10.7
Senior	5	60 - 89	8.9

Raw Chi-Square = 3.516 df = 12 Significance .9907 p. < .05

Table 2

Difference Between E^3 Students and Other IIT Engineering Students with Respect to Perceived Occupational Fit

Group	Number of Subjects	Score Range	Raw Total
E^3 Students	29	40 - 89	51.8
Other IIT Engineering Students	27	60 - 89	48.2

Raw Chi Square = 5.409   df = 4   Significance .2478   P < .25

Table 3

Mean Difference Before and After Training

Semantic Differential - E^3 Students

Variable	Number of Subjects	Mean	Standard Deviation	Difference Mean	df	t - value
Evaluation						
Before Training	20	2.662	.581	.1061	19	.141*
After Training	20	2.556	.498			
Potency						
Before Training	20	3.266	.621	.2520	19	3.13**
After Training	20	3.014	.641			
Activity						
Before Training	20	3.072	.591	.1726	19	1.56*
After Training	20	2.900	.535			

* $P < .10$
** $P < .01$

ABSTRACT

FACTORS RELATED TO SUCCESS AND FAILURE IN AN EXPERIMENTAL ENGINEERING PROGRAM

SUSAN FELDMAN-ROTMAN

M.S.

ILLINOIS INSTITUTE OF TECHNOLOGY

1976

The role of personality, performance and evaluation factors in predicting success and failure in an experimental undergraduate engineering program were investigated. High internal locus of control, more positive faculty and self-evaluation and greater academic credit allocation by the end of the first year differentiated the successful from the unsuccessful students. These factors suggested approaches to screening, early identification of potential failures, and interventions aimed at minimizing the drop out rate.

DETAILED COURSE DESCRIPTION: E^3 PROBLEMSOLVING SEMINAR

Sharon H. Poggenpohl
Institute of Design

Mike Merzer
Counseling Center

Barry Bickley and Tom Methenitis, E^3

Purpose:

1. To bring problemsolving processes to awareness.
2. To acquaint E^3 students with different formats and techniques for approaching problemsolving.
3. To develop playful, flexible approaches to problems.
4. To understand through experience how various techniques can enliven the group process leading to better participation and more cohesive teams.

Format

The approach was pragmatic - user-oriented, rather than theoretic. Each seminar began with a discussion of the technique which was followed by team problemsolving using the technique on a prepared "problem" or an a problem brought by a team or team member to the seminar. The seminar concluded with a review of each team's experience with the technique under discussion.

Team membership was fluid and changed from session to session. A considerable amount of attention focussed on group dynamics in relation to specific techniques.

Topic in the Series

1. Eliminating Mental Blocks
2. Searching for Visual Inconsistencies
3. Brainstorming
4. "PO"
5. Synectics
6. Matrixing, Morphological Analysis
7. Ranking and Weighting

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ABSTRACT

OCCUPATIONAL COMMITMENT AMONG COLLEGE STUDENTS

Felicia A. Dudek
Psychology 577
Illinois Institute of Technology
April 1974

The purpose of this study is to test for differences between groups of college students on a single variable, that is, commitment to occupational choice (as defined by a score on the Occupational Plans Questionnaire), and further, to relate the Occupational Plans Questionnaire (OPQ) scores for one of the groups with their relative academic rank.

Illinois Institute of Technology (IIT) currently offers an experimental engineering program, "Education and Experience in Engineering," (E^3), funded by the National Science Foundation. This program encompasses an interdisciplinary approach to learning, the mastery concept of learning, and learning initiated by project work rather than classroom lecture. Students in this program learn engineering by actually performing engineering functions--something which engineering students in the regular curriculum do not experience during their college careers. E^3, because of its rather unstructured, unique, and demanding format, requires different skills from its students than are required from students in the traditional curriculum. It is hoped that OPQ performance will differentiate E^3 from students in other disciplines. However, it is not known how, or even if, E^3 students actually differ from other students, particularly other engineering students.

APPENDIX XIV

BOARD OF ADVISERS

E^3 BOARD OF ADVISERS

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APPENDIX XV

REPORTS ON E^3 BY

J.C. HOGAN AND K.G. PICHA

ILLINOIS INSTITUTE OF TECHNOLOGY

Armour College of Engineering
Office of the Dean

TO: E^3 Program Center

FROM: P. Chiarulli

DATE: October 10, 1975

SUBJECT: SUMMARY OF CONVERSATION WITH DEAN J.C. HOGAN, NOTRE DAME

I recently had a telephone conversation with Dean Hogan relative to the potential of E^3 as an engineering program and as an ECPD accreditable program. Following is some rough-and-ready reactions developed by him during his recent visit to IIT and the E^3 Program Center.

1. It would seem to be worthwhile for IIT to put the E^3 Program up for ECPD accreditation. There is present sufficient strength in the program to likely make it accreditable. Even if accreditation is not awarded, no serious harm will be done and, in fact, the institution will have had an opportunity for extensive consultation with an outside group relative to what would need to be done to improve the E^3 program and/or to make it accreditable.

2. Can such a program be run on a reasonable cost basis? Dean Hogan was concerned that the one-on-one basic approach of E^3 could be too expensive in comparison with traditional engineering programs. I discussed with him my "calculation" that a fully operating E^3 program (100 students) could be operated with a full-time director, two full-time associate directors, and 15 1/3-time faculty members, representing the various disciplines. I particularly noted the additional (no cost) resource present in the E^3 program due to student-to-student learning processes. Dean Hogan noted that this analysis seemed to be reasonable.

3. He was particularly impressed with the strong features of student interactions and the fact that the basic educational thrust is through use of "real and practical problems."

4. It would seem to be worthwhile to develop a correlation between learning achievement through the module system and what students typically learn through equivalent regular course approaches. Dean Hogan and I discussed possibilities of developing a measurement through giving an overall integrated final examination to a group of E^3 students and a group of equivalent level "regular" students in some of the basic core areas covered by modules.

5. He was disappointed in the present E^3 Program Center approach of developing suitable research project support at the $2,000-$3,000 level. He believes this is too low and that E^3 has potential to develop project support at higher levels.

6. Is there a critical mass problem? He basically expressed a concern that there may not be sufficient depth for stability in terms of an orderly continued development of the E^3 program. I noted the concept of two full-time Associate Directors in addition to the Director and that in my view that approach made it possible to have depth and continuity.

7. Dean Hogan has the impression that the E^3 Program may be too isolated from existing departmental activity. Though there is representation of many departments on the E^3 program staff, that in itself did not seem sufficient to develop appropriately interrelationships. He suggested that there ought to be a conscious effort for some E^3 laboratory and project activities taking place in a variety of departmental laboratories, using appropriate equipment and facilities in these departmental laboratories and including extra-E^3 staff consultation.

8. At my initiation, we discussed questions of how one might reach consensus as to the appropriateness and the quality of student projects for granting project credit at proper levels. I noted particularly difficulties I was having getting agreement as to how good (or bad) these projects were. Dean Hogan suggested that one effective mechanism might be the review of the projects by an extra-E^3 jury.

FC/vpb

cc: S.A. Guralnick
J.J. Brophy
H. Weinstein

Illinois Institute of Technology
Chicago, Illinois 60616, 312 225 9600

E3

Education and Experience in Engineering

TO: Dean P. Chiarulli

FROM: E^3 Program Center

DATE: October 17, 1975

REFERENCE: Your October 10, 1975 Memorandum to the E^3 Program Center: "Summary of Conversation with Dean J. C. Hogan, Notre Dame."

Dean Hogan's comments are encouraging to us. In his brief visit there were obviously things we didn't cover, things which show up in his comments. If you see him or write, you might indicate the following clarifications. Thanks. Numbers refer to those in your memorandum.

4. The only "equivalent level" that would be appropriate would be examinations at the senior level, since studies in the core curriculum do not end for the E^3 students until their senior year.

5. The budget figures Dean Hogan referred to must be those established by the project groups for internal use only, as an exercise in budgeting. They do not represent external support.

6. Besides the three directors, longer term staffing represents additional means for stability. Examples are Professors E. Stueben (Mathematics) and K. Schug (Chemistry). Professor Baugher (Physics) was with the program for three years, and it is hoped that similar longer term affiliations will occur in the future.

7. Several laboratories from other departments have been used by E^3 students, such as those in Environmental Engineering, Electrical Engineering, Mechanical and Aerospace Engineering, Physics, and Chemistry. E^3 students use the E^3 laboratory/workshop for special modeling and experimentation, but use other laboratories as are available at IIT.

8. The "jury" to judge projects should be constituted by persons external to IIT and should be charged with the responsibility to compare E^3 projects with senior projects from other engineering departments at IIT.

Report on Evaluation of E^3 Program, October 28, 1975

by K. G. Picha

The E^3 Program at Illinois Institute for Technology was reviewed on October 28, 1975. In addition, copies of a brochure describing the Program, the final report on the Windmill Siting Project and the NSF Advisory Panel to IIT were studied very carefully. Some internal documents were also reviewed. The assignment was specifically to give advice on how ECPD might view the E^3 Program. This will be done but additional comments will be made as well.

The E^3 Program is exciting and has brought national recognition to IIT as a result. The Program has been carefully structured to meet ECPD requirements regarding curricula content. The only weakness observed was in the engineering science stem. The IIT core curriculum requires only twenty-seven hours of engineering science while ECPD requires at least the equivalent of one year, which would be thirty-two hours at IIT. The records kept on the project work will indicate additional mathematical, basic science and engineering science. However, it is important to demonstrate for <u>every</u> student in the E^3 Program that he has at least an additional five semester hours of engineering science.

The major problem I see for the E^3 Program accreditation regards stability of the Program. Where ECPD evaluates a new program at any institution, it seeks to satisfy the EE&A Committee and the Board of Directors that the program is stable and likely to remain stable for six years. Clearly, this is a major problem for IIT since the Director is likely to reture in a year or so and oneof the Associate Directors is likely to leave. The other Associate Director is new to the administration of the E^3 Program. Secondly, the report issued in late October by the Curriculum Committee Subcommittee charged with reviewing the Program has recommended that the degree program for E^3 be terminated. Whether or not the recommendation is implemented by the IIT administration is one matter; the fact remains, that apparently there is not strong support for the program by the Faculty.

If the E^3 Program is to receive a favorable evaluation by ECPD, it is my judgment that there must be an indication of strong faculty support as well as administrative support. It would appear that a real selling job has to be done in the next few months to develop faculty support. I cannot evaluate the effect of the likely retirement of the Director.

The reports of the NSF Advisory Committee were remarkably accurate in their assessment of the problems E^3 was facing at IIT. They have been concerned from the beginning as to how the Program could be integrated in the IIT structure after the NSF grant terminated. I fear the situation E^3 finds itself in has deteriorated since the November, 1974 visit of the Advisory Committee. Obviously, a one-day visit cannot lead to the reasons for the deterioration. However, it is clear that a program the size and cost of E^3 would be a likely target for elimination during the severe budget crunch IIT faces. On the other hand, it was sensed that some emotional and perhaps personal issues were involved on both sides were clouding or shading an honest evaluation of the true issues involved. It was recommended that the NSF Advisory Committee hold a mock ECPD visit in the spring of '76 to assist the E^3 Director in the evaluation of accreditation problems he will encounter. It is my judgment that this mock visit will come too late to be useful. IIT has problems now and I would urge that the NSF Advisory Committee meet prior to the ECPD visit to give whatever advice they can to get things back on track.

Problems unrelated to accreditation include faculty participation in the E^3 Program. This seems to have been a problem from the beginning and it is not surprising. Since Departmental participation is carried out by persuasion it will be and has been difficult to get the dedicated, convinced and excited faculty members needed to make the program go. Most programs of the E^3 type that go horizontally across department lines have a major problem and the only times I have seen it work is when a real leader can persuade good people to participate. The reward structure must, and in my judgment has, at IIT, recognized this, at least in merit increases and promotion. Only tenured faculty members should participate since it is my judgment that tenure should be earned by outstanding scholarship and not by simply being a good teacher and participating in innovative programs. Mind you, this is a personal opinion.

E^3 seems to be experiencing difficulties attracting the number of students it needs to remain viable and cost efficient. Although E^3 is well-known to engineering educators, it is not getting into the popular press that students and their facilies read. Much more needs to be done to get coverage in <u>TIME</u>, <u>NY TIMES</u>, and the various national news services. There are students interested in participating in relatively unstructured programs as evidenced by the successful recruiting of WPI and Hampshire College. But, their recruiting is done nationally. If IIT could do the same kind of recruiting, the image of IIT being a Chicago-oriented Institution would change a bit and this might help IIT recruit for other programs as well. Ken Norse, previously Admissions Director ar WPI, warned a couple of years ago that his experience was that the new high-school graduates were less interested in unstructured programs and were indeed looking for structure in their curricula. I pass this along not as a fact, but rather an admonition, since if true, it means more hard work in admissions.

I would support the recommendation given by the NSF Advisory Committee that project support be sought in local industry and various government agencies at all levels. It is realized that such project work might skew the original directions sought for the E^3 project activity. On the other hand, I observed that projects were being undertaken along lines of interest of a group of students and that the theme concept was being skewed at the moment. In addition to financial support, the value of such projects in increased awareness of people in industry and government might assist in the recruiting problem.

Finally, I would like to comment on the Windmill Siting Project I studied. It is likely that this is one of the better projects completed at IIT. I found it to be an excellent piece of work, giving the students experience in theoretical as well as experimental work. If all projects lead to the same degree of sophistication IIT has much of which to be proud.

K.G. Picha, Dean *
School of Engineering
University of Massachusetts
Amherst, Massachusetts 01002

11/4/75

KGP:oht

*Original signed by K.G. Picha

APPENDIX XVI

MOTIONS TO CURRICULUM COMMITTEE AND IIT FACULTY ON ADOPTION OF E^3 PROGRAM

To: Curriculum Committee and Department Chairmen
From: T. P. Torda, Project Director-Experiment In Engineering Education
Date: November 19, 1971
Subject: Motion to be placed before the Curriculum Committee-November 23, 1971

Motion for the Granting of the BSE Degree:

It is moved that the Curriculum Committee recommend that the Faculty approve the granting of the degree Bachelor of Science in Engineering (BSE) to the students entering in the fall of 1972 who complete the program developed by the Experiment in Engineering Education staff.

Supporting Statements:

The following points are offered in support of this motion:

1) At the end of four years, the students participating in the curriculum will have studied and acquired competence in material equivalent to that included in the common mathematics and science and engineering science core programs.

2) During the program the students will develop--in depth and at a level equivalent to the other engineering disciplines programs--engineering competence in analysis and synthesis and in engineering decision making through working on engineering projects and designs which will involve several engineering disciplines. Guided self-study of "learning modules" of advanced engineering content, equivalent to pertinent discipline-oriented courses now in the IIT curriculum, will augment the project work.

3) In the curriculum, the students will have satisfied the equivalent of the general education requirements by the sequence of projects which will have societal significance and which will be performed under the joint guidance of engineering, humanities, and social science faculty. Guided self-study of social science and humanities material as well as seminars will also be provided.

4) Students who may wish to transfer from the BSE program to another degree program may do so with the approval and under conditions stated by the respective department. Since all students in the BSE program will have a "portfolio" recording both performance on projects and learning module completions, transfer will be accomplished by giving appropriate credit for the equivalent courses required by the specific Department.

5) Workshop/laboratory developed to support the BSE program provides students experience in physical phenomena as well as engineering technology.

6) Students graduating from the BSE program will have an ECPD equivalent education in all respects. After graduation of this first class, this will be an ECPD accreditable education.

7) Responsibility for enforcing high quality of educational standards rests with the 17 faculty members staffing the program (from 12 Departments: Chemistry, Civil Eng., Electr. Eng., Humanities, I Eng., Inst. Des., Man. and Fin., Math., MMAE., Phys., Pol. Sc., Psych.) each of whom is in close contact with his Department.

8) The aim of the curriculum for the BSE degree is to give an educational opportunity which does not exist at the present time to a small number of students representing a wide spectrum of abilities: an engineering education in interdisciplinary problem solving within constraints of social needs (economic, political, legal, etc.).

9) Since this is an experimental curriculum, faculty review and approval will be sought on an annual basis.

The June, 1971, issue of the Proceedings of the IEEE is devoted to the assessment of the change in engineering education (not only in electrical engineering, but in engineering in general). J.R. Whinnery, the guest editor, states: "It will be news to none of the readers that higher education in general and engineering education in particular are undergoing the most sweeping set of changes of our generation."

Eric A. Walker, in the article The Major Problems Facing Engineering Education states that: "Now, in addition to these dilemmas" (distribution of time available for teaching science or engineering practice, how much design, how much theory and how much analysis, how broad the curriculum, how much hamanities) "we find ourselves confronted with the problem of finding sufficient time to cover the material considered necessary. It is obvious that many of our constraints, schedules, credits, fifty-minute periods, lectures, laboratories, and lock-step methods must be replaced by new methods and systems designed to teach more efficiently."

Other authors write about trends in graduate education, and how education for preparation to solve problems of national priorities (ecology, bio-engineering, urban problems, power generation and distribution, etc.) is becoming of major concern. However, such trends, more and more, penetrate curricula in undergraduate engineering education and experimentation in educational methodology is becoming more and more pervasive: projects are becoming the focus instead of more conventional laboratory exercises, and "the major objective of the laboratory has become to arouse the student's curiosity and interest, and motivate his study of the theory, a reversal from the traditional order."

L. Dale Harris and Albert R. Wight write in An Extensive Experiment With The Problem Oriented Approach to Learning: "Typically, education procedures emphasize the transmission of textbook content to the mind of the student. Many persons question the merit of this approach, and believe that the problem oriented emphasis promises to be better. A four-year experience with problem oriented approaches in electrical engineering undergraduate instruction is described. Here the learner searches for principles, concepts, facts, and techniques in solving a contiguous set of problems developed by the instructor. The monologue of the lecture is deemphasized in favor of dialogue in small groups. The learner uses all resources (texts, lectures, laboratory, computer, classmates, student advisors) to find his best solution to each problem, but ultimately he must justify his solution in a small group discussion. The experience described indicates that problem-oriented approaches can be simultanously more effective and less expensive than the lecture approaches."

Some trends in engineering education in England are described by R. Spence: "Engineering education has been unduly influenced by attitudes more appropriate to the natural sciences. It should instead acknowledge the ultimate concern of the engineer for design rather than analysis, for systems rather than constituent components, and for value to the community in place of mere increase of knowledge. Advocacy of an engineering education which is consistent with engineering practice is supported by suggestions concerning curriculum structure, syllabus content, and educational methods."

Other sources also indicate recognition of need for change in engineering and scientific education. Philip H. Abelson in the editorial Training Scientists for New Jobs (Science, 12 Nov. 1971) says that "...Almost all of the major problems of society involve a component of science and technology. The discipline of a good education in science, with it emphasis on fact and on a systematic approach to problem solving, could be an important component in training for many non-research careers in the public and private sectors."

The quoted material supports some of the educational philosophy in E^3.

T. P. Torda
November 22, 1971

ILLINOIS INSTITUTE OF TECHNOLOGY

INTEROFFICE MEMO

TO Professor William Danforth

FROM T. Paul Torda

DATE February 1, 1972

SUBJECT Bachelor of Science in Engineering Degree (E^3)

The following is in reference to our conversation of February 1. I hope that the attached information will be of use to you and your committee. Please request further information as needed..

I will appreciate your advice in what material to supply to the faculty before the next faculty meeting for their information.

TPT/fd
Attachments

It is moved that the Faculty approve the granting of the degree Bachelor of Science in Engineering (BSE) to the students entering in the fall of 1972 who complete the program developed by the Experiment in Education staff.

Since this is an experimental curriculum, faculty review and approval will be sought on an annual basis.

The Curriculum Committee has approved this motion on November 23, 1971.

The following points are offered in support of this motion:

1. At the end of four years, the students participating in the curriculum will have studied and acquired competence in material equivalent to that included in the common mathematics and science and engineering science core programs.

2. During the program the students will develop--in depth and at a level equivalent to the other engineering disciplines' programs --engineering competence in analysis and synthesis and in engineering decision-making through working on engineering projects and designs which will involve several engineering disciplines. Guided self-study of "learning modules" of advanced engineering content, equivalent to pertinent discipline-oriented courses now in the IIT curriculum, will augment the project work.

3. In the curriculum, the students will have satisfied the general education requirements by the sequence of projects which will have societal significance and which will be performed under the joint guidance of engineering, humanities, and social science faculty. Guided self-study of social science and humanities material as well as seminars will also be provided.

4. Students who may wish to transfer from the BSE program to another degree program may do so with the approval and under conditions stated by the respective department. Since all students in the BSE program will have a "portfolio" recording both performance on projects and learning module completions, transfer will be accomplished by giving appropriate credit for the equivalent courses required by the specific Department.

5. Students graduating from the BSE program will have an ECPD equivalent education in all respects. After graduation of the first class, this will be an ECPD accreditable education.

6. Responsibility for enforcing high quality of educational standards rests with the 19 faculty members staffing the program (from 12 Departments: Chemistry, Civil Eng., Electr. Eng., Humanities, I. Eng., Inst. Des., Man. and Fin., Math., MMAE, Phys., Pol. Sc., Psyc.) each of whom is in close contact with his Department.

LEARNING MODULES IN THE CURRICULUM
LEADING TO THE BSE DEGREE

These comments are intended to explain the purpose and structure of learning modules and their relationship to course content in conventional curricula.

The Function of Modules: The new curriculum leading to the Bachelor of Science in Engineering degree is based on a sequence of projects selected by the students. The students are vertically grouped into small project groups and these are coached by faculty advisers from technical and non-technical departments. In the activity of finding solutions to the selected problems, the students are supported by a large collection of individually paced and tutored "learning modules" (modules for short) and, if appropriate, by a workshop/laboratory designed to build and test models of designs pertaining to the projects. In the following, an attempt will be made to define modules as they pertain to study of the physical and engineering sciences and the social sciences. Modules conveying communication skills (verbal, written and visual) have a special structure.

The Purpose and Structure of Modules: Modules are units of information which serve to broaden the base of knowledge needed for solving problems or parts of problems. Modules may take different forms, i.e., they may be part of a book, they may be specially prepared written or audio or audio-visual material, or may be a seminar discussion based on assigned reading, etc.

Modules may be designed to supply additional knowledge in the primary field of study (engineering), or to impart knowledge in fields other than the primary, but related to the projects (in the social sciences: sociology, political science, economics, industrial psychology, management, and law).

The Difference between Modules and Courses: Material in modules may also be found as parts of courses in the traditional curricula. However, curriculum modules differ from courses in that they are individually studied, project motivated, and self-contained in the sense that prerequisites are a minimum. Thus, while the course subdivision is "pyramidal" in the sense that learning of subsequent parts is dependent on previous parts, the modules needed for problem solving incorporate prerequisites as much as possible. Also, modules state learning objectives, sample tests, and include competency tests for the use of "proctors".

Relationship of Contents of Modules and of Courses: It is possible to compare coverage of information in modules with that in courses. As a general guide, ten to fifteen modules, will cover one three-credit course. This corresponds to approximately ten to fifteen hours of independent study and work on the part of the student when learning the contents of one module. (These figures, of course, may vary depending on the type of course.) Thus a parallel listing of courses and modules will determine, at any time, the student's "equivalent" standing. Such a tabulation will be prepared for comparison of performance in the new curriculum with that of conventional IIT courses. If at any time the student wishes to transfer to the conventional curriculum, his coverage of equivalent courses may be identified accurately. By taking one or two additional modules, the student may then finish certain courses and may even be ahead of the students who are at the transfer point in the conventional curriculum.

Partial Competency or Mastery?: There is a basic difference between courses taken and modules covered. It is generally possible to pass courses with a C-grade, indicating that 60 to 66 per cent of competency is required. Modules ensure that no gaps in knowledge exist by requiring mastery performance for module study completion.

It is moved that the Faculty approve the granting of the degree Bachelor of Science in Engineering (BSE) to the students entering in the fall of 1972 who complete the program developed by the Experiment in Education staff.

Since this is an experimental curriculum, faculty review and approval will be sought on an annual basis.

The Curriculum Committee has approved this motion on November 23, 1971.

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4. Students who may wish to transfer from the BSE program to another degree program may do so with the approval and under conditions stated by the respective department. Since all students in the BSE program will have a "portfolio" recording both performance on projects and learning module completions, transfer will be accomplished by giving appropriate credit for the equivalent courses required by the specific Department.

5. Students graduating from the BSE program will have an ECPD equivalent education in all respects. After graduation of the first class, this will be an ECPD accreditable education.

6. Responsibility for enforcing high quality of educational standards rests with the 19 faculty members staffing the program (from 12 Departments: Chemistry, Civil Eng., Electr. Eng., Humanities, I. Eng., Inst. Des., Man. and Fin., Math., MMAE, Phys., Pol. Sc., Psyc.) each of whom is in close contact with his Department.

APPENDIX XVII

REPORT OF THE SUBCOMMITTEE OF THE CURRICULUM COMMITTEE AND E^3 PROGRAM CENTER RESPONSE

Pages 277-293 inside

REVIEW OF THE E^3 PROGRAM

by

George Brubaker

Joseph Chung

John Root

Gerald Saletta

James Vrentas

Herbert Weinstein, Chairman of Subcommittee

Submitted to IIT Curriculum Committee October 21, 1975

INTRODUCTION

The E^3 Program has been reviewed by this committee in an attempt to evaluate the program with regard to its future status at IIT. The evaluation has been particularly difficult because the goals of E^3, in large part, can only be described in a subjective manner. Traditional engineering education may also have subjective goals, but it also has a long history that can be studied; E^3 does not. Student performance in the traditional programs is tested in many different ways such as licensing examinations. However, because of statistical sample size and the difficulty in arranging a large scale testing program which was in part due to E^3 Program Center reticence, E^3 student performance could not be directly tested. In fact, since E^3 is a "rapidly" developing program, its short history could be considered irrelevant when it implies anything other than success. The subjective nature of the program has in turn led to an evaluation which is also in part subjective. The committee has definéd a scope for this review which recognizes this fact. Therefore, the scope of the review does not completely coincide with the change to the committee made by Dean Peter Chiarulli and the Dean Carl Grip on behalf of the Curriculum Committee.

The Review Committee has limited its work to three areas. The first of these was the gathering of the best available statistics on E^3 student performance and assembling these into "performance charts". Realizing fully that the time constant for program change in E^3 is very small even when compared to the short record length of the program, these statistics must be considered important evidence relating to the value and success of the E^3 Program because there is no other objective evidence. The committee also obtained subjective opinions from students and faculty relating to success and quality of the engineering education of E^3 students. Finally, committee members formed subjective opinions from interviews and studies of the professional project reports. The committee felt that it could not, and should not, concern itself with the evaluation of program goals not directly related to engineering education. These goals could be realistically evaluated after a much longer program record length had been attained.

E3 STATISTICS

It is not a simple matter to gather E^3 statistics because of the record keeping procedure of the Program Center. However, the Program Center was able to prepare a histogram for each student, showing the number of credits earned each semester in Mathematics-Science-Engineering Science (MSES), Professional Projects (PP), and Humanities-Social Studies (HSS). Each histogram was labeled with a student number, the date the student entered the program, the date the student left the program (if he dropped out of E^3 or graduated), and the level of the student (freshman, sophomore, etc.) if still in the program. The Registrar also supplied statistics for E^3 registration for the current semester (Fall, 1975). Finally, credit awards were obtained for a representative group of E^3 project reports.

The enrollment and student performance statistics are shown in Tables 1 and 2 and Figure 1. Table 1 shows one current enrollment in E^3. These data are from the Registrar's first computer readout of the semester. There are only 14 students other than entering freshman enrolled in E^3. Table 2 shows the performance of the 53 students wh entered the E^3 Program prior to September, 1975. This Table is a composite of E^3 and Registrar statistics which showed a small disagreement. Three of these 53 graduated last year, after the program had been in effect only three years. These 3, therefore, entered the program after at least one year of conventional college work. Of the remaining 50 students, 36 (72%) dropped out of the program. The 14 students remaining in the program are further separated equally into 7 who remain on schedule and 7 who are behind schedule.

Two of the latter 7 are two years behind schedule. The results of averaging course credits awarded are plotted in Figure 1 for the 17 students reported to be in the program by the E^3 Center. The left-hand set of curves is actual average credit awarded per semester in MSES, PP and HSS as a function of semester in program. The right-hand set shows the minimum credit awards required by a new set of E^3 rules. It is obvious that the new set of rules were necessary; previously, students did their professional project work before they had learned the math, physics and engineering science necessary to do them well. The professional project served to convince the student he needed the MSES component rather than to provide a mechanism whereby he could build an engineering education on a strong foundation in MSES. Furthermore, the students do not meet the HSS requirements of 3 credits per semester.

PROFESSIONAL PROJECTS EVALUATION

A set of professional project final reports were examined by the committee. The grades for these reports fell into three categories - successful, acceptable and unsuccessful. The credit awards for the projects are shown in Table 3. The average credit award per student ranged from half a semester equivalent to a whole semester equivalent. Total credit awards per project ranged from 35 to 86; or 1 to almost 3 years equivalent of student effort.

Further evaluation of the project work becomes subjective; the committee read these reports and made evaluations. The general opinion of the members was that not a single report examined warranted the credits given in educational value. (It is stressed here again that the committee was evaluating the engineering education provided by E^3.) The student effort may have been worth the award, but if so, the student's time was not efficiently spent.

It was felt that projec. work stressed the Edisonian approach to problem solving. Students did not have a sufficient background in engineering either to know what had been done before or how to build on previous knowledge in an orderly, systematic and scientific manner. There was a strong tendency to "re-invent the wheel" in each report. This has been noted by both students and faculty in the program.

The committee understands the concept of project work in E^3 to be something that will breaden the student's understanding of engineering principles through application to real problems, and that will broaden his outlook on the interaction of science and society through a study of the social consequences of his solution. In fact, the conduct of the program appears to have narrowed the student's training. Thus, interviews with faculty suggest that, for the average E^3 student (though certainly not for the best), faculty interaction frequently takes the form of faculty members supplying direct answers to specific problems. The faculty recognizes that this is counter to the objectives of the program. Our interviewees also note that the average student does not respond to any answer except the direct solution to his immediate problem, and failing to obtain that, he either turns to another faculty member or grinds the original contact down until his needs are met. The project reports document this approach in the bibliographies and contact logs for many of the projects. Telephone calls and personal contacts are descrived which must, in many ways, parallel the interactions with E^3 faculty.

The texts of these reports provide ample evidence for a superficial treatment of fundamental science and engineering principles. Because the student has had no Laboratory work in physics and chemistry, he does not have a background in making measurements. He must learn how on the project, and do so only for the measurements he thinks he must take. This is not efficient or braod education.

He gets none of the theory of making measurements in a controlled laboratory setting.

Equations are used with citations to the literature, usually undergraduate texts, with no real indication that the student understands how or why these expressions were derived. There were very, very, few derivatives or integrals in the reports. Derivations were not manipulated to obtain the most useful form of an equation. The equations were used in the form in which they were found and the data fitted to them. In none of the reports could any engineering analysis be found which was at the level of an IIT senior course. This is borne out by specific comments made by some students upon completion of their work to the effect that they did not really understand the system they worked on nor did they learn the fundamentals of engineering science.

As an example, the project on Residential Energy was given a grade of "acceptable" and the 8 students involved received 64 credits for the report. The work involved covered considerably less than that which is covered in undergraduate heat transfer and thermodynamics courses. The 8 students received a total of 90 credits for the semester in which they did the project.

The only conclusions that can be made are that these students did not do much that semester, earning only 11 credits on the average; and they did not learn much, since most of their time was spent on a professional project which covered less than 6 credits of engineering work.

It was also noted that this project experience is not very different from that found with other projects. We believe that the superficiality of the engineering analysis (or lack of it) which is evident in these reports is not the experience IIT wants to provide its students with for project work in industry. It also does not constitute good technical education; the whole concept of building tomorrow's technology on the best of what is available today is missing.

The ideas of model building and testing within a carefully prescribed protocol, the foundation of modern reseaarch and development, is missing from the E^3 Program in part because of the lack of fundamental background in MSES among the students.

In the typical engineering curriculum, about 75 credits of MSES are required. Since E^3 requires only 52 hours of MSES, the implication is that the additional material is obtained in the project work. However, examination of project reports has convinced the committee that the E^3 education does not even provide for equivalence with the MSES portion of the regular IIT engineering education and that graduates of the program should not even be classified as engineers.

INTERVIEWS

A) Student Evaluation

1) Module concept for coure courses

This concept is unanimously endorsed because of the freedom and flexibility it gives the student and because most students feel that they have a higher retention rate using the modules. Also, the pressure of testing is removed and students are given the chance to develop self-discipline and the ability to organize. On the other hand, most students feel that some motivation or form of discipline from the faculty is required if the module system is to encourage a student to progress at a satisfactory rate. Indeed, there is convincing evidence (Figure 1) that the majority of students are unable to provide for themselves an effective program of self-discipline.

2) Projects in E^3

Most students feel that project work is beneficial because it gives them experience in practical problem-solving, a chance to work with other people in a group, a chance to apply to "real" engineering problems what they learn in a book and an incentive for learning more engineering in order to solve problems. In addition, they feel they get a chance to consider the social aspects of engineering problems and obtain experience in writing proposals and final reports. Some students feel that MSES and HSS experience is integrated in the project work, but others feel that the integration of the MSES and HSS program with project work is artificial or non-existent. There exists evidence (completed reports) which would tend to support the latter viewpoint. Furthermore, some students complain that the group format allows poor students to lower the quality of a project. There is also a difference of opinion as to whether or not there exists adequate resources for carrying out projects satisfactorily. In some instances, there seems to be insufficient money or time to do a good job. Students appear to have rather naive concepts of what real engineering problems, social awareness and group dynamics are really all about, so it is difficult to assess their evaluation of the project program.

3) Faculty-Student Relationships

Students generally feel that the student-faculty relationship is quite close, but there is some complaint that the faculty is not as available as it should be. Furthermore, there is a strong dissatisfaction with student advising. Indeed, the advising has been characterized as poor, and this characterization seems to be justified since a large number of people in E^3 have gone through an entire year with little progress. There is also some complaint that the faculty is somewhat authoritarian with the students.

4) General Comments on E^3

1. The rules and requirements are never set down and they change too often for a student to really be sure where he stands. The program suffers from a large number of "growing pains".

2. Some feel that the program seems to be preparing a person toward a job in management but there appears to be no instruction in this area.

3. Some feel that the program will not give adequate technical preparation to be practicing engineers and they are willing to spend extra time to receive regular BS and advanced degrees. There appears to be a definite lack of student confidence in the quality of the technical degree they are receiving.

B) Faculty Evaluation

1) General Feelings

The faculty interviewed were people who were generally favorably disposed towards E^3. Faculty who had participated and subsequently became vocally anti-E^3 were avoided. The group interviewed felt, in general, that E^3 had good ideas in the module concept and the project work. They were not satisfied with the way the program was put together.

2) MSES Component

Faculty in general felt that the module concept was a good way to handle this part of the program and that mastery was indeed equivalent to B+. However, there was concern about the pace the students kept in their modules and the advising in relation to this problem. It is interesting that several faculty members mentioned that they thought a junior-senior E^3 might be better, building on a standard two-year MSES program. Apparently, self-paced instruction is working well when the students work at it.

3) HSS Component

There appears to be a real problem in integrating HSS into the project work, since projects tend towards design and problem-solving. Efforts to bring an HSS course structure unique to E^3 was rejected out of hand. A seminar approach to HSS in E^3 also failed for lack of student participation, however.

4) Professional Projects

No difference was seen between upper or lower level projects but a distinction was seen in student roles in project organization and leadership. It is not clear from the experiment that students from all 4 years can be put together on a project team to everyone's benefit.

Several members felt that there was a tendency to be superficial in project work and a tendency to "re-invent the wheel".

The idea of project work is felt to be a good learning took, goving the student experience he doesn't get in a traditional engineering program. However, there was general agreement that the projects were not good vehicles to motivate students to learn fundamentals. Since this is a central concept of E^3, this is a particular damaging conclusion. Concern was expressed by most that the technical content of the projects were more on a technician or "popular mechanics" level than one would typically expect of our juniors and seniors. A recurring problem was that students would not focus on the technical "meat" of the project. Because of the "wheelspinning", many projects were past due or rushed to completion with the result that many tasks were not accomplished or the goals were redefined which cut out some technical content.

The project concept was tried in the senior year of C.E. as an elective with a good deal of success. The following semester, the project elective was tried using students in all 4 years with less student satisfaction.

5) Administration of Program

The faculty interviewed felt that the program administration was poor and a substantial problem. The program director was seen to be a major problem. Several constructive suggestions were apparently rejected in an autocratic manner, though later adopted by E^3. Not one faculty member interviewed had praise for the administration of the program, or even felt it was adequate. Almost every faculty member commented about the poor organization of the program. The students are not able to organize themselves and the concept of the faculty member "steering" the students did not work well.

Another related problem is that junior faculty members appear to be needed in the program, but the IIT administration does not consider E^3 participation important at tenure decision time.

SUMMARY AND CONCLUSIONS

The evidence developed in this study has convinced the committee that the E^3 experiment has been unsuccessful. The concept of project oriented motivation to lead a student to achieve a college education appears invalid. The students who have started the program have "voted with their feet". The great majority have left the program. The students who have remained have not progressed in MSES and HSS at an acceptable rate on an acceptable schedule. The committee's evaluation of the professional project reports was that they do not begin to equal the senior achievement level at IIT. Many changes have been amde in E^3 procedures which the E^3 staff feels will solve these problems. It is felt that the students do not get an engineering education in the program. They learn instead intangibles - group dynamics, social consciousness and organization. These subjects are usually obtained in on-the-job training by our engineering students--very successfully, from the record. Our concern is where the E^3 students will obtain a thorough grounding in the fundamentals of science and engineering after they graduate. The committee feels that the risk involved to student careers exceeds the benefits of testing new regulations for E^3 student progress. Because of these considerations, it is recommended that E^3 be dropped as an IIT engineering degree-granting program.

The modular approach to MSES has some very good points. It is recommended that IIT encourage the Math, Physics and Chemistry Departments to evaluate self-paced instruction as an option for some of their courses. It is felt that the MSES program belongs with the departments who give these courses to all IIT students. This will preserve an ordered sequence to this work together with the necessary laboratory work. Furthermore, the project work is worth preserving and could be made a senior year elective for all students. It would be important to maintain its multidisciplinary nature. It should not, however, become a significant fraction of the credit requirements for any degree.

Respectfully submitted

George Brubaker

Joseph Chung

John Roo.

Gerald Saletta

James Vrentas

Herbert Weinstein, Chairman

*Original signed by the above named

TABLE 1

E^3 STUDENT REGISTRATION
(from Registrar)

9-26-75	SEMESTER LEVEL	NO. OF STUDENTS
	01	11*
	02	1
	03	2
	04	2
	05	4
	06	1
	07	1
	08	3

*1 of these is part-time

9-26-75

TABLE 2

E^3 STUDENT PERFORMANCE CHART

YEAR ENTERED	NUMBER (TOTAL)	PT-TIME OR COOP	DROPPED OUT OF PROGRAM				GRAD 1975	OFF SCHEDULE		ON SCHED.	GRAD 1976
			1972	1973	1974	1975		1 YEAR	2 YEAR		
1972	29	1	4	13		3	2	1	2	3	2
1973	15			2	3	5		3		2	
1974	9				1	4	1	1		2	1
1975	11	1									

(BEST COMPOSITE OF E^3 STATISTICS AND REGISTRAR STATISTICS)

1/26/75

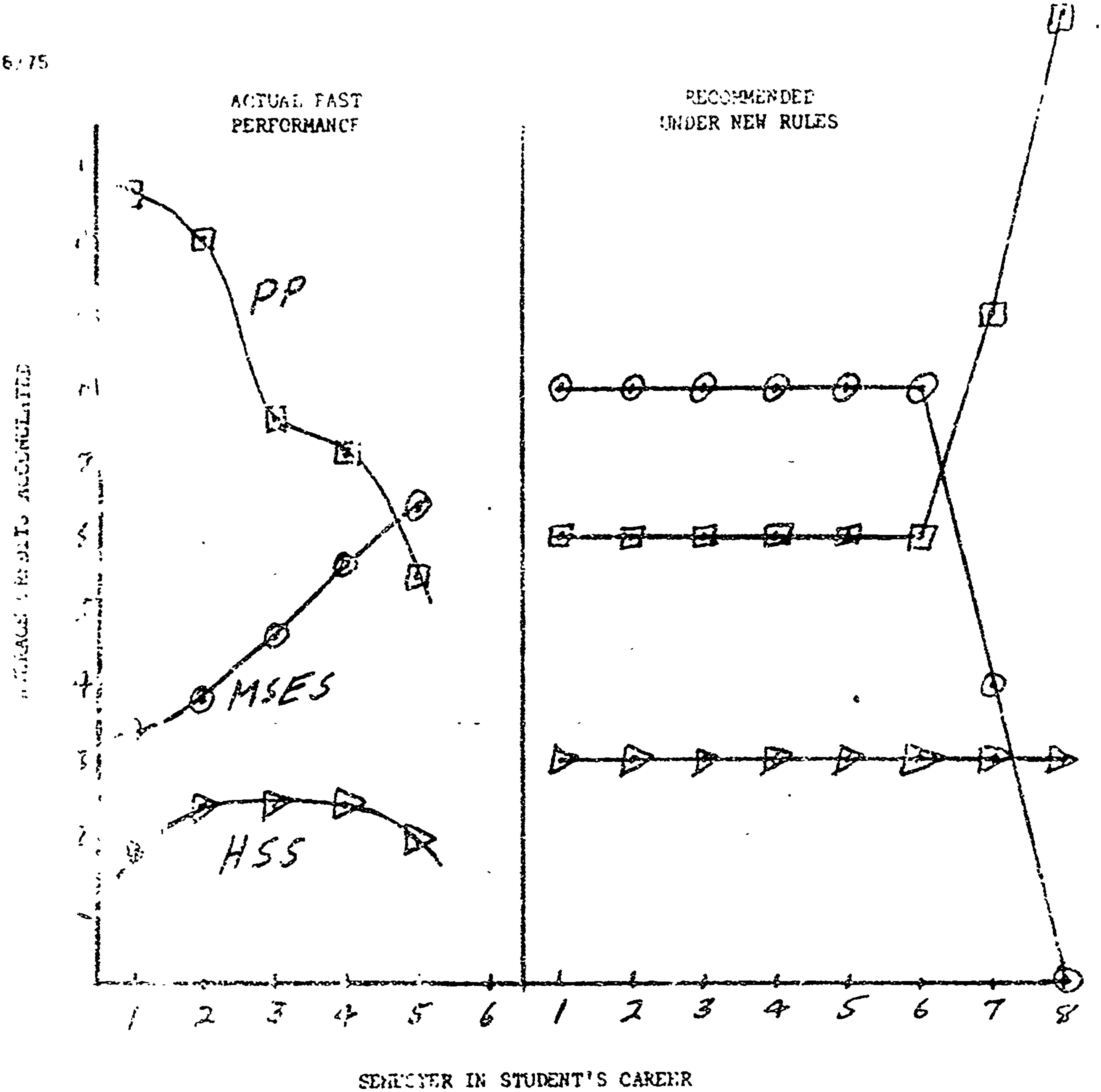

Figure 1. Average performance of E^3 students by semester.

17 students reported to be in E^3 Program.

(NOTE: MSES credits given for module work only. HSS credits given for projects as well as courses.

TABLE 3

PROFESSIONAL PROJECT CREDIT AWARDS

TITLE	NO. OF STUDENTS	CREDITS AWARDED	TOTAL CREDITS	AVERAGE CREDIT	PROGRAM DURATION SEMESTERS
PACKAGING	5	17, 4.5, 4, 11.5, 16.4	53.4	10.7	2
TOP WIND ANALYSIS	4	15, 15, 21, 18	69	17.3	2
CARGO SUB	7	8, 8, 2, 9.5, 9, 7, 10	53.5	8	1
H_2 ECONOMY	5	8, 6, 10, 10, 10	44	8.8	1
SHORT DISTANCE TRANS.	3	15, 13, 12	40	13.3	1
RES. ENERGY	8	7, 10, 9, 6, 7, 8, 7,10	64	8	1
DENTAL OCCLUSION	5	6, 5.5, 9, 7, 7.5	35	7	1
INCINERATOR	6	11, 15, 12, 13, 15, 10	86	14.3	2
COANDA TUBE	2	21, 14	35	17.5	2

APPENDIX XVII (2)

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E^3 PROGRAM CENTER RESPONSE

to Review of the E^3 Program
by the Subcommittee on E^3 of the
IIT Curriculum Committee

Submitted to Curriculum Committee
February 5, 1976

INTRODUCTION

The Subcommittee on the Review of E^3 was appointed by Dean Carl M. Grip in March, 1975, and issued its "Review of the E^3 Program" to the Curriculum Committee on October 21, 1975.* On the basis of interviews with faculty and students, student written final reports of past projects, and certain statistical information requested from the E^3 Program Center, the Subcommittee concluded that the E^3 Program was a failure and that granting of the BSE degree should be discontinued.** The present document is a response to that "Review."

It is clear to those who have worked in the E^3 Program Center for an extended period that the members of the Subcommittee understood neither the goals of the BSE Program nor its operation. The "Review" contains many misstatements and misinterpretations of the structure of the curriculum, the functioning of project groups, the advising system, the role of the E^3 project final report, and the evolution of the Program. E^3 projects are compared with senior engineering projects even when all the students on the team were freshmen, as was necessarily the case in the first year of the Program; the relationship between module work and project work is misrepresented; non-technical components of the curriculum are ignored altogether.

Many of the misconceptions of the Subcommittee could have been corrected easily had the E^3 Program Center been given the opportunity to discuss the findings before the "Review" was issued. The Subcommittee, however, refused to do this, and, in fact, avoided contact with the E^3 Program Center administration. This departure from custom may have been supported by good reasons, but none have been provided. In any case, the result is that much relevant material was not examined, and invalid conclusions were drawn.

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* It was the third such subcommittee appointed and had among its members three faculty who had prior service on the subcommittee. The composition of the Subcommittee included two members of the Chemical Engineering Department, one from Electrical Engineering, one from Chemistry, one from Economics, and one from Humanities (History).

** These conclusions stand in contrast to the reports made by the previous subcommittees.

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OUTLINE OF THIS RESPONSE

This response, prepared by the E^3 Program Center, is in three parts. Each part represents a different level of discussion, moving from an analysis of specific statements made in the Subcommittee "Review" to a discussion of the BSE Program in terms of engineering education generally.

PART I, ITEM-BY-ITEM CLARIFICATION, is a direct comparison of statements in the "Review" with comments by E^3 Program Center Staff. The comments clarify or expand the statements from the "Review".

PART II, AN ASSESSMENT OF THE SUBCOMMITTEE "REVIEW," more fully addresses three dimensions of the Subcommittee's document: the scope and method of the "Review," the use of numbers and statistics, and the evaluation of E^3 projects and project reports.

PART III, E^3 AND ENGINEERING EDUCATION, is devoted to two general areas of concern: the BSE Program in terms of undergraduate engineering education, and four issues raised about the Program. These four are:

-student attrition and rate of progress;
-the quantity of core material required;
-the quality of project learning;
-the nature of the degree (BSE) granted.

The three parts need not be read in the order here presented; they have been prepared to allow the reader freedom in this regard. Such freedom has as its cost some repetition. We have tried to keep such unavoidable repetition infrequent.

This Response is an E^3 Program Center response, and should be read in conjunction with other materials supplied to the Curriculum Committee and the faculty generally. These include materials from the President of IIT, the Dean of the Armour College of Engineering, the E^3 Board of Advisers, ano the Program Center itself.

PART I: ITEM-BY-ITEM CLARIFICATION

"Review" Statements	Comments
1. The evaluation has been particularly difficult because the goals of E^3, in large part, can only be described in a subjective manner. (p.1, lines 2-4)	The goals of the E^3 Program have been concisely defined in three proposals to the National Science Foundation and in numberous publications. All documents were available to the Subcommittee.
2. Traditional engineering education may also have subjective goals, but it also has a long history that can be studied; E^3 does not. (p.1, lines 4-6)	Evaluation of the E^3 Program in terms of the goals it purports to achieve is possible even if it has a short history.
3. Student performance in the traditional programs is tested in many different ways such as licensing examinations. (p.1, lines 6-7)	Student performance is tested in more exhaustive ways in the E^3 Program Center than in conventional engineering curricula. These tests are all documented in student files. Such files were available to the Subcommittee on request. Apparently, these files were either not used or were misinterpreted by the Subcommittee. Graduating E^3 students are encouraged to take licensing examinations in the same way as are other students at IIT. One of three June, 1975, graduates took and passed the EIT examination.
4. However, because of statistical sample size and the difficulty in arranging a large scale testing program which was in part due to E^3 Program Center reticence, E^3 student performance could not be directly tested. (p.1, lines 7-10)	The E^3 Program Center has never been "reticent" to expose its students to valid comparative examinations. As a matter of fact, the Subcommittee was offered assistance in preparing an instrument by which E^3 students and randomly selected students from other IIT engineering curricula could be compared. The Subcommittee did not accept this offer.

5. In fact, since E^3 is a "rapidly" developing program, its short history could be considered irrelevant when it implies anything other than success. (p.1, lines 10-12)

The E^3 Program Center is unable, in spite of much effort, to understand this statement.

6. The subjective nature of the program has in turn led to an evaluation which is also in part subjective. The committee has defined a scope for this review which recognizes this fact. Therefore, the scope of the review does not completely coincide with the charge to the committee made by Dean Peter Chiarulli and the then Dean Carl Grip on behalf of the Curriculum Committee. (p.1, lines 12-17)

Although the "nature" of the E^3 Program is not subjective (see 1), the Subcommittee should have -- in minimum compliance with scientific custom -- defined and published the "scope of this review." This should have been done the more, since it stated that the scope of the Subcommittee's review did not "completely coincide with the charge to the committee..." The charge of the two deans should also have been published by the Subcommittee. (The charge appears in Part II of this response, p. 22.)

7. The Review Committee has limited its work to three areas. The first of these was the gathering of the best available statistics on E^3 student performance and assembling these into "performance charts." Realizing fully that the time constant for program change in E^3 is very small even when compared to the short record length of the program, these statistics must be considered improtant evidence relating to the value and success of the E^3 Program because there is no other evidence. (p.1, lines 18-24)

The Subcommittee's reference to the "best available statistics on E^3" excludes, by choice of the Subcommittee, documented statistics and evidence offered by the E^3 Program Center. Indeed, more "evidence" of student performance is collected in the E^3 Program than in other departments at IIT.

8. The committee also obtained subjective opinions from students and faculty relating to success and quality of the engineering education of E^3 students. Finally, committee members formed subjective opinions from interviews and studies of the professional project reports. The committee felt that it could not, and should not, concern itself with the evaluation of

(For a discussion of evaluation method, see Part II, pp. 11-20.) It is of interest to see that the Subcommittee found it possible to learn here about E^3 goals in such detail that it was able to separate them into those related and those "not directly related to engineering education," when in (1) it stated that E^3 has largely subjective goals. Needless to say, all goals of

program goals not directly related to engineering education. (p.1, line 24 - p.2, line 2)	the BSE Program -- as defined and accepted by the NSF and IIT -- are directly related to engineering education.
9. It is not a simple matter to gather E^3 statistics because of the record keeping procedure of the Program Center. However, the Program Center was able to prepare a histogram for each student, showing the number of credits earned each semester in Mathematics-Science-Engineering Science (MSES), Professional Projects (PP), and Humanities-Social Studies (HSS). Each histogram was labeled with a student number, the date the student entered the program, the date the student left the program (if he dropped out of E^3 or graduated, and the level of the student (freshman, sophomore, etc.), if still in the Program. (p.2, lines 6-13)	It is very simple to get statistics on E^3; all anyone has to do is to ask for data. All data were supplied to the Subcommittee for which the members asked, with the caveat that those data alone were not sufficient or relevant to any systematic evaluation of the E^3 Program or student performances. However, the chairman refused to discuss this matter with members of the E^3 Program Center.
10. The Registrar also supplied statistics for E^3 registration for the current semester (Fall, 1975). (p.2, lines 14-15)	The Registrar's early tabulation (which was used by the Subcommittee) is know to be both incomplete and incorrect.
11. The enrollment and student performance statistics are shown in Talbes 1 and 2 and Figure 1. Talbe 1 shows the current enrollment in E^3. These data are from the Registrar's first computer readout of the semester. There are only 14 students other than entering freshman enrolled in E^3. Table 2 shows the performance of the 53 students who entered the E^3 Program prior to September, 1975. This Table is a composite of E^3 and Registrar statistics which showed a small disagreement Three of these 53 graduated last year, after the program had	Tables 1 and 2 and Figure 1 are incorrect. For correct information and further amplification, see Tables 1-5 and the accompanying text in Part II of this response.

been in effect only three years. These three, therefore, entered the program after at least one year of conventional college work. Of the remaining 50 students, 36 (72%) dropped out of the program. The 14 students remaining in the program are further separated equally into 7 who remain on schedule and 7 who are behind schedule. Two of the latter 7 are two years behind schedule. (p.2, lines 17-28)

12. The results of averaging course credits awarded are plotted in Figure 1 for the 17 students reported to be in the program by the E^3 Center. The left-hand set of curves is actual average credit awarded per semester in MSES, PP and HSS as a function of semester in program. The right-hand set shows the minimum credit awards required by a new set of E^3 rules. (p.2, line 28 - p.3, line 5)

The analysis of the data by the Subcommittee is confusing and inconsistent, and the number of students, as well as their standing and performance are misquoted. Both sides of Fig. 1 are incorrect. It is important to observe here that the "new set of rules" were in effect since the Fall term of 1972 and, therefore, are not new. The only thing that is new is the way the Registrar is being notified about the "standing" of a student--and this procedure is still changing due to changes in the Registrar's procedures.

13. It is obvious that the new set of rules were necessary; previously, students did their professional project work before they had learned the math, physics and engineering science necessary to do them well. (p.3, lines 5-7)

This statement suffers from an error of omission. Nobody, not even E^3 students, can perform at a higher level than that for which he has the background. Students in the E^3 Program receive project credits at the level appropriate to their standing and <u>not</u> higher. The Subcommittee omits in its reporting that project credits are awarded at various levels (freshman, sophomore, junior and senior) and that these are not treated as equal in value -- as they cannot be!

14. The professional project served to convince the student he needed the MSES component rather than to provide a mechanism whereby he could build an engineering education on a strong foundation in MSES. (p.3, lines 8-10)

This statement completely misunderstands the "motivation to learn" concept of project based learning and confuses the pedagogical approaches of conventional curricula and those of the E^3 Program.

15. A set of professional project final reports were examined by the committee. The grades for these reports fell into three categories - successful, acceptable and unsuccessful. (p.3, lines 13-15)

Since there are no grades in E^3 (except for mastery -- B+ or better), the three categories "we are proud of", "good work", "work not acceptable in E^3"represent the overall quality of the particular project.

16. The credit awards for the projects are shown in Table 3. The average credit award per student ranged from half a semester equivalent to a whole semester equivalent. Total credit awards per project ranged from 35 to 86; or 1 to almost 3 years equivalent of student effort. (p.3, lines 15-18)

Table 3 and the explanation of the credit distribution in the text is a complete misrepresentation of how and for what work credits are awarded to students in the E^3 Program. MSES, HSS, and PP credits are lumped by the Subcommittee without regard to level of performance (freshman through senior) and category in which credits are awarded. Table 3 and its "interpretation" constitute a careless and unjustified attack on faculty working in the E^3 Program Center.

17. Further evaluation of the project work becomes subjective; the committee read these reports and made evaluations. (p.3, lines 19-20)

Even subjective evaluations should have criteria. The Subcommittee provides none.

18. The general opinion of the members was that not a single report examined warranted the credits given in educational value. (It is stressed here again that the committee was evaluating the engineering education provided by E^3.) (p.3, lines 20-23)

"General opinion" is too unclear to be helpful. Who was included in the "general opinion" (there were three engineering faculty members on the Subcommittee)? We are able to substantiate positive evaluation of project quality by outsiders.

19. The student effort may have been worth the award, but if so, the student's time was not efficiently spent. (p.3, lines 23-24)

If "student effort may have been worth the[credit] award," why was student time not efficiently spent? In any case, the use of "may have been" dilutes the assertion to meaninglessness.

20. It was felt that project work stressed the Edisonian approach to problem solving. Students did not have a sufficient background in engineering either to know what had been done before or how to build on previous knowledge in an orderly, systematic and scientific manner. There was a strong tendency to "re-invent the wheel" in each report. This has been noted by both students and faculty in the program. (p.3, line 25 - p.4, line 4)

It is not established how the Subcommittee determined whether the students had "sufficient background in engineering." Apparently it did not investigate (during the 7 1/2 months of its effort) the background knowledge of the students who had worked on the reports the Subcommittee read. Further, what do students in conventional curricula do for three years but solve academic or textbook problems? Is that not "re-inventing the wheel?" BSE students have, on four occasions in as many years, come up with solutions at which large companies with millions of research dollars and many Ph.D.'s have also arrived. Is this really "re-inventing the wheel?" Again, no numbers support the last sentence. (For further discussion, see Part II of the Response.)

21. Because the student has had no laboratory work in physics and chemistry, he does not have a background in making measurements. He must learn how on the project, and do so only for the measurements he thinks he must take. (p.4, lines 22-25)

This is not true. Project group members have had to take rigorous training in instrumentation identical with or equivalent to laboratory courses in MMAE. Group members also used laboratory procedures and facilities in the EE, Env.E. Chem., and MME departments. Instrumentation is available in the E^3 workshop/laboratory and students have to design specific experiments together with instrumentation (selection, calibration, and setup),and have to learn about instrumentation often beyond that learned by students in conventional curricula.

22. In none of the reports could any engineering analysis be found which was at the level of an IIT senior course. (p.5, lines 7-8)

E^3 projects are not intended to be equivalent to senior courses in the other engineering curricula. Moreover, only two projects listed in the Subcommittee's Table 3 had senior members.

23. The work involved covered considerably less than that which is covered in undergraduate heat transfer and thermodynamics courses....they did not learn much, since most of their time was spent on a professional project which covered less than 6 credits of engineering work. (p.5, lines 14-15, 18-20)

Undergraduate heat transfer and the introductory thermodynamics are learned through learning modules. Advanced (applied) thermodynamics was learned as part of the project. Again PP is misstated as professional project; professional and project is correct.

24. In the typical engineering curriculum, about 75 credits of MSES are required. (p.6, lines 5-6)

This is incorrect. The maximum requirement in MSES is 75 and the minimum 54, with an average of 65. However, the original requirement, as agreed to by the Curriculum Committee, and subsequently the faculty, is between 51 and 52 for the BSE degree. This is the minimum followed by the E^3 Program.

25. ....there is convincing evidence (Figure 1) that the majority of students are unable to provide for themselves an effective program of self-discipline. (p.6, lines 20-22)

This is frequently true for new students. The BSE Program has the aim of dealing with this lack and the Subcommittee's "Figure 1" supports a claim of success. It requires time for a student to learn a self-paced system. E^3 modules are used as an option in the IIT Honors Program and two out of twelve (with GPA $\geq$ 3.5) have had to take incompletes in the mathematics module approach due to procrastination.

26. ....there is a strong dissatisfaction with student advising. Indeed, the advising has been characterized as poor, and this characterization seems to be justified since a large number of people in E^3 have gone through an entire year with little progress. (p.7, lines 18-21)

If a student in other curricula flunks out, is the adviser considered derelict? Advising in the E^3 Program Center is handled centrally by a committee of six faculty members, and each student meets at least twice a semester with this committee. The quality of advising is far above the IIT norm.

27. The rules and requirements are never set down and they change too often for a student to really be sure where he stands. (p.7, lines 24-25)

Rules and requirements are printed and distributed to all students. Moreover, when the student is advised by the Program Design Committee, rules and regulations are reviewed.

28. The idea of project work is felt to be a good learning tool, giving the student experience he doesn't get in a traditional engineering program. However, there was general agreement that the projects were not good vehicles to motivate students to learn fundamentals. Since this is a central concept of E^3, this is a particularly damaging conclusion. Concern was expressed by most that the technical content of the projects were more on a technician or "popular mechanics" level than one would typically expect of our juniors and seniors. A recurring problem was that students would not focus on the technical "meat" of the project. Because of the "wheel-spinning", many projects were past due or rushed to completion with the result that many tasks were not accomplished or the goals were redefined which cut out some technical content. (p.9, lines 8-18)

Each student's task on a project demands knowledge of material usually beyond the MSES level, particularly when the student is past the freshman year. In each area of study, knowledge needed in project work is learned only after the appropriate fundamental material is learned. The level of project work and the accomplishments vary depending on the academic standing of the participating students. Nowhere do students in traditional curricula undertake more or better planning than they do in E^3. If the original plans do not lead to solution of the problem, or were too ambitious because of the lack of student experience, new plans have to be made. Such changes occur only with the approval of the Review Board and must be justified.

PART II: AN ASSESSMENT OF THE SUBCOMMITTEE REVIEW

SCOPE AND METHOD

Introduction

Before we can assess the work of the IIT Curriculum Subcommittee which produced the "Review of the E^3 Program," we must proceed as we should in the instance of any evaluating body. We must examine the charge to the Subcommittee, determine the manner in which that charge was carried out, and, finally, evaluate the outcome of this activity in terms of the findings. It is our intention here to examine those elements in order to display what we perceive to be weaknesses in the "Review."

Charge to the Subcommittee

Initial attempts to comprehend this "Review" are hampered by the absence of any clear description of what it is that the Subcommittee was asked to do. The minutes of the Curriculum Committee contain no charge to the Subcommittee, nor does the present chairman of the Curriculum Committee have a copy of such a charge. However, we have obtained from the Subcommittee chairman, on December 5, 1975, copies of two documents attached immediately following this section of PART II. The first of these is a memorandum, dated January 16 1975, from President Martin to Dr. Carl Grip, then chairman of the Curriculum Committee, calling for the E^3 Review Committee to "look into this whole matter and make some recommendations to me at an early date."

The second is an undated, unsigned sheet entitled "Charge from Deans." It asks various questions, from the very specific ("Are there part-time students?") to the very general ("Do we need a generalist [in] an age of specialization?"). It also includes two "criteria for tests of program: a) does it lead to successful career for students? b) does it bring more good students to IIT?" While these questions are not altogether clear, and some of them may be unanswerable, any comparison of the questions with the "Review" findings verifies the understatement that "the scope of the review does not completely coincide with the charge to the committee.."In fact, only one of the seven charge items is addressed.

Research Design

Considering the breadth of the charge, it might be assumed that the Subcommittee would be particularly eager to establish for its readership the criteria it used in gathering data and reaching evaluation, the research and data gathering techniques, and the overall design of the work done. None of these, we submit, appears in the "Review."

There is no discussion of research design in the "Review." Its introduction tells us that the Subcommittee would rely upon three principal sources of data: (1) "the best available statistics on E^3 student performance," (2) "subjective opinions from students and faculty relating to success and quality of the engineering education of E^3 students," and (3) "subjective opinions [formed by Subcommittee members] from interviews and studies of the professional Project [sic] reports." The last category, of course, contains no data, but rather the committee members' responses or reactions to data. The Subcommittee has thus mixed its conclusions with its data.

Nowhere are standards set forth against which data gathered from these sources can be measured. Nor is there any explanation why the Subcommittee chose these three particular sources, and omitted other available ones. There is no clear discussion of how the data were actually gathered; one finds no indication of sampling procedures, no tabulation of responses to questions, no indication of what statistics were sought, and hence, how the Subcommittee defines the "best possible statistics" of which it speaks. The faulty approach of the Subcommittee is here so manifest that it is futile to respond to all details. Let us focus instead on but two general areas: (1) the interview design and technique, and (2) the presentation and interpretation of the findings.

Interviews

A fundamental weakness in the interview segment of the "Review" is the absence of any description of the design and method. It is implied that because interviews tap the "subjective opinions" [sic] of those interviewed, it is not possible to conduct, report, or interpret the results with any precision. This is not the case. Interviewing is a methodological technique which must be applied in a rigorous and systematic fashion if it is to be of value, and the method employed must be described along with the results.

To interpret interview data, it is necessary to know at least the manner used to select interviewees, the numbers of students and faculty chosen, and the procedures and instrument, if any, used in conducting the interviews. The "Review" is silent on all these counts. We have, however, acquired additional information since the submission of the "Review" from members of the Subcommittee, from E^3 Program Center personnel who were interviewed by the Subcommittee in the gathering of data, and from members of the E^3 NSF Board of Advisers who met with four members of the Subcommittee on December 8, 1975.

We learned that not all members of the E^3 student body were interviewed, and already knew that not all faculty members were. We should therefore have expected that those interviewees chosen would have been selected in such a way as to produce a sample that was truly random, or else representative. If the sample were to be representative, the criteria of representation should have been made explicit. Instead, when the Subcommittee conducted student interviews, only those students -- a total of eight -- who chanced to be present in the E^3 basement rooms of the El building were included in the sampling. Such a group scarcely constitutes a statistically reliable random or representative sampling. We have even less information about the selection of faculty interviewees. At a Curriculum Committee meeting after the submission of the "Review" we learned that twelve out of forty-seven former and present active faculty members had been interviewed. We do not know how many of these are still associated with the E^3 Program Center, nor do we know the length of tenure in the Program of any of the interviewees. The sample did not include the Director or either Associate Director. The solitary allusion to the composition of the faculty sample is made in the opening paragraph of this section of the "Review." (page 8) There we are told that the faculty members with the most negative attitudes toward E^3 were screened out. We must ask, however, whether avoiding faculty who were vocally "anti-E^3" really excludes those most negatively predisposed; whether the committee had sufficient knowledge to make that prejudgment of faculty attitudes; and whether such a procedure is methodologically sound.

Interview techniques, lengths, and the nature of the questions asked all remain extremely vague in the "Review." Some of the faculty interviewees were, in the words of a Subcommittee member, "drawn into conversation." It seems that no records were kept either of questions asked nor of specific responses. While this style of interviewing is unavoidable in some research settings, it requires considerable preparation, skill, and detailed post-interview record keeping. Common pitfalls which must be avoided using this technique are: interviewer bias, faulty recollection, and the lack of agreement between interviewer and interviewee on the meanings of questions and responses. There is also often a tendency to give undue attention to the attitudes and opinions of the more articulate of the subjects, thus possibly biasing the findings.

We can adduce no reason why a formal interview schedule was not used, particularly since such a procedure is recommended in IIT's own Guidelines for the Review of Graduate Programs. Carefully preplanned interview schedules or questionnaires provide greater accuracy and consistency to interviews. Though such procedures may not be able entirely to eliminate bias, they inevitably make potential sources of possible bias more evident.

We have learned from some of the students who were interviewed that they were asked no more than two or three very general questions, and that some, but not all of their responses were recorded in writing. Students were not informed of the purpose of the interview, and none of them, so far as we can learn, was interviewed for more than fifteen minutes. The extreme brevity and informality of these interviews cast doubts on the quality of findings based upon them. A member of the Board of Advisers, after meeting with some of the students interviewed, summed up the interview pithily as "what's a nice boy like you doing in a Program like this?"

Presentation

The findings themselves are presented vaguely and unsystematically. The Subcommittee's lack of rigor in design and technique is reflected most clearly in its heavy dependence upon pseudo-quantification. We are given no true quantitative analysis. Instead we find terms like "most," "several," "some," "a large number," and "general agreement," to name but a few. These terms have no precise meaning in most contexts, and none at all here where the size and quality of the sample are themselves not specified.

Evaluation of the interview results is made even more difficult by the Subcommittee's demonstration of the way in which it uses source (3) mentioned on page 12 above: "subjective opinions [formed by Subcommittee members] from interviews..." It is impossible in many instances to determine whether the summarized reported statements represent actual responses of interviewees, the Subcommittee's interpretation of those responses, or some combination of general conclusions and inferences drawn by the Subcommittee on the basis of several, or perhaps all, of the interviews. The tangled web of combined findings and conclusions might be illustrated by passages such as the following:

> There appears to be a real problem in integrating HSS into the project work, since projects tend toward design and problem solving. (p.8)
>
> It is not clear from the experiment that students from all four years can be put together on a project team to the benefit of all (p.9).

In the context of the "Review," are these statements interview responses, interpretations, or conclusions?

Even where statements clearly represent the conclusions of the Subcommittee, the Subcommittee's manner of reporting its findings makes it impossible to judge whether or not those conclusions are warranted. There are apparent inconsistencies. We are told that "Some feel that the Program will not give adequate technical preparation to be practicing engineers..." but later, when this point is restated, it is given a far graver turn: [There is a] "definite lack of student confidence in the quality of the degree they are receiving." "Some" of a sample of eight out of twenty-nine becomes "definite lack of student confidence."

It is disturbing to learn that, while using selected student comments to attack the Program, the Subcommittee nonetheless feels that "Students appear to have rather naive concepts of what real engineering problems, social awareness, and group dynamics are all about, so it is difficult to assess their evaluation of the project program." In view of the fact that the "Review" displays evidence of student satisfaction with many aspects of the E^3 Program, it is curious that the section called "General Comments on E^3" contains only negative comments. Could there have been no positive general comments when the body of the "Review" contained so many praises of specific components of the E^3 Program?

Essentially, we must question whether the Subcommittee's proceedings could possibly yield reliable results. It is clearly difficult to denominate what is found in this segment of the "Review," but "findings" is a totally inappropriate term. Conclusions based on interviews conducted as these were can neither be accepted nor rejected. They must simply be disregarded.

That aspect of the "Review" to which it is most difficult to respond lies in the series of implied and unspoken assumptions upon which at some later point in the "Review" conclusions are based. These are so common in the "Review" that it would be useless to attempt to respond to them all. Let us take but an instance. The "Review" asserts that "the goals of E^3, in large part, can only be described in a subjective manner." Nonsense!--The goals of the Program have been explicitly stated on many occasions, including three successful proposals to the National Science Foundation, several publications in national journals, as well as conference papers and E^3 workshops. It is doubtful that the goals of any other engineering curriculum at IIT have been stated more explicitly than those of the E^3 Program. These explicit statements of goals have been readily available, though they were neither requested by the Subcommittee nor accepted when offered. Yet it is upon this false assertion that the Subcommittee bases its approach: "The subjective nature of the Program has in turn led to an evaluation which is also in part subjective." Assuming we accept the false assertion, we are nonetheless startled to learn that BECAUSE a program is subjective, its evaluation IN TURN, must be subjective! And from this <u>non-sequitur</u>, there shortly emerges the remark: "The committee has defined a scope for the review which recognizes <u>this fact</u>." [Italics added] Given the torturous reasoning of the earlier statements, it is difficult to know just what <u>this fact</u> refers to.

In the "Review's" all-too-brief discussion of its method, it enters the following caveat: "The Committee felt that it could not, and should not, concern itself with the evaluation of program goals not directly related to engineering education." [Italics added] The E^3 Program has been established by both NSF and IIT as an undergraduate engineering program. It has no goals "not directly related to engineering education," any more than has any other IIT undergraduate engineering curriculum. The Subcommittee appears to have chosen to evaluate selected portions of the E^3 Program, and to have justified its procedure by simply asserting that the Subcommittee's implied conception of engineering education is the appropriate framework.

The very language and tone of this "Review" speak bias. Negative comments are introduced which seem designed to reflect upon the E^3 Program, though they clearly have nothing to do with the Program. We are told for instance:

> Another related problem is that junior faculty members appear to be needed in the program, but the IIT administration does not consider E^3 participation important at tenure decision time. (p.10)

Even assuming this statement were true, does it display a failure or weakness in the E^3 Program? We learn that:

> Some feel that the Program seems to be preparing a person toward a job in management, but there appears to be no instruction in this area.(p.8)

The E^3 Program Center does have faculty from the Department of Management. But more importantly, is the fact that "some" of a sample of eight see a particular career opportunity emerging from their studies a trenchant critique of the E^3 Program?

Summary

The "Review" taken as a whole contains no clearly stated goals, no research design, no criteria against which the E^3 Program is to be evaluated, no criteria for judging the relevance, completeness, or reliability of the data gathered. It is methodologically careless and incomplete, and is couched in a style which strongly suggests an implicit bias against the Program. All of this is doubly unfortunate since it appears that the Subcommittee has not rigorously undertaken a serious task. Plainly, they might have guided themselves to the production of an acceptable report by reliance upon the techniques spelled out in detail in the IIT Guidelines for the Review of Graduate Programs. (1973) Against the standards there set out, the inadequacies of this "Review" are evident. Its conclusions reflect negatively not only on the E^3 Program, but also inevitably upon the competence of the forty-seven IIT faculty members who have taught in it and the many others who helped to shape it.

ILLINOIS INSTITUTE OF TECHNOLOGY
INTEROFFICE MEMO

TO Dr. Carl Grip

FROM T. L. Martin, Jr.

DATE January 16, 1975

SUBJECT REVIEW OF E^3 PROGRAM

During the past several months I have had a number of reports, some in conflict with others, regarding the successes and failures of the E^3 program. Dr. Torda has spoken to me on several occasions, voicing his concern over the future. Others have expressed other concerns about the present activities as well as its future.

I feel a need for some expert advice. So, would you please ask that the E^3 Review Committee, a subcommittee of the Curriculum Committee of which you are Chairman, look into this whole matter and make some recommendations to me at an early date.

Tom

Thomas L. Martin, Jr.

cc: J. J. Brophy
P. Chiarulli
P. Torda

TLM/df

Charge from Deans

1) Are there part-time students? what arrangements have been made for them?.

2) Are there incentives for participating in seminars and such? How is credit given for seminairs?.

3) Grading methods?.
How does it fit into IIT framework?.

4) Test program against ECPD criteria.

5) Criteria for tests of program
a) does it lead to successful career for students?.

b) does it bring more good students to IIT?.

6) Do we need a generalist an age of specialization?.

7) How good are E^3 student reports?.

USE OF NUMBERS AND STATISTICS

Introduction

The E^3 Program at IIT was developed as an alternative to traditional engineering programs in which emphasis is placed on technical content and specialization. The Program addresses the acknowledged need for engineers who are not specialists but rather generalists who have had an interdisciplinary education which recognizes the social sciences and humanities as an essential component of engineering. In this context the study of psychology and the application of psychological techniques to the recognition and solution of technical problems is as much engineering as is the study of heat transfer and its application to problem solving.

Student performance in the E^3 Program is tested in many ways including licensing examinations, admission to graduate study and employment in industry. The E^3 student must pass mastery examinations in the core material at a level not required of the non-E^3 engineering student. It is true that an E^3 student need not cover all the material in the physics sequence required of non-E^3 students for example, but he will have acquired knowledge equally pertinent to an engineering education. The Program has not yet completed one year of operation as it has been conceived: a program in which all levels of students are involved in a given project; a program in which senior students are mentors and tutors. To judge the success of the Program in all dimensions at this point seems premature.

Credit System

Credits in the E^3 curriculum are earned in three areas; Mathematics, Science, Engineering Science (MSES), Professional and Project Learning (PP), and Humanities and Social Sciences (HSS). MSES credit is earned primarily through the demonstration of the student's mastery of material in the so-called "common core" courses.[1] This material is available for self-study in the 331 modules written by the IIT faculty. For the most part, the modules are based on texts currently used in IIT courses. (This has the advantage that texts are available in the IIT bookstore.) However, if an E^3 student takes a course in Introductory Biology, for example, and receives a grade of B or better, he will receive MSES credit. PP credit is earned for project associated learning and non-project associated learning at an advanced level. The student may acquire this advanced level knowledge through participation in seminars, faculty guided study (somewhat similar to a reading course but usually with less faculty time involved), and by taking advanced courses in which a grade of B or better is earned. HSS credit is earned for project associated learning in the humanities and social sciences, for seminar participation and course work. All credit for the BSE degree must be earned through demonstration of mastery.

Enrollment and Student Progress

The Subcommittee "Review" contains incorrect figures in Tables 1 and 2. Correct enrollment figures are given here in Tables 1 and 2 below. It is

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1 Math 103,104,203,204,303; Physics 103,104,203,204; Chem. 111,113; EG 101,102; CS 202; ES 205,206,207,208,310,311,312,313 - total hours 75. BSE requires a minimum of 52 hours of MSES. This requirement was set forth in the material requesting faculty approval for the BSE degree, and was approved by the IIT faculty in 1973 and 1974. Most IIT engineering programs do not require all 75 hours listed above. The self-study modules are designed to minimize repetition of material, just as departments not requiring all core courses cover some of the core material in departmental courses.

obvious that the major loss of E^3 majors occurred among the first entering group (1972). This class has continued to present the greatest difficulty in terms of change of major and being "off schedule." This 1972-73 year was also high in terms of faculty attrition. The inclusion of this first group in calculating various averages obviously skews those averages. It should be clear that the special difficulties of the start-up class have not led to the relaxation of academic standards or requirements for those students.

Table 1

E^3 STUDENT REGISTRATION*
FIRST SEMESTER 75-76 (as of 10/20/75)

Semester level	Registration level	No. of students
01	1b1	7
02	1b2	1
02	1b3	2
03	2b1	0
04	2b2	0
04	2b3	7
05	3b1	1
06	3b2	0
06	3b3	2
07	4b1	2
08	4b2	3
		25

An additional 3 students are in industry for their co-op periods.

1. E^3 course numbering system is as follows:

E3P abc

a = 1 freshman level
a = 2 sophomore level
a = 3 junior level
a = 4 senior level
b = 1 PP
b = 2 MSES
b = 3 HSS
c = 1,2,3,4, number of times work is being done at the indicated level

Source: E^3 Program Center records.

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* These figures include only full time day students.

Table 2

E^3 STUDENT PERFORMANCE CHART
(EVENING STUDENTS NOT INCLUDED)

			Dropped out of Program								Graduated	
Year Entered	Number (Total)	Part time or Co-op	1972 Dec.	1973 June	1973 Dec.	1974 June	1974 Dec.	1975 May	1975 Dec.		1975 May	1975 Dec.
1972-73	29	3	2	10*	1	1	3	2	0		2	2
1973-74	17	2	-	-	1	3	-	4	0		1	-
1974-75	6	-	-	-	-	-	-	-	2		-	1
1975-76	8	-	-	-	-	-	-	-	-		-	-

	Behind Schedule		On Schedule	May 1976 Graduation
	1 year or less	2 years		
1972-73	2	3	5	1
1973-74	4	-	5	1
1974-75	2	-	2	-
1975-76	-	-	8	-

Source: E^3 Program Center records.

* One student deceased.

Table 3 has been added to show a comparison of Freshmen attrition figures for the E^3 Program, the engineering departments, the physical sciences, and IIT as a whole. This table is based on data from the Office of the Dean of Engineering. It is clear from Table 3 that E^3 Freshman attrition from IIT falls below all three of these IIT averages. In terms of "attrition" to other majors, only in 1972-73 did the E^3 figure exceed that for engineering generally. If one considers attrition for the entire period in which the E^3 Program has been in existence, one finds that 12% of the students have left IIT, which is well below IIT freshman attrition. Table 4, which complements Table 3, was compiled from data supplied by the Dean of Students' office based on numbers of change of major forms and thus reflects changes of majors occurring in the sophomore and upper level years.

Table 5, based on registrar's data, gives IIT enrollment figures and some idea of overall attrition from IIT. (It must be remembered that transfers into IIT at an advanced level and re-admissions are included in these figures.) For instance, taking the freshman class of 1970-71, making a comparison with the original registration of 644, in any succeeding semester, the following changes in enrollment may be recorded:

Spring 71	10%
Fall 71	8%
Spring 72	16%
Fall 72	23%
Spring 73	26%
Fall 73	28%
Spring	29%

So at best, 71 percent of the original freshman class would have graduated on schedule, despite a gain in enrollment (transfers) in Fall, 1971.

Table 6 shows the number of modules mastered by E^3 students. Current module activity remains somewhat less than desired (average of 30 modules per student semester) but vastly improved over the first year of the program. Not reflected in these figures is the improved performance of each successive entering class. In addition, students who transfer into the E^3 Program are granted credit for MSES work completed in earlier courses, and thus have lower overall MSES requirements outstanding.

Table 3

IIT FRESHMAN STUDENT ATTRITION

	1970-71			1971-72			1972-73			1973-74			1974-75		
	Orig. Reg.	% left IIT	% trans.other dept.	Orig. Reg.	% left IIT	% trans.other dept.	Orig. Reg.	% left IIT	% trans.other dept.	Orig. Reg.	% left IIT	% trans.other dept.	Orig. Reg.	% left IIT	% trans.other dept.
E^3	0	-%	-%	0	-%	-%	27	18%	30%	16	0%	19%	4	0%	25%
ChE	37	16	22	27	7	26	33	15	21	Data not available			Data not available		
CE	19	5	32	15	13	40	8	12	0						
EE	117	13	20	111	21	19	64	19	14						
EG	3	67	0	0	-	-	2	50	0						
ES	8	25	75	22	0	50	0	-	-						
FPSE	19	32	5	14	21	0	21	19	5						
ISE	11	18	36	4	25	0	14	36	36						
MMAE	58	22	0	39	18	31	52	21	21						
MME	4	50	0	4	25	50	6	0	50						
Eng.	276	18	25	216	18	23	200	20	18						
Phy.Sci.	97	20	39	108	18	43	57	23	37						
IIT	626	21	29	528	20	24	450	22	20						

Source: Information provided by Dean of Armour College of Engineering.

Table 4

Change of Major Data
Day - Undergraduate Division

Academic Year	Number	Enrollment	% of Errollment
1970-71	224	2172	10.3%
1971-72	155	2085	7.4%
1972-73	145	1986	7.3%

Data for the last two years were not readily available, but experience is consistent with the above data.

Source: Information provided by Dean of Students.

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Table 5

IIT Undergraduate Enrollment Figures

Fl'68	Sp'69	Fl'69	Sp'70	Fl'70	Sp'71	Fl'71	Sp'72	Fl'72	Sp'73	Fl'73	Sp'74
4-570	4-507										
3-498	3-451	4-518	4-484								
2-612	2-568	3-537	3-478	4-535	4-476						
1-680	1-599	2-604	2-543	3-541	3-467	4-562	4-456				
2360	2125	1-612	1-571	2-546	2-482	3-448	3-433	4-456	4-417		
		2271	2076	1-644	1-582	2-590	2-543	3-497	3-473	4-460	4-455
				2266	2007	1-556	1-512	2-557	2-486	3-445	3-422
						2156	1944	1-531	1-487	2-540	2-456
								2041	1863	1-526	1-489
										1981	1822

Source: Information provided by Registrar.

Table 6

MODULE RECORD

Term	Module Total	Number of Active Students	Average Module Per Student
Fall 1972	174	28	6.2
Spring 1973	223	25	8.9
Summer 1973	35	10	3.5
Fall 1973	338	30	11.3
Spring 1974	416	25	16.6
Summer 1974	27	6	4.5
Fall 1974	321	25	12.8
Spring 1975	448	30	14.9
Summer 1975	136	14	9.7
Fall 1975	559	25	22.4

The average module equals .214 semester hours.

Source: E^3 Program Center records.

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Professional and Projects

Table 7 represents a credit breakdown of the nine projects which the Subcommittee examined in detail and which it summarized in Table 3, p. 16, of the "Review." Forty-one projects either in the preliminary or implementation phases have been undertaken by E^3 students. Eliminating the one project in which students received grades of I, the average credits earned is 5.3 credits per student per project per semester. A complete list of the projects is given in Table 8.

Table 9 lists the technical seminars and mini-courses which have been offered by the E^3 Program Center. The Theme Seminar provides background information for project identification. These are listed in Table 10. Table 11 lists the seminars for which HSS credit was granted.

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Table 7

PROJECT CREDITS
(REVISION OF TABLE 3, SUBCOMMITTEE REPORT)*

Project Title	No. of Students	Project & Professional Credit: Project	Project & Professional Credit: Seminars	Project Related HSS Credit	Duration of Project
Coanda Tube	Fresh. 4	0,0,12,16	2,3	2	Fall 72 - Spring 73
	Soph. 0				
	Junior 0				
	Senior 0				
Short Distance Transportation	Fresh. 3	9,10,11	0	2,2,5	Fall 72
	Soph. 0				
	Junior 0				
	Senior 0				
Incineration	Fresh. 6	8,9,9,10,11,12	1,2	2,2,3,3,3	Fall 72 - Spring 73
	Soph. 0				
	Junior 0				
	Senior 0				
H_2 Economy	Fresh. 3	9,10,10	2	1,1	Fall 73
	Soph. 2	6,9	1	2	
	Junior 0				
	Senior 0				
Residential Energy	Fresh. 2	8,10	1	2	Fall 73
	Soph. 5	5,5,6,7,9	2,2	2,2	
	Junior 1	6		2	
	Senior 0				
Cargo Submarine	Fresh. 5	6,6,6,9,9,	1	1,1,2,3	Spring 74
	Soph. 2	6,6		2,3	
	Junior 0				
	Senior 0				

Table 7 (Continued)

Project Title	No. of Students	Project & Professional Credit		Project Related HSS Credit	Duration of Project
		Project	Seminars		
Topography Wind Analysis	Fresh. 2**	4,17	2	1	Spring 74, Summer 74, Fall 74
	Soph. 0				
	Junior 3**	12,12,16	3,3,7	1,3,4	
	Senior 0				
Packaging	Fresh. 1	2			Fall 74 - Spring 75
	Soph. 3	12,16,17	1	0	
	Junior 1	4	2	0	
	Senior 0				
Dental Occlusion	Fresh. 1	6	0	1	Spring 75
	Soph. 2	4,5	0	1,1	
	Junior 1	6	3	1	
	Senior 1	8	3	1	

Source: E^3 Program Center Records.

* This table includes the nine projects presented on p. 16 of the Subcommittee "Review".

** Student status at beginning of project, Spring, 1974.

Table 8

LIST OF E^3 PROJECTS

1.	Auto Vehicle Location	Fall 75
2.	Tech. Assess. - Deep Tunnel	Fall 75
3.	Acoustics - Evening	Fall 75
4.	Science & State Government	Fall 75
5.	Urban Noise	Fall 75
6.	Acoustics - Day	Fall 75
7.	Solar Energy	Fall 75 Incomplete
8.	Highway Traffic Control	Fall 75
9.	Dental Occlusion	Spring 75
10.	Snow Job	Fall 75 (Fall 74)
11.	Space Colonization	Spring 75
12.	Self-Sufficient Community	Spring 75-Summer 75
13.	Dental Screening	Spring 75
14.	Flywheel Energy Storage	Fall 74-Spring 75
15.	Beach Erosion	Fall 74-Spring 75
16.	L/V System	Fall 74-Spring 75
17.	Helicopter Dynamics	Fall 74-Spring 75
18.	Packaging	Fall 74-Spring 75
19.	Fuel Economy	Spring 74
20.	Highway Lighting	Spring 74
21.	TWA	Spring 74-Fall 74
22.	Cargo Submarine	Spring 74
23.	Supplemental Energy	Fall 74
24.	Water Quality	Fall 73-Spring 74
25.	Solar Energy	Fall 73
26.	Waste Heat	Fall 73
27.	Life Space	Fall 73
28.	Hydrogen Economy	Fall 73
29.	Noise Control in Industry	Spring 73
30.	Vestibular System Testing	Spring 73
31.	Dual Mode Vehicle	Spring 73
32.	Tornado Study	Spring 73
33.	Camera Shutter	Spring 73
34.	Solid Waste Incineration	Fall 72-Spring 73
35.	Coanda Tube	Fall 72-Spring 73
36.	Dual Mode Mass Transit	Fall 72-Spring 73
37.	Short Distance Transportation	Fall 72
38.	Alcohol Detection	Fall 72
39.	Auto Emission	Fall 72
40.	Plastic Recycling	Fall 72
41.	Steering System for Urban Vehicle	Fall 72

Source: E^3 Program Center Records.

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Table 9

MINI-COURSES AND TECHNICAL SEMINARS

	Mini-Courses	Technical Seminars
1972-73		Basic Algebra Fluid Mechanics Ecology of Aquatic Systems
1973-74	Differential Calculus Dynamics Physics - Thermodynamics Chemistry Integral Calculus Solid State Electronics Optics	Fluid Mechanics Thermodynamics Advanced Calculus Ecology of Aquatic Systems LaPlace Transforms
1974-75	APEX-METRO	Fluid Measurements Modelling Vibrations Matrices Instrumentation Machine Shop System Dynamics & Control
1975-76		Queueing Simulation Management Acoustics

Small Group Dynamics is a continuing activity which carries both PP and HSS credit.

Source: E^3 Program Center Records.

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Table 10

THEME SEMINARS

1972-73 The City

1. R. Fancher and C. Tranby, Commonwealth Edison, "Water Pollution - Waste Heat"
2. S. Kumar, IIT, "High Speed Tube Transportation"
3. P. Baker, City of Chicago "City Organization and Engineering Projects"
4. S. Morris, Northeastern Illinois Planning Commission, "Policy Plan vs. Construction Solution to Urban Problems"
5. Jack O'Brien, Mercy Hospital, "Engineering Problems at Mercy Hospital"
6. James Patterson, IIT, "Urban Waste Treatment - Solid Waste Management"
7. Paul Griffith, IIT, "Economic Problems in the City"
8. Marshall Soloway, City of Chicago, "O'Hare Airport - Prospects and Plans"
9. Richard Scharf, IIT, "The City as a Concept"
10. Florence Torda, IIT, " Social Organization of the City"
11. Peter Tyor, IIT, "The Urban Political Machine"
12. James Bertucci, IIT, "Air and Water Pollution - Health Control"
13. Arthur Stawinski, IIT, "The City and Alienation"

1972-73 I Energy: Resources and Ecology

1. Donald Shaw, Midwest Population Center, "Man's Olympian Arrogance"
2. W. W. Brandfon, Sargent and Lundy, "Outlook: Fossil and Nuclear Fuels"
3. R. B. Rosenberg, IGT, "Energy Supply - What are our Alternatives?"
4. S. W. Anderson, Commonwealth Edison, "Transmission"
5. Choate Brown, Sargent and Lundy, "Site Survey"
6. Irving Faber, Kent School of Law IIT, "Impact of Legislation on the Power Industry"
7. Joseph Baugher, IIT, "Energy Flow in the Sun-Earth System"
8. Ken Schug, IIT, "Energy and Matter in the Geosphere"
9. James Bertucci, IIT, "Energy Relationships in the Biosphere"
10. Florence Torda, IIT, "Values, Value Conflict and Policy"
11. Richard Scharf, IIT, "American Political Values and Resource Decisions"
12. Mark Solomon, IIT, "Energy and Ecology as Public Policy Issues"
13. Edwin Stueben, IIT, "Limitations of Prediction and Technology Assessment (or Figures Don't Lie but Liars can Figure)"
14. Ken Stevens, IIT, "Alternative Technology, Appropriate Technology"

Table 10 (Continued)

1973-74 II Packaging

1. T. Willis and K. Stevens, IIT, "Packaging of the Self"
2. James Lott and F. Torda, IIT, "Homes as People Packages I"
3. D. Joshi and J. Bertucci, IIT, "Homes as People Packages II"
4. James Lott and K. Stevens, IIT, "The Place of Work as a People Package I"
5. J. Baugher and M. Solomon, IIT, "The Place of Work as a People Package II"
6. P. Torda and R. Scharf, IIT, "The Transportation Unit as a People Package"
7. P. Torda and S. Kalpakjian, IIT, "Packaging of Things I"
8. T. Willis and R. Scharf, IIT, "Packaging of Things II"

1974-75 Communications

1. Bruce Vanderporten, IIT, "Communications as an Economic Resource"
2. David Goldberg, Illinois Law Enforcement Commision, "Emergency Service Coordination"
3. R. F. Irving, IIT, "The Problem of Communications"
4. Wm. Hetzer, IITRI, "Man-Machine Communications"
5. Paul DeForest, IIT, "Communications in Science and Technology"
6. Carole Goodwin, IIT, "Social and Political Communications"
7. Dan Costello, IIT, "Information Theory Applied to Communications Engineering"
8. Bruce De Maeyer and William Demlow, Illinois Bell Telephone Co., "Electronic Telephone Switching: The System and its Introduction"
9. David Ramey, FAA, Warren Holtsberg, FAA, Tom McMahon, O'Hare International Airport, Barry Bickley, E^3 student, "FAA: Air Traffic Control System"
10. Les Peach, IIT, "Time Multiplexing and Telephone Communications"
11. Susan Catania, Member Illinois House of Representatives, "Delivery of Technical Information to State Legislators"
12. Bernhard Ebstein, IITRI, "Implementing Communication Systems, System Design, Client Education, Hardware Procurement"
13. Milton Pikarsky, RTA, "The Engineer and Communication"
14. Martin Cooper, Motorola, Inc., "Mobile Two-Way Communication"

Table 11

HSS SEMINARS

1972-73	The Decision Making Process Photography Space and Time Corruption in the City Health Care Delivery in the U.S. The Short Novel Theories of Personality
1973-74	Perception Technics and Civilization Shakespeare Writing Skills
1974-75	Photography Business Law Land Use History of Technology

EVALUATION OF E^3 PROJECTS AND PROJECT REPORTS

The evaluation of E^3 projects by the Subcommittee of the Curriculum Committee was based mainly on an examination of nine final reports written by student teams. The use of the final reports as the basis of the evaluation is invalid; the reports are primarily an exercise in technical writing and are not intended to be documentation of total learning by the students in the course of the project. Students are told to eliminate derivations and excessive detail and to edit the reports so that they may easily be condensed for publication. Analysis and experimentation (methods, results, etc.) are reported in student and project log books which are retained by students.

The Subcommittee avoided receiving suggestions from the E^3 Program Center staff on methods for project evaluation. One approach which might have been used would have been to attend credit allocation sessions and question students and faculty as to the educational content of the projects. The project report gives the results of the project and is not a report on the educational experiences and learning gained by the students in the course of the project. These are recorded on standard forms in the students' files and form a detailed transcript. Due to time pressures, the objectives of the project may not be fulfilled, or the students may adopt an approach which does not lead to a solution. Such a project might therefore be termed

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a "failure"; however, in the process, the students may have learned a good deal.

The Subcommittee states that "in none of the reports could any engineering analysis be found which was at the level of an IIT senior course." (p.5) It must first be noted that only two of the nine projects listed in Table 3 of the "Review" (p.16) had seniors on the team. (Refer to Table 7 of this Response.) Three of the reports were written in 1972-73 when all but two students in the Program were freshmen; three other reports date from 1973-74 and represent mainly the work of freshmen and sophomores. In commenting negatively on the Residential Energy Project, the Subcommittee states that "the work involved covered considerably less than that which is covered in undergraduate heat transfer and thermodynamics courses." (p.5) This statement reveals a basic misunderstanding on the part of the Subcommittee. Project work is not a different pedagogical tool for teaching the material found in standard courses.

The Subcommittee refers to E^3 students' project activities as "reinventing the wheel." (pp.4,9) Although there is nothing wrong with the discovery method of learning, we should like to cite a few examples illustrating the originality of some of the projects. We cite six projects and the academic standing of the students who worked on them.

(1) Alcohol Detection Ignition Interlock. The project team devised a system more effective than that which was developed by General Motors. Four freshmen.

(2) Tornado Detection and Warning. The project team developed a real time detection and warning system which is better than those currently in operation. Six freshmen.

(3) Fleet Vehicle Location. The team designed a system for vehicle location identical to that of Boeing -- without any knowledge of the Boeing

system (except that Boeing was working on one and could not provide information to the project team). Two freshmen, one each sophomore, junior and senior.

(4) Aquatic Systems Analysis. Two members of the IIT Board of Trustees who learned about the project recommended that the report be made available generally, to professionals in the field. Two freshmen, four sophomores, one junior.

(5) Topography Wind Analysis. The project team, as a part of its project work, developed a preliminary proposal at a level of sophistication at which NSF-RANN (now ERDA) has let several large research grants. One freshman, three juniors.

(6) WRIDE. This team produced a new method of measuring railroad rail-wheel interaction. Southern Railway expressed great interest in this work. Three sophomores, four juniors.

The Subcommittee is also mistaken about the connection between module work and projects. In the first year of the E^3 Program (1972-73), the idea of having project needs serve as the sole motivation for students to study mathematics and science was tried and proved to be unsuccessful. Beginning in 1973-74, students were instructed to prepare, with faculty help, study plans listing modules covering subject matter related to the project, together with a schedule for completion. For example, students on the Aquatic Systems Project concentrated on chemistry and biology, while those on the Packaging Procedures team stressed statics, dynamics, materials, etc. All entering students are counseled to begin the mathematics modules immediately since this material is universally important. Problems with lagging background in fundamentals are found mainly with some of those students who entered in 1972.

One of the most disturbing conclusions of the Subcommittee is that "not a single report examined warranted the credits given in educational value." (p. 3) Forty-seven faculty members, representing most of IIT's departments, have been E^3 project advisers. As advisers they had ultimate responsibility and control over the awarding of credits. Is it reasonable to believe that they gave large amounts of undeserved credit? Advisers from engineering and science departments on projects run during Fall semester, 1975, were asked to comment in writing on this issue (Eight responses were received).

Question:

Were the number of credits granted consistent with average IIT credit for comparable effort at the level at which the credit was granted?

Response:

Yes. They worked hard and seemed to earn their credits. Minimal number of credits were awarded consistent with the efforts of the students on this "proposal stage" project.

I believe so. At most (name omitted) was 5% too high and (name omitted) was 20% too high, but (name omitted) may have been 10% too low.*
*Based on intuition prior to credit evaluation. Difference too small to argue about.

Yes. However, there was some discrepancy between the credits given for the day acoustics group and the evening acoustics group. The credits allocated within my group were consistent with credit values awarded in special research projects I have conducted in the Physics Department, with classes I have taught. (Names omitted) agreed that the credits were consistent with projects they have been involved with. The problem is that they are extremely capable and would elevate the credit level of any project they are associated with. Some criticism has been leveled by my students at their previous projects and credit allocated for them. They felt that they had done much more work in my group and received less credit than in earlier project experiences.

Credits granted to E^3 seniors tend to be slightly high, subject to the question of credit to be allocated for final report writing and oral presentation.

Yes. (four replies without additional comments)

It is true that during the first year of the Program, due to lack of experience in evaluating projects of the E^3 type, faculty tended to be generous. Since that time, norms and criteria have been developed and the number of credits awarded now averages about six per semester per student, and these are awarded for various modes of learning and achievement. All project credits are not equal -- for example, those earned on the freshman level (and so labeled with a 100 course number) may not be used to fulfill requirements at a higher level. The E^3 credit requirements for advancement appear immediately following this section of the Response.

The Subcommittee refers to the total of all credits awarded to students on a project as if it had some significance. Credits are awarded to individuals for their individual accomplishments and no credit is assigned to the project as a whole. To say that "Total credit awards per project ranged from 35 to 86, or 1 to almost 3 years of student effort" (p.3) is as enlightening as saying that 1300 credits, or the equivalent of 10 B.S. degrees, were awarded in Physics 103 last semester.

In order to evaluate the project work properly, the Subcommittee might first have asked for a statement of the goals involved and the criteria used to determine if these goals were satisfied. The goals and criteria for their evaluation are as follows:

(1) Development of Problem Solving Skills.

The faculty is to evaluate the ability of the student to recognize problems and to devise reasonable approaches toward their solution. Students are to learn how to conduct a literature search and how to obtain information from resource persons. As appropriate, they are to devise experiments and use analysis to verify or negate hypotheses.

(2) Development of Organizational and Management Skills.

The students are to learn how to work with fellow engineering students towards solving problems which have no known solutions. In addition, they are to work with professionals from other disciplines, such as law and the social sciences. They should be able to organize the work by dividing tasks, making schedules, arranging for the use of laboratory facilities, etc.

(3) Development of Communication Skills.

The students are to demonstrate an ability to write proposals, interim and final reports, keep log books, and prepare a variety of other written materials. They also must prepare and present effective oral statements of their work to peers, E^3 faculty, and other members of the faculty and interested public.

(4) Learning of Basic and Professional Engineering Materials.

Besides learning MSES material using learning modules, the students should be able to use standard books and journals. They should recognize the need for these materials and should be able to schedule learning to coincide with specific needs and tasks during the course of a project.

(5) Understanding the Significance of Problem Solving.

Students must demonstrate awareness of the implications and origins of engineering work within the social and humanistic dimensions of contemporary society and technology.

STUDENT ADVANCEMENT PLAN

The following student advancement plan was accepted by the E^3 group (students and faculty) at the Monday Open on March 3, 1975.

I. Rate-of-Progress Guidelines

To provide a balanced rate of progress through the E^3 Program over a period of eight semesters and to meet Institutional requirements, the following schedule of credit accumulation is recommended for full-time students:

Semester	PP	MSES	HSS
1 through 6	6	8	3
7	9	4	3
8	13	0	3
TOTAL	58	52	24
(Required)	(54) 52	(50) 52	24

An additional requirement for graduation is the earning of a minimum of 16 hours of PP credit at the 400-level.

II. Pre-requisites

To help ensure that an E^3 student is adequately prepared for increasing levels of study on advancing through the program, the following pre-requisites will ordinarily be required. The enforcement will occur at a pre-registration meeting with the PDC late each semester at which the student's program for the following semester is planned.

E^3 Courses	Pre-requisites		
	PP	MSES	HSS
200-level	8	12	4
300-level	18	28	10
400-level	30	42	16

Students not meeting those requirements and not granted waivers therefrom, will continue at the same level in PP, MSES and HSS registration. A full time student may not register at the 100 level more than 4 times or at the 200 or 300 level more than 3 times.

PART III: THE E^3 PROGRAM AND ENGINEERING EDUCATION

INTRODUCTION

Throughout the life of the E^3 Program at IIT, there has been a natural tendency to compare the Program with the offerings of the other engineering departments. Such comparison is most clearly supported on the ground that, when matters are reduced to fundamentals, we all are granting baccalaureate degrees in engineering. These comparisons have highlighted the ways in which E^3 and other departments differ in the structuring of undergraduate education, in curriculum content, and in the learning "atmospheres" of the programs under comparison.

While comparison is an obviously available tool for comprehending new phenomena, truly valid comparison must go beyond superficial differences, and must ultimately reach that level at which the basic differences between the phenomena being compared emerge clearly. In the case at hand, that level is reached only by looking beyond structure, curriculum, and atmosphere, to some rather fundamental questions of engineering education, professional education, and probably higher education itself.

Some Basic Distinctions

An examination of this level of issues involves, at the least, making some conceptual distinctions which are often glossed over or forgotten, especially when the situation appears to require a definitive decision in a limited time period. (Those who took part in the early shaping of the E^3 Program, for instance, had the opportunity to raise and discuss some of these basic distinctions, although they too had to leave many of them at midpoint in order to get the details of the Program into place for the arrival of the first students.) While these broader issues of engineering, professional, and higher education will be continuing ones on which honest people disagree, the distinctions are very much in order if the arguments surrounding these issues are to be fruitful and enlightening.

The first such distinction which must be made is between engineering as a body of knowledge and engineering as an activity. As a body of knowledge, engineering rests heavily upon the sciences proper -- physics, chemistry, perhaps biology -- and mathematics. In addition, it has, over generations of practical and educational development and convention, acquired another component which is called engineering sciences; based upon the sciences, but moving beyond them in a way which has proved to be of particular value to engineers and the kinds of problems they address. Thus the content of that body of knowledge called engineering is based, in a typically professional manner, upon engineering as an activity. Engineering as an activity, however, goes beyond that which is comprehended by any particular body of knowledge.

A part of the body of knowledge called engineering, and a smaller part of engineering as an activity, form that which is typically transmitted in undergraduate engineering educational programs, as offered throughout the United States. For a variety of reasons, the remainder is acquired, if at all, by engineers "on the job." That which is transmitted to emerging engineers in colleges and universities is both less and more than the total actually used by any engineer. It is less in that it leaves out much in terms of information, skills, and behavioral attributes that is needed by practicing engineers; more in that it usually includes more and different information than is typically used by any particular engineer in practice.

That which forms a patterned program for transmitting this knowledge we call curriculum. At this point, the second critical distinction must be made, in order to clarify the discussion. We here define curriculum to include all that which is taught. This not only includes all that which is required of engineering students beyond their engineering and science courses, but also goes beyond that which is contained in course descriptions. The distinction is between curriculum and course work. Obviously, material relevant to engineering as an activity or practice is taught in engineering courses, although it is not usually a part of the formal course content. Much of this teaching occurs informally, as, for instance, when faculty serve as engineer role models for students. The ways in which faculty members approach the study of engineering, the ways they treat knowledge, the ways in which they go about defining and solving problems, the assumptions they make about the meaning of engineering and technology in the larger social context, their attitudes toward proprietary knowledge or secret research -- all of these things form a part of an engineering student's curriculum, although they rarely appear in the description of courses or in the syllabi which are passed out on the first day of classes.

Because these matters are not considered appropriate as formal course content or course foci, they generally receive incomplete attention and less than critical examination. Yet no practicing engineer would, if questioned, consider them unimportant in the preparation of engineers for careers.

Finally, a distinction must be drawn between engineering as an activity or practice and engineering as a profession. While there has been a continuing debate, much of it sterile, as to whether or not it is correct to consider the practice of engineering a true profession, it is not necessary to resolve that issue in order to recognize that engineers occupy a social and occupational position which calls upon them to show proper and serious regard for the social and cultural origins and impacts of their work. Engineers call upon themselves to practice engineering in conformance with certain moral and etnical standards -- standards albeit imprecisely stated in many cases. As in all professions or quasi-professions the special characteristics of the work call for special attitudes and responsibilities to be displayed behaviorally. It is possible for engineers of great talent to behave unethically or to conduct their affairs in cultural and social oblivion, but we could not label such engineers "professional" in any but a crass sense, no matter how talented they might be.

If then, our aim is the preparation of students for a profession, it follows that our curricula, both within and beyond course work, must be consciously designed to achieve this end, in terms of transmitting knowledge of both that body of knowledge called engineering and that activity called engineering. Preparing people for "jobs" will not do; engineering makes greater demands. Society makes greater demands. The best of our students make greater demands.

Innovative Educational Programs

The call for reexamination of educational programs, mentioned above, has led to new engineering programs which will not only make curricula more efficient or effective, but also will require educators to reassess and redirect their goals toward the satisfaction of needs which are not currently addressed by the goals of high quality traditional curricula. The traditional curricula have been adapted to emerging needs by slow incremental change. As a result many, if not most, degree programs are heavily overloaded with traditional material, on the one hand, and adaptation to contemporary needs and the ever-advancing "state of the art" on the other. They allow both students and faculty little opportunity for reflection on the goals on engineering as a profession.

For precisely these reasons, a fundamental reexamination of professional education is in order. Doubtless, popular reactions to the unintended side effects of unbridled technological "advance" have also played a role in the timing of such reexaminations.

An emphasis upon public technology, technological forecasting, the limits to growth, engineering for public service, and socio-engineering, to name a few, has produced new centers of attention for engineering educators at a variety of institutions.*

Likewise, a critical reexamination of traditional teaching and learning methods has produced institutions which place a heavy emphasis upon expermential learning as a supplement or substitute for the more conventional lecture, recitation, laboratory, quiz, and examination techniques.**

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* Among the most prominent are Worcester Polytechnic Institute, Georgia Tech, Vanderbilt, Harvey Mudd, and MIT.

** Evergreen State College, the University of Western Washington, Empire State University, Harvey Mudd, WPI, University of Texas, University of the Redlands, University of Alabama, University of South Carolina, Wilmington College.

The contribution of IIT to this growing national effort has been the E^3 Program. In some cases, new institutions were chartered to undertake these new missions; in other cases the entire institution revamped its practices; in yet a third category, new divisions or colleges were established. In the case of IIT the E^3 Program Center was established as a degree-granting unit, the only one of its kind in the Institute, having less than full departmental autonomy despite its authorization for baccalaureate degrees.

In virtually all cases, these new educational programs have been greeted with considerable suspicion when founded within traditional settings of higher education; E^3 is not alone in its experience at IIT. On the other hand, it may be expected that the new programs are likely to have their greatest impact in precisely those settings, where they are a continuous influence upon other curricula. This had clearly been the case at IIT, whether or not credit has been given to the E^3 Program Center.

Recurring Issues

The E^3 Program had adopted the aim of preparing students for a profession and has defined and structured its goals and methods to achieve it. Nevertheless, several issues have been touched on in the recent Subcommittee "Review"which have occupied the attention of the E^3 Program Center long before that document was prepared, and will continue to do so.

The E^3 Program suffers from high student attrition and student delay in receiving the BSE degree. The figures in Part III of this document indicate that, except for 1972-73, the first year of the Program, this is a non-issue; E^3 "attrition" both for students leaving IIT and students changing majors within IIT, is at or below comparable numbers for engineering at IIT.*

In addition to students "behind schedule", E^3 has students "ahead of schedule." Again, the Mastery (B+ or better) concept requires a different rate of progress for some students. This experience is consistent with "Keller Plan" experience elsewhere. It would be a likely result throughout IIT if only honor grades were used. More critically, E^3 students and faculty argue that the granting of a degree must depend upon the achievement of a level of performance consistent with the goals of the Program, and that in such an important matter, time must be a secondary or tertiary consideration.

The quantity of core material (MSES) in the Program is insufficient for the education of good engineers. There is no "correct" amount of core material for the education of engineers. IIT engineering departments differ in their requirements. Engineering degree programs at different colleges and universities also vary widely in their requirements. Until some convincing data can be provided to show a clear correlation between core material requirements and engineering excellence, this issue remains one on which no particular number of credit hours may be defended intelligently. In addition, the relative learning involved in 52 credits at Mastery level as opposed to 54-75 credits (the IIT range for BS degrees) at "C" level may be considered. The requirements of the E^3 Program make sense in terms of its goals and have been accepted by the Curriculum Committee and the IIT faculty on two occasions as suitable for the BSE degree.

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* The first year "attrition" was caused by a number of factors common to new programs, and may have been aggravated by the large size of the first year group.

The quality of student project work is lower than we expect of IIT undergraduates. Certainly that project work is different from that done by other IIT undergraduates. It has been repeatedly stated that E^3 projects enlist students from freshman through senior years, unlike any others at IIT. They also require careful problem definition from students, unlike other projects at IIT. They require the preparation of proposals, logs, reports, and presentations in a professional manner.

As pointed out earlier in this document, project reports are project reports; they are not transcripts of student team members. Coupled with the E^3 Program Center's insistence that the freshman, sophomore, junior, senior sequence is a chronological rather than an educational sequence, a point recognized to some extent by all departments, the comparison of E^3 projects with departmental senior projects makes for slight illumination. Yet it is this comparison which is used to justify the assertion italicized in the previous paragraph.*

BSE recipients ought not be called engineers at all. Considering their departure from traditional patterns of learning, one is tempted to agree willingly with this statement, except for the fact that the graduates are continuing their engineering studies in highly regarded graduate schools and working as engineers. Indeed E^3 Program undergraduates are working for

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* It is worth adding that E^3 Projects have also received praise from within and beyond the walls of IIT.

engineering firms and in engineering positions. To the great pleasure of the E^3 Program Center these pre- and post-BSE positions represent a mix of public and private sector employment.

While the universe of BSE degree holders is small, their post-BSE situations would be more than satisfactory to any department at IIT. The Program Center will continue to help its students find and secure suitable positions and admission to graduate programs. The E^3 Program Center has every reason to be totally confident that by these standards of judgment, its graduates are recipients of a high quality engineering education. It assesses the Subcommittee's statements to the contrary as unfounded.

Conclusion

We have attempted in this portion of our Response to the Subcommittee "Review" to look at some of the issues of engineering and professional education -- issues which have occupied the attention of serious educators. These issues transcend the Subcommittee's work; they are of great moment, however, to the E^3 Program Center. Indeed some of them were recommended for study in the "Charge From the Deans" to the Subcommittee.

IIT plays a significant role in the preparation of undergraduate engineers. If the Institute is to maintain a leadership role in engineering education, it must not only have quality faculty and quality students, but must also provide for them a range of opportunities and learning settings which will meet their various needs. It is in this context that the E^3 Program and its activities should be viewed.

APPENDIX XVIII

E^3 PROGRAM CENTER
DEPARTMENTAL SELFSTUDY

Pages 361-390 inside 430

E^3 PROGRAM CENTER DEPARTMENTAL SELF-STUDY

Prepared in Conjunction With
North Central Association
Accreditation Visit
1976

Prepared by: Richard K. Scharf
Associate Director,
Program Development
October 8, 1975

TRANSMITTAL NOTE

The materials included in this departmental self-study follow closely the format of the INTERIM EVALUATION GUIDE FOR INSTITUTIONAL ASSESSMENT (1974). All parts (I-V) are included. Because the E^3 Program Center has been under development for the past five years, and because it departs significantly from usual departmental procedures in terms of decision-making and planning, it is thought appropriate to include the material outlined in Part V of the GUIDE, even though this material is not sought as a part of the normal Departmental Input. Materials sought in the GUIDE which are not applicable at the department level have been omitted.

In those instances where the GUIDE uses the terms "institution" and "institutional", this study substitutes "E^3 Program Center", either explicitly or implicitly. Where the term "administration" is used in the GUIDE, it is taken in the self-study to constitute "director and associate directors".

No attempt is made to provide in this self-study an overall introduction to and description of the E^3 Program Center or its curricula. It is assumed that such information, which would greatly lengthen the self-study, will provided by the INTRODUCTION TO E^3 attached.

I. INSTITUTIONAL OBJECTIVES AND STATEMENT OF PURPOSES

The stated goals and purposes of the E^3 Program Center are taken from the following sources: proposals and reports to the National Science Foundation, papers and publications by members of the Program, the degree requirements of the Program (leading to the Bachelor of Science in Engineering), and a review of the actual academic programs of graduates and graduating students.

Formal Statements

The Education and Experience in Engineering (E^3) Program embraces two major objectives:

1. Education of engineers to a high level of interdisciplinary competence so that they may be able to solve problems within technological, social, economic, legal, etc., constraints.

2. Achievement of proper motivation for students to attain this high educational level.

The program is designed to educate highly competent engineers who are not only able to develop the necessary technology to solve problems, but who are also able and willing to assume responsibility to assure that such innovation proceeds with a minimum of side effects harmful to the human race.

The E^3 Program offers radical departures from conventional undergraduate curricula. It is interdisciplinary, it integrates liberal arts directly into the engineering curriculum, and it employs new approaches to learning and learning evaluation.

Engineers are problem-solvers and projects form the basis of the E^3 Program from entrance through graduation. The problem solving effort is carried out by small groups consisting of undergraduate students of various levels. Supervision and guidance are provided by faculty members from the various academic fields involved in each problem.

The project work is supplemented by lectures, directed individual study, and seminars. The lectures are given in all fields (technology, natural sciences, humanities, and social sciences). The basic content of the engineering education is contained in guided self-study material called learning modules. Group discussions and seminar presentations are vital elements of the program at several stages of problem solving.

The E^3 Program is a project based program leading to a Bachelor of Science in Engineering degree from Illinois Institute of Technology.* E^3 was developed in order to

* The Program is supported principally by the National Science Foundation, GY9300.

- Bridge the gap between education and industrial needs.
- Bridge the gap between curricula and education needs.
- Respond to growing demands for engineers to exercise social responsibilities in their careers.
- Respond to the needs of contemporary students while maintaining high educational standards.

E^3 Goals

Reflecting these needs and projecting the directions which the engineering profession is likely to take, the Program has five principal goals.

1. To educate interdisciplinary problem solvers.
2. For students to become learners on a continuing basis - to become students.
3. For students to become effective self pacers.
4. For students to become honest and realistic self evaluators.
5. For students to work in teams of engineering and non-engineering professionals.

In achieving these goals, the Program's home is that realm in which the engineering and educational environments overlap. E^3 operates by applying several characteristics of the engineering environment to the educational process.

Engineering Environment

Viewing engineering as a problem solving process, it is possible to identify four phases in that process which must be undertaken.

- Problem recognition.
- Problem definition.
- Development and choice of alternative approaches.
- Development and choice of alternative solutions.

All four of these phases of problem solving are central to the curriculum in the E^3 Program.

Educational Environment

We observe, as educators, that all programs, schools, or curricula must undertake the following activities:

- Providing settings and modes for learning. (This is obviously true for students, but less widely recognized as essential for faculty as well.)
- Advising and guiding students through their undergraduate studies.
- Evaluation of students and Program. (Evaluation of new programs is, of course, more rigorous than for established ones.)
- Providing credentials and recognition for both students and Program. (This function is more critical for novel or innovative programs than it is for those about which the contents and graduates are widely known.)

The degree requirements for the BSE degree, which is granted only to students enrolled in the E^3PC, are stated quantitatively and qualitatively. The Program requires a minimum of 128 semester credit hours, consistent with other engineering curricula at IIT. Those credit hours must be distributed among three categories of study: Mathematics, Sciences, and Engineering Sciences (MSES); Project and Professional Study (PP), and Humanities and Social Sciences (HSS). The credit distribution must be, minimally, MSES-52, PP-52, and HSS-24. The first category, MSES, includes that curricular component corresponding to the Core Curriculum of the Institute's engineering department programs. This includes basic science, mathematics and engineering science material. The second category, (PP) represents a combination of advanced level engineering study and engineering design. The third component, HSS, includes the general education requirements of the Institute as they pertain to engineering students.

Qualitatively, there are additional degree requirements of the E^3PC. A considerable proportion of the HSS work done by any student in the Program is designed to occur in conjunction with the engineering project work being undertaken by the student. Likewise, the MSES component is spread over the four undergraduate years and is undertaken in conjunction with the needs of the engineering projects. Hence all three components of the curriculum must be undertaken by the student in a simultaneous and integrated plan of study focussed on problem-solving activity.

Another qualitative dimension of the degree requirements concerns the distribution of PP effort at the various levels of undergraduate study. Project and professional study must display increasing sophistication based on learning in the basic sciences, mathematics and engineering sciences. Hence project work credited at the sophomore, junior, and senior levels must be preceded by fixed levels of learning in these basic areas, lest the problem-solving activities remain at a rudimentary level.

A third qualitative dimension of degree requirements concerns the distribution of the student's learning in the various areas of engineering. Students are required to elect areas of formal study which considerably transcend the curricular boundaries of any given engineering field or department. This election is monitored by the Program Design Committee (a faculty advisory group) on a regular basis to ensure both breadth and coherence in any student's individual curriculum.

Finally, all work must be performed at the Mastery level. The Mastery concept, taken from self-paced instruction, is used throughout the E^3 Program. The principal purpose of the Mastery concept is to foster self-pacing and self-evaluation on the part of students. While credits earned during any semester are variable, performance levels are not, with one exception. In the area of PP work, students at each successive level of study are expected to demonstrate higher performance levels in order to demonstrate Mastery.

A review of the curricula actually undertaken by graduates and graduating seniors indicates great breadth and diversity, consistent with both the E^3PC requirements and the student's particular career and graduate study interests. No two students have the same overall study program; different areas of study have been omitted from their curricula. Each student has successfully tailored his/her program to his/her post-BSE plans, whether employment or graduate study.

The E^3PC provides service to students in other departments in two modes. Honors and other students enroll in E^3 projects to fulfill requirements in freshman design or as free engineering electives. Honors students in mathematics and in statics and dynamics have been granted permission to complete course requirements through E^3 self-paced Learning Modules in lieu of regular class attendance requirements.

Appropriateness of Goals and Purposes to Clientele

The E^3 Program Center relies upon the IIT Admissions Office, interviews, and student self-selection in the admission of students to the Program. Any student who meets IIT admissions criteria for the college of engineering is academically acceptable to the Program. In addition, each prospective student, freshman or transfer, is interviewed by the Director or one of the Associate Directors in order to acquaint the student with the Program and to provide the sort of information upon which the student may make an informed judgment as to whether or not the Program is appropriate for him/her.

In addition, the Program holds E^3 Workshops on several Saturdays during the academic year so that high school seniors considering the Program may receive extensive information and some experience in the approach that E^3 employs. On the basis of the Workshop, extensive printed information, and an interview with Program administration, the student elects to enter the E^3 Program. It is felt that the use of these measures is necessary in light of (a) the innovative approach to undergraduate education that the E^3PC employs and (b) the demands imposed on the students to accept the responsibility for their own education to a greater degree than is characteristic of conventional curricula.

After the student enters the Program, repeated interviews by both the Program Design Committee and the faculty in the Program provide the basis for reassessment of the suitability of the Program for each individual student. These interviews are conducted at least twice a semester. The regular Program Design Committee meetings are also a device whereby the student can compare his/her performance with the expectations of the faculty in a formal setting. Of course, such comparison also occurs on a daily basis in regular project team meetings, at which both faculty and students are present.

From the inception, students have played a large role in the setting of Program goals, within the framework of the formal statements which open this section of the self-study. In addition to the Program Design Committee, the Program has a weekly or biweekly "Monday Open", a faculty-student meeting at which matters of concern to the entire E^3 community are discussed and decided. A Council, made up largely of students, but with faculty representation, serves to deal with the sorts of problems arising from the conduct of team activities. The Review Board, which has the formal responsibility for the assessment of project proposals, interim reports, final reports, and presentations, consists of two faculty and one student, the student member being different for each project team. Almost all major policy documents generated by the E^3PC have been the result of joint faculty-student committee work. The "minimum rate of academic advancement" standards were first formulated by students, as were the first workshops for incoming E^3 students.

Observers of the E^3 Program have commented that student understanding of the E^3 Program and its goals greatly exceeds the normal level of student comprehension in other academic programs. The faculty and administration of the Program have felt totally confident in allowing the students to manage introductions for incoming students, in using students for recruitment purposes, and in having students represent the Program locally and nationally. In turn, the students regularly use the Program standards in evaluating the statements and work of engineers who visit the Program to make presentations of their work. Their choices of graduate study and career also reflect their internalization of the goals and purposes of the Program, which goals and purposes they play a critical part in formulating.

Adequacy of Resources for the Accomplishment of Goals and Purposes

The following are the E^3PC budgets for 1971-1976, during which period the Program has been supported in the main by the National Science Foundation. These are followed by the 1976-77 budget, when the Program becomes incorporated in the regular IIT academic budget.

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D. C. 20550

6.

MAY 10 1971

57009

Dr. John T. Rettaliata, President
Illinois Institute of Technology
3300 South Federal Street
Chicago, Illinois 60616

Grant GY-9300
Proposal No. 0/5651

Dear Dr. Rettaliata:

It is a pleasure to inform you that $175,000 is granted to Illinois Institute of Technology for support of "An Experimental Approach in Undergraduate Engineering Education." This grant is under the direction of T. Paul Torda, Department of Mechanical and Aerospace Engineering and terminates on September 30, 1972.

This grant is made subject to the attached budget summary and the applicable terms and conditions described in "Grants for Education in Science" (NSF 69-19).

Sincerely yours,

/s/ Gaylord L. Ellis
Acting For
Wilbur W. Bolton, Jr.
Grants Officer

Enclosure

REVISED BUDGET FOR PHASE I OF THE PROPOSAL:

AN EXPERIMENTAL APPROACH IN UNDERGRADUATE ENGINEERING EDUCATION

Duration: One Year.

Personnel

T. P. Torda, Principal investigator,
IITRI Professor
Academic year (50% of time)
Summer full-time 2/9

H. Knepler, Co-ordinator for humanities
Chairman, Dept. of Humanities
Academic year (25% of time)
Summer 1/9

D. L. Tagliacozzo, Coordinator for social sciences
Professor of Sociology
Director, Academic Year Institute in Sociology
Academic Year (25% of time)
Summer 1/9

C. Uzgiris, Coordinator for curriculum definition
(task 1)--engineering and physical sciences
Asst. Professor--Department of Mechanical
and Aerospace Engineering
Academic year (50% of time)
Summer full-time 2/9

R. Dix, Coordinator for curriculum design (task 2)
--engineering and physical sciences
Assoc. Professor--Dept. of Mechanical and
Aerospace Engineering
Academic Year (50% of time)
Summer full-time 2/9

15 IIT staff on part time Academic Year and summer	16,000
Research Assistants (4) @ $5,500 Part-time during academic year Summer full-time	22,000
Secretary (1½)	9,000

REVISED BUDGET

CONSULTANTS & TRAVEL EXPENSES

IIT Faculty and Staff Travel of investigators to 15-20 representative universities	$ 5,000
Consultants from other institutions in engineering, physical and social sciences	10,000
Consultants in education	8,000

MISCELLANEOUS

Reproduction and supplies	2,500
Communications	2,500
Final Report	1,000
Computer Time	4,500
Employees Benefits (5% of salaries)	5,100
Indirect Costs (44% of salaries)	35,000
TOTAL COST	$175,000

Endorsements:

T. P. Torda
Professor

Andrew A. Fejer
Chairman

Arthur Grad
Dean, Graduate Sch

Robert H. Jarrell
Business Manager

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D. C. 20550

APR 18 1972

Dr. John T. Rettaliata, President
Illinois Institute of Technology
3300 South Federal Street
Chicago, Illinois 60616

Grant GY-9330
Amendment No. 1
Proposal No. 2/5742

Dear Dr. Rettaliata:

It is a pleasure to inform you that an additional $726.200 is granted to Illinois Institute of Technology for support of the project entitled "An Experimental Approach in Undergraduate Engineering Education" as outlined in the above-numbered proposal. This project is under the direction of T. Paul Torda, Department of Mechanics and Mechanical and Aerospace Engineering.

The funds provided by this amendment are intended to support the project in accordance with the attached budget summary. Funds awarded under the grant, as amended, now total $901,200.

Unless otherwise amended, this grant will expire on June 30, 1974.

The indirect cost rate shown in the attached budget summary is a fixed, predetermined rate, which is not subject to adjustment.

Except as modified by this amendment, the grant conditions remain unchanged.

Sincerely yours,

WILBUR W. BOLTON, JR.
GRANTS OFFICER
Wilbur W. Bolton, Jr.
Grants Officer

Enclosure

ILLINOIS INSTITUTE OF TECHNOLOGY

TORDA

BUDGET

UNDERGRADUATE EDUCATION IN SCIENC

SCIENCE COURSE IMPROVEMENT PROGRA

2/Y10-574

TWENTY-FOUR MONTHS

	First 2 years Budget per year	
A. Salaries & Wages		
1. Project Director, full time (12 mos.)	$ 39,500	
2. Executive Administrator, full time	16,000	
3. Faculty, 7-1/2 F.T.E., w/summer participation	131,480	
4. Graduate Interns (4 @ $5,800/yr.)	23,200	
5. Technicians, (1), (12 mos.)	16,000	
6. Secretary (1); Clerical (1)	16,500	$242,680
B. Fringe Benefits (5% of Salaries & Wages)	12,134	
C. Overhead on Salaries (44% of Salaries & S & W)	106,779	118,913
D. Expenses		
Independent Project Evaluation (CIRCE)	9,500	
Consultants (including visiting professors)	5,000	
Undergraduate assistants (5), part time	4,000	
Books, communications, supplies, travel	8,000	
Workshop/laboratory	25,000	
Computer	4,000	55,500
E. GRAND TOTAL (rounded)		$417,100
Two years operations		834,200
IIT contributions ($54,000/yr.)		-108,000
NSF request, first two years		$726,200

GY-9300 #1

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D. C. 20550

JUN 13 1974

Dr. M. D. Venema, Acting President
Illinois Institute of Technology
3300 South Federal Street
Chicago, Illinois 60616

Grant GY-9300
Amendment No. 2
Proposal No. 4/00078

Dear Dr. Venema:

It is a pleasure to inform you that an additional $850,000 is granted to Illinois Institute of Technology for renewed support of the project entitled "Education and Experience in Engineering (E3 Project)," under the direction of T. Paul Torda, Department of Mechanics and Mechanical and Aerospace Engineering.

The funds provided by this amendment are intended to assist in the support of the additional level of effort outlined in the above-numbered proposal for approximately twenty-four months commencing July 1, 1974.

The attached budget summarizes the NSF share of such additional support. Funds awarded under the grant, as amended, now total $1,751,200.

Unless otherwise amended, this grant will expire on June 30, 1976. The grant period excludes the flexibility period described in Section 120 of NSF 73-26, "NSF Grant Administration Manual."

Commencing with the date of this amendment, the provisions of FL 25, "Administration of NSF Project Award," attached, are applicable to this grant.

Income, as defined in paragraph 231 of NSF 73-26, generated as a result of the activities supported by this grant, will be maintained in a separate account and shall be accounted for and used in the ways specified below:

a. Income received during the life of the grant will, to the extent practicable, be used to offset costs otherwise allowable and chargeable to the grant.

b. Income, regardless of when received, may also be used to cover reasonable expenses associated with the administration of the income producing activity.

c/s - 1974-75 - 73107 } 1x2331
1975-76

GRANTEE BUSINESS OFFICE COPY

Total income receipts and disbursements will be reported semi-annually to the Foundation. Remaining income not used for the above purposes received during the life of or within three years after the expiration of this grant will be remitted to the Foundation semiannually with the above reports.

Except as modified by this amendment, the grant conditions remain unchanged.

Sincerely yours,

Wilbur W. Bolton, Jr.
Grants Officer

Attachments

Illinois Institute of Technology
Chicago, Illinois 60616, 312 225 9600

E3
Education and Experience in Engineering

May 14, 1974

Dr. John L. Snyder, Program Manager
Materials and Instruction Development Section, HES
National Science Foundation
Washington, DC 20550

Dear John:

Attached, please find the modified budget to comply with the amount available you indicated. You will note that the budget for the proposal: "E^3 and the Computer" has been incorporated into the one attached and this shows up as increases in faculty and graduate assistant salaries as well as in travel and computer related expenses.

The attached budget is based on the assumption that all the tasks included in the original "Proposal to the National Science Foundation, The Third and Fourth Years of Implementation, Education and Experience in Engineering (The E^3 Program), September, 1973" may be carried out. However, as we discussed it during your visit in Chicago on April 16, 1974, the E^3 Program staffing for next year has run into difficulties. Although the staffing problems extend over all four colleges (E&PS, L.A., Law, and Management and Finance), special problems have arisen in the area of the social sciences. Needless to say, we are working on solving some of these problems, but some major ones remain unresolved as of this date.

We expect that most of the staffing questions will be settled in a satisfactory manner within the next few weeks. If this is not possible, we will submit a detailed plan for modification of the tasks we have proposed to carry out during the next two years.

Sincerely yours,

Paul

T. P. Torda
Program Director

TPT:gj

Enclosure

cc: Dean S. A. Guralnick
Dean P. Chiarulli

E^3 PROPOSED BUDGET
6/1/74 – 6/1/76
(Revised 5/2/74)*

A. Staff	6/1/74 to 5/31/75	6/1/75 to 5/31/76
1. Project Director-T. P. Torda	$ 40,000.	$ 42,400.
2. Administration	6,930.	7,350.
3. IIT Faculty	181,900.	171,900.
4. Postgraduate Interns	20,000.	20,000.
5. Graduate Interns	29,000.	25,000.
6. Undergraduate Assistants	5,000.	5,000.
7. Technicians	22,000.	23,400.
8. Secretaries	14,600.	15,000.
	$ 319,430.	$ 310,050.
B. Other Costs		
9. Fringe Benefits (10% of salaries)	$ 31,943.	$ 31,005.
10. Lab/Workshop-Equipment and Supplies	23,500.	20,000.
11. Clerical and other Expendable Supplies	11,500.	9,500.
12. Travel	6,000.	3,000.
13. Consultants	11,500.	11,500.
14. Computer	4,500.	1,500.
15. Communications Lab.-Equipment and Supplies	3,700.	800.
16. Workshop Conferences	10,100.	10,100.
17. Indirect Costs (24.4% of salaries)	77,941.	75,652.
	$ 180,684.	$ 163,057.
Total for year	$ 500,114.	$ 473,107.
18. IIT Contribution	50,114.	73,107.
19. Requested from NSF	450,000.	400,000.

S. A. Guralnick, Dean, Graduate School

R. H. Jarrell, Business Manager

 attached explanation of budget revisions.

Explanation of Budget Revisions

(Revised 5/2/74)

a) Fringe benefits (item 9) has been revised to 10% to conform more closely to our experience with the present E^3 staff.

b) Indirect costs (item 17) has been substantially reduced to 24.4% of salaries and in part offsets reduced IIT contribution (item 18).

c) The activities of the proposed program "E^3: The Role of the Computer"
Supplement to NSF Proposal for
Support of the Project
"Education and Experience in Engineering
(E^3) Program"
NSF Grant GY9300
T. P. Torda
Principal Investigator
April, 1974

These activities reflect the increases in items 3,5,8,10,11,12,14 for the period 6/1/74 to 5/31/75.

d) The activities of the CIRCE item in the proposed budget have been absorbed in item 3.

e) Item 1 has been slightly modified to conform with more accurate projections.

NOTE:
THIS BUDGET IS BASED ON THE PROPOSAL TO THE NSF SUBMITTED SEPTEMBER 4, 1974. IN THIS REGARD, PLEASE REFER TO THE "MEMORANDUM OF TRANSMITTAL TO DEAN P. CHIARULLI OF THE REVISED (MAY 2, 1974) BUDGET FOR E^3."

ILLINOIS INSTITUTE OF TECHNOLOGY

CHICAGO, 60616

COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES
OFFICE OF THE DEAN

March 27, 1974

Dr. John Snyder
Materials & Instructional Development Section, HES
National Science Foundation
Washington, D.C. 20550

Dear Dr. Snyder:

Paul Torda has given me a copy of your recent letter to him of March 8. I was very pleased to note the kind words included regarding the evaluation of the E^3 Program and of its potential for continued success and significant national importance.

I am taking it upon myself specifically to respond to the basic point you raised relative to IIT's ability to assume total funding for the program in what we call Year V, the 1976-77 academic year. The point is well taken and requires a clear and unequivical response. I believe most of the answers are contained within the enclosed materials relative to the establishment of the E^3 PROGRAM CENTER (E^3PC). We started upon the development of these materials immediately following your site visit last December. There were a series of discussions between Paul Torda and myself, including feedback from E^3 faculty, and, following our agreements, continued discussions with Dr. Brophy. A basic approach was tentatively approved and we were requested to produce the necessary documentation. These materials were jointly developed by Paul Torda and myself. I am stressing the "jointly" for purposes of emphasis that this is not a document casually or lightly approved by the IIT Administration. As the dates indicate, these materials have been formally submitted to Dr. Brophy. Upon his approval, a formal announcement will be made. A copy of that notice will be forwarded to NSF.

The formal announcement of the E^3PC will include all the implications of organization and conditions noted in the establishment document and in my covering memorandum. It would specifically include the funding implications which I have attempted to analyze in complete detail. As has been noted, I expect problems, but I do not expect problems any more difficult that are customarily met in our other regular activities, particularly those involving outside funding of major programs. If these materials are not sufficient for your purposes, please call or write and I will attempt to clarify further or expand upon what is presented.

I was most interested to note your estimate of direct costs of $400,000 as compared to our proposed budget of $213,000 for Year V in Appendix I of the attachment. Your figure is based on the requested amount in our proposal which includes several items connected with the development phase of E^3. For example, evaluation, educational research, faculty internship and conferences, etc., will be carried out only if funding can be obtained from appropriate government agencies or private foundations.

Though the attached materials indicate the manner in which IIT will fund the E^3 Program adequately, they do not address themselves to another aspect of IIT's intent to continue the E^3 Program after the period of NSF support. One may well consider whether a program's continued existence is justified even though the funding support basis is assured, either in academic terms or in terms of efficiencies. Again, in my thinking, I foresee no major problem provided student interest continues to develop (and in this case it is recognized that E^3 should have the benefit of special recruitment efforts).

Academically the E^3 Program is important to IIT not only in its own right but also in terms of the stimulation it has been and will continue to be for some time for all of our undergraduate programs, be they engineering, science or liberal arts. In my view we would make a grave academic error to drop a program which is serving as a very necessary focus and catalyst for all other programs. The listing in Section 2 of the basic establishment document is not a random listing of items lightly put together. It is a listing of significant and existing developments which will have permanent effect on all of IIT's undergraduate programs.

As example, I have included copies of letters which Professor Stueben, Chairman of our Honor's Committee, recently sent to our Freshmen and Upperclassmen Honors Students. Professor Stueben has been an E^3 faculty member from the very beginning.

Another enclosure is Professor Swanson's prepared Introductory material for students in an advanced Chemical Engineering Course he is organizing for next year using the self-paced instruction mode. Last year Professor Swanson was an E^3 faculty member.

I have also enclosed a copy of Professor Leonard's proposal to his department for a major revision of the Civil Engineering curriculum which would include utilization of E^3 methodology for a significant portion of that program, particularly for advanced discipline and design components. Last year Professor Leonard was an E^3 faculty member.

In the final analysis though the basic question will be "what do the students want?" I believe our experience to date clearly indicates there is a reasonably sized component of students who want and can profit from an E^3 Program. As long as these students are there the program will continue. We have based our estimates on 100 total enrollments--but we have not explicitly stated where our low "cut-off" point may be. Nor would we wish to at this time. Such a decision is very complex and necessarily is reached through an integration of many factors. I do point to our Industrial Engineering program with a total enrollment of 44 and to our Metallurgical and Materials Engineering program with a total enrollment of 27. I do not point to these programs happily because of the inefficiencies of staffing these programs are too terrible to consider with equanimity!, but, and for a variety of reasons, these programs are still offered at IIT. Similar consideration would, of course, apply to the E^3 program.

It is recognized that starting with Year V, there will be a transition period of about three to four years for full integration of the E^3 program as an integral part of IIT. During such a transition period, special assistance, special protection, special allowances must be made In this sense the E^3 program would not be forced to satisfy the same criteria of "effectiveness" as regular long-established programs at IIT.

In this connection the question of Director of E^3PC is quite important. As my memorandum to Dr. Brophy states, Professor Torda is slated to be the initial Director of E^3PC. The E^3 Program is, of course, being developed strongly in Professor Torda's image. Without his leadership it would necessarily be a significantly different program. During these formative years, and including the transition period starting in Year V, his leadership and his influence will be crucial. Professor Torda becomes 65 years old during Year V. At IIT retention of a faculty member on a full or part-time basis after age 65 is at the option of both parties. Presuming Dr. Torda's essential contributions to the continued development of the E^3 Program, there would be no barriers to his continued participation in the E^3PC.

I must apologize for this dissertation--it can no longer be called a letter--but I did wish to give you a complete answer to the questions which have been raised and, in addition, it did give me an excellent opportunity to organize and put down on paper a loose connection of thoughts which I have been developing vis-à-vis E^3 and its future.

E^3 is critically important for IIT. But of even greater significance is its importance in its own right as a great step forward in the evolvement of technological education and the impact it may well have on the national scene.

Thank you for your patience in getting this far. Again, in the event I have not responded completely please write or call and I will do what I can to supply any additional information which may be required.

Sincerely yours,

Peter Chiarulli

P. Chiarulli
Dean

Enclosures
cc: J.J. Brophy, Academic Vice-President
T.P. Torda, E^3 Program Director

PC/vnb

APPENDIX I: BUDGET

SALARIES	TOTAL	IIT	SPONSORED RESEARCH
Full-time Faculty (9 mos.)			
Project Director	$ 30,000	$ 30,000	$
Assoc. Director (H&SS)	18,000	14,500	3,500
Assoc. Director (E&PS)	18,000	14,500	3,500
Part-time Faculty (9 mos.)			
13 Faculty - 1/3 and 1/2 time			
5 full-time equivalents	75,000	75,000	
Full-time Staff (12 months)			
Administrative Aide	12,000	12,000	
Secretary	7,000	7,000	
2 Technicians	22,000	11,000	11,000
Assistants (9 months)			
Graduate (half-time)	14,000	14,000	
	$196,000	$178,000	$ 18,000
OPERATING COSTS			
Office Services	800	800	
Xerox	800	800	
Ditto	600	600	
Visual Aids	300	300	
Building & Grounds	600	600	
Telephone	400	400	
Equipment	3,500	1,500	2,000
Expendable Supplies	9,000	6,000	3,000
Promotional	1,000	1,000	
	$ 17,000	$ 12,000	$ 5,000
TOTALS	$213,000	$190,000	$ 23,000

II. EVALUATION OF PROGRESS AND ACHIEVEMENT IN RELATION TO GOALS AND PURPOSES

How are Student Aspirations and Achievements Evaluated?

The following means are employed in such evaluation: examinations, student portfolios, evaluations from self, peers, faculty, and supervisors, and anecdotal records. Examinations are used in the evaluation of student performance on Learning Modules, a form of self-paced study. These are called mastery examinations and, consistent with the Mastery concept, may be repeated until the student reaches mastery level. Mastery level is defined as performance in which there are no conceptual errors and only minor errors of calculation.

Each E^3 student has an extensive file, fully documenting his studies. This file is reviewed on a regular basis by the Program Design Committee, which functions as an academic adviser for each student. At least twice during each semester, the Committee meets with each student / to assess his/her performance and plans for the coming study period. The student's file, which is fully accessible to him/her at any time, also contains self, peer, and faculty evaluations gathered in the course of project work, the comments of the Review Board, a record of the student's credit allocations, and summaries and evaluations of work experience outside the university.

Each project team is visited biweekly by the Review Board, which reviews the team's progress in terms of its goals, suggests alternate courses of action, approves modifications in proposals, and arranges for presentations and submission deadlines for written materials. The members of the Review Board, faculty and student, serve as an outside check for the faculty and students on the project team.

It is recommended, although not required, that each student keep a personal log of his/her learning activities. A weekly report, based on the student log and his/her anticipated study during the coming week, is submitted weekly, one copy going to the faculty advisers to the project, one to the Review Board. The logs are used extensively at the end of each semester when each student is required to document his/her participation in the project team prior to the allocation of project credit (PP category).

The project is a student initiated activity. Projects are not pre-defined by faculty. The goals, techniques to be used, design of experimentation, modeling, and analysis are developed by the student members of the project team in consultation with the faculty members. The problem definition, proposal, revised proposal, reports (interim and final) and oral presentation, are student responsibilities and are each evaluated by peers, faculty, Review Board, and, in some cases, outside experts, Each project is required to keep a project log apart from the individual logs discussed above.

Evaluation of student achievement is also measured by admission and scholarships to graduate study, by post-BSE employers, and by organizations with whom students are co-oping or holding internships.

It can be seen that various modes of evaluation are used in the Program: specified levels of performance for Mastery and rate of student progress; value added for logs, log summaries, documentation of project learning; student developed goals for project work and credit allocation; external evaluation by graduate schools and employers of various kinds.

How are the Aspirations and Achievements of Instructional Staff Evaluated?

Faculty and teaching graduate student achievements are evaluated by means of reports from supervisors and by self, peer and student reports. Near the end of each semester, all students and faculty are asked to submit evaluations of each member of the faculty with whom they have worked during that semester. The evaluation asks the evaluator to state the context in which he/she worked with the particular person and to characterize the person's performance, using specific examples. The evaluator's name does not appear on these forms and the forms themselves are internal to the Program. A faculty committee, elected by the Program faculty, reviews these evaluations and prepares a summary. On the basis of this summary, the Director and the Associate Directors prepare letters to the chairmen of the respective faculty member's department and the appropriate IIT deans with recommendations for promotion, raise, and tenure.

In preparing letters of recommendation, the E^3 administration also assesses the faculty member's adaptability to new teaching settings and the academic climate of the E^3PC. Faculty are also evaluated in terms of seminars, colloquia, and practica which they offer while in the E^3 Program Center. Likewise, papers and publications are included in the overall evaluation by the Program.

No specified levels of performance are used in evaluating faculty achievements. Rather, comparative measures, value added, and evaluation in terms of faculty developed goals are used. For graduate students performing instructional tasks, much the same process is used, although feedback to the students' major departments is less formal and typically takes the form of a request to continue or discontinue the graduate assistant in his/her E^3 instructional role.

How are the Aspirations and Achievements of the Program Administration Evaluated?

It must be established that the evaluation of the E^3 administration, apart from the achievements of its staff and students, is not a clear cut task. It is difficult to separate the Director and Associate Directors from the rest of the E^3 community for evaluation, as almost all tasks within the Program are shared by various elements of the community. One Associate Director devotes only half of his time to administrative tasks; the other Associate Director is not full-time with the Program.

Administration achievements are evaluated by means of reports (formal and informal) of supervisors and reports of external consultants. Among the former may be included the National Science Foundation (program monitor, proposal reviewers), the E^3 Board of Advisors, and the IIT administration.

The Program administration has on no occasion been denied permission for any of its proposed activities by the NSF monitor. Informal comments indicate full satisfaction with the Program administration. The NSF monitor has summarized the confidential proposal reviews as highly favorable.*

The E^3 Advisory Board is made up of outstanding members of the academic, industrial, and government communities to provide outside monitoring of the Program in terms of national trends in education and employment. The members of the Board visit the Program on a semi-annual or annual basis, review written material, interview faculty and students, confer with IIT administration, and issue reports to the Program and to the National Science Foundation, focussing on perceived strengths and weakness of the Program. The Board has consistently given high marks to the Program administration.

The IIT administration has issued no written material which evaluates the Program administration achievements, although the three individuals involved have received raises and promotions. In addition, the Program has been called upon to provide public relations material for IIT and E^3 students have been asked to make presentations to new members of the IIT Board of Trustees.

The Program has made extensive use of outside consultants to help evaluate its proposed programs and methods. An educational conference was held in 1972 with several experts from various universities, all of whom have experience with innovative programs. During the years 1972-74, the Program contracted for the services of the Center for Instructional Research and Curriculum Evaluation (CIRCE) at the University of Illinois to conduct formative evaluation of the Program.

The Program administration has been responsible for the planning and execution of E^3 Workshops at regional and national conferences of engineering educators. Feedback from these workshops has been positive.

In 1973, the Program administration secured funding for the Introduction to Engineering, a program for introducing high school juniors to the study of engineering through a series of Saturday

* The E^3 Program has held three grants from NSF: planning year, first two years of implementation, second two years of implementation.

Workshops along E^3 lines. The program was highly successful and has been adopted by IIT as a central component of its Early Identification Program, which is now conducted on a continuing basis. This component continues to be administered by an E^3 faculty member, and uses the project skills of E^3 students extensively in its planning and execution.

III. EDUCATIONAL AND LEARNING EXPERIENCES

How can Learning Experiences be Evaluated in Terms of Desired Outcomes?

The means of evaluation include judgment of faculty, supervisors, and students, interviews, group discussions, tests, reports, lists of accomplishments and tasks completed. The types of experiences evaluated include formal instruction, tutorial and individualized instruction, off-campus learning, independent and self-directed study, and student initiated and student run programs.

Learning is evaluated by faculty serving as project team members, seminar leaders, practicum directors, and course instructors (particularly in humanities courses, but also in skills and tools courses for which students are allowed to register). Students serving as co-op students or as student interns off-campus are evaluated by both faculty and their supervisors in the work setting. Module examinations and tutoring are evaluated by undergraduate and graduate proctors and by faculty. The modules themselves are evaluated by students and revised on the basis of such evaluations. Learning which involves the use of off-campus resources is a common feature of the E^3 Program and involves meeting with appropriate specialists, using documents, reports, and libraries. Such learning, which is project related, is evaluated in the project context.

Project team learning is evaluated by students in the project, through regular meetings and the process of credit allocation, by each student himself/herself via the credit request and documentation, by the project team faculty, and by the Review Board.

The Program Design Committee, through regular interviews with each student, undertakes long range evaluation in terms of a student's study and career goals. The Review Board, in its regular biweekly meetings with each project team, evaluates individual learning within the team context. It receives weekly learning summaries from each student, as well as all documents produced by the project team.

Individual students are also interviewed by the E^3 Advisory Board in its regular semi-annual visits to the Program. Finally, interviews of students are conducted by a subcommittee of the IIT Curriculum Committee in terms of meeting overall IIT standards and requirements for the granting of degrees.

Plans are currently under way for longitudinal evaluation of students who have left the Program through graduation, change of major, change of institution, or termination of higher education. The means of evaluation will include written questionnaire and interview. It will be carried out by E^3 faculty, with special assistance from the IIT Counseling Center, Department of Psychology and Counseling.

There are several group discussion settings for evaluating learning experiences. The Monday Open (a meeting of the whole E^3 community) discusses such matters as they come to general attention. In addition, a group dynamics seminar, conducted by faculty and graduate students from the Department of Psychology and Counseling, is a required activity for all new students and faculty. Special conferences are called when matters of educational concern arise which cannot be settled within the normal daily operation of the Program.

The semesterly process of credit allocation begins with the submittal of a credit request on the part of each student. The project team then meets to analyze the learning that has been involved in the project, who was responsible for that learning, what level of learning was achieved, and to decide upon an equitable distribution of credit for that learning. After reading the project report and observing the project presentation (public), the Review Board ratifies or alters the arrangements reached by the project team. Among more advanced students this awesome task becomes routine, indicating that the student is acquiring the appropriate and desired skill at self-evaluation.

Finally, learning is evaluated in terms of student initiated and student run programs. The Orientation Workshop for new students and prospective students was originated by E^3 students after one year of the Program's operation. The Workshop is totally student administered, although one or two faculty are asked to appear and make introductory comments. It convenes in May to assist students who have been admitted to the E^3 Program.

The Introduction to Engineering for High School Students used the project team approach and several of the projects were devised and developed by the E^3 students who were also in charge of the various high school student project teams.

The document on standards for acceptable advancement toward degree was originally prepared by a student committee after extended discussion of this topic in Monday Opens.

It is a central concern of the E^3 Program that students not be evaluated principally in terms of faculty prescribed tasks, nor exclusively in terms of tasks undertaken to fulfill the Program's requirements, but also in tasks going beyond Program requirements.

How can the Program's Climate for Teaching and Learning be Evaluated in Terms of the Desired Outcomes?

The educational climate in the E^3PC is intense and is frequently a subject of concern among faculty and students. It is discussed at individual student's Program Design Committee meetings, at Monday Opens, in Group Dynamics Seminar, at special meetings, and at staff meetings. The climate has changed frequently over the past several years, as would be expected in a developing program which departs substantially from traditional learning settings and modes. Virtually every student, faculty member, consultant, and outside evaluator has made a contribution to the E^3 climate.

IV. RESOURCES FOR PROVIDING EDUCATIONAL LEARNING EXPERIENCES

Faculty and Instructional Staff

The E^3 faculty and other staff are drawn from IIT resources. With the exception of the Associate Director for Program Development and the Coordinator of Learning Resources, all faculty in the E^3 Program hold regular faculty appointments in other IIT departments. As the Program has no graduate curriculum, all graduate students who perform instructional functions are likewise taken from regular departmental graduate programs.

Faculty receive joint appointments to their respective departments and to the E^3PC for the terms of their service with the Program. Normal percent of activity in the Program is either one-third or two-thirds during an academic year or semester. Attempts are made to avoid more than one-third turnover in staff form one year to the next. Some faculty have been with the Program from its inception.

The faculty are drawn from the Armour College of Engineering, Lewis College of Sciences and Letters, the College of Architecture, Planning and Design, the Chicago Kent College of Law, and the Stuart School of Management and Finance.

Graduate students from mathematics, science, and engineering serve as module proctors and tutors in those areas. In addition, extensive use is made of graduate counseling students as facilitators on project teams. Because of the heavy emphasis that the Program places upon effective communications, graduate assistants in visual communications and composition are attached to the Program, in addition to the faculty in those areas.

Faculty are utilized in terms of two kinds of competencies. In terms of academic competency, faculty serve on project teams, prepare and revise learning modules, conduct tutoring, lead seminars, and advise individual students in personally developed study programs. Because the Program cannot at any time have representation from every department on campus, faculty are frequently asked to direct learning in a broader range of areas than they might actually be teaching in departmental courses. At no point are faculty asked to undertake such direction beyond their self-defined competencies. At occasions when such need arises, faculty members not assigned to the Program are asked to guide and consult with students.

In terms of non-academic competencies, such as advising and counseling, preparing of reports, chairing committees, and so forth, the Program encourages faculty to undertake those non-academic duties for which they feel best suited and prepared. These include, as examples, Program Design Committee, Review Board, Council, Steering Committee, organization of national and regional conferences and workshops, etc.

Other Learning Resources

Beyond the Crerar and Kemper libraries at IIT, the Program maintains a small basic text and journal collection, along with materials that have been collected from public and private sources in the course of project research. E^3 students regularly make use of off-campus libraries and collections in the Chicago area.

The Program maintains a general laboratory/workshop for its students, along with a darkroom and a graphics workshop. The laboratory/workshop is supervised by a qualified technician who offers students training in the use of equipment and tools and assists students in the preparation of drawings and designs. The graphics workshop and darkroom are supervised by appropriate staff from the Institute of Design, who instruct students in the preparation of negatives, prints, kodalith slides, drawings, and so forth. The emphasis on visual communication techniques starts at the beginning of each project and terminates with the preparation of printed material and oral-visual presentation of project achievements.

In the purchase of supplies and equipment for the various laboratory and workshop facilities, discussion occurs among students, faculty, administration, and specialized persons with qualifications to recommend alternatives.

Because student projects transcend the limitations of the general laboratory/workshop, students in the Program make use of specialized research and teaching laboratories throughout the IIT campus. These have included laboratories in environmental engineering, electrical engineering, vibrations, instrumentation, and the environmental wind tunnel.

Financial Resources

Financial resources are the result of a budget negotiated with the IIT administration, particularly the office of the Dean of the Armour College of Engineering.

V. DECISION-MAKING AND PLANNING

Information on decision-making and planning processes is collected in the records of conferences, visits by the Advisory Board, and minutes of meetings. The mechanisms for decision-making and planning processes were of special importance during the years 1971-72, at which time the Program was being formulated in detail, preliminary planning was being undertaken, and preparations for incoming students were being made. The records of staff meetings during this period constitute an ongoing discussion and evaluation of planning.

Planning continues to be carried out in a variety of places, with special responsibility falling upon the Program administration. Students, faculty, department chairmen, academic deans, academic vice-president, and provost all play a part in planning and decision-making in the E^3 Program. The three E^3 administrators meet regularly with the Dean of the Armour College of Engineering, the Acting Dean of the Lewis College of Sciences and Letters, and the Acting Dean of Graduate Studies to discuss budget and staffing of the Program. Staffing planning and arrangements are begun a calendar year in advance of effective appointment. In 1974-75, the Program administration met with each appropriate department to discuss Program staff needs, and to allow long-range planning on the part of co-operating departments. Departing staff are asked to make recommendations from among their department faculty for replacements, after which the department chairmen are consulted as to availability of appropriate staff.

Both long and short range planning are regularly discussed at the bi-weekly staff meetings and at the all-E^3 Monday Opens. In addition, faculty committees, student committees, and joint committees are charged with developing planning reports. In February, 1974, a one-day E^3 conference was held to assess and reformulate plans in several areas of E^3 activity. No major plan or decision has been made for the Program without substantial input from students and faculty, with the exception of some staffing decisions which have not had direct student input.

<u>What External Persons and Groups are Involved in Planning and Decision-Making and What Role do They Play?</u>

The principal source of external input to planning and decision-making has been the E^3 Advisory Board. The Board is composed of highly accomplished individuals from industry, academia, and public service who report to the Program and to the National Science Foundation on the extent to which the Program is achieving the goals it has set out. The Board members have also provided input to the Program on the basis of their experience in undertaking research and innovative programs.

The Board has made recommendations to the IIT administration for the orderly implementation of the Program and the incorporation of the Program into the Institute's academic offerings.

The Program has received informal input from attendees at regional and national workshops held in conjunction with the American Society for Engineering Education. This input has come from faculty at other institutions having innovative project based programs, in order to systematically share information of mutual benefit in planning.

On various occasions, consultants have been called upon to make assessments of several dimensions of the Program to assist in planning. These have ranged from a two day consultation with four specialists to informal visits by experienced educators.

Because the Program has been principally funded by the National Science Foundation, the three proposals accepted by the Foundation have served as the key planning documents for the Program. On those occasions when it has been necessary to depart from proposed plans, clearance has been secured from the Foundation.

<u>How are Students Involved, and Assisted by Faculty, in Decisions Regarding Their Own Programs in Relation to Desired Outcomes?</u>

As the goals of the Program include the preparation of students who, as professionals, are self-starting, self-pacing, self-directing, and self-evaluating, the total web of student-faculty-administration relationships has been designed to move students from the traditional "assigned task performance" behavior characteristic of freshmen to the stated goals of the Program during the four years they are with the Program. Hence every action involving student plans and goals is a joint faculty-student activity. Projects, study plans, advising, committees of various sorts--all are designed to work toward the educational goals of the Program.

Success is measured in large part by the decreasing need of the Program's students for faculty guidance and direction. As students move from freshman to senior they move from learning modules to wholly independent study, from well-defined but limited project activities to project leadership and management, from being advised by the Program Design Committee to advising the Program Design Committee of their plans, from being shown the social and cultural dimensions of their work to taking such dimensions into account reflexively, from being apprised of their strengths and weaknesses to self-assessment and the formulation of plans to deal with those strengths and weaknesses, from career guidance to the identification on an individual 'sis of what constitutes a desirable career for a student so edu ed.

In order to r n the stated goals, the Program monitors students very closely during the early portion of the curriculum to help them learn to monitor themselves, using the faculty as resources.

APPENDIX XIX

EMPLOYMENT PROFILES OF E^3 GRADUATES

John Valentine Ballun	Graduated BSE, 1976 Employed: Victor Valve
J. Edward Carryer	Graduated BSE, 1975 Employed: Sargeant & Lundy
James H. Heyland	Graduated BSE, 1976 Employed: Illinois Tool
John C. Mikulka	Graduated BSE, 1977 Employed: United States Air Force
Tom Nelson	Graduated BSE, 1975 Employed: Linde Division - Union Carbide
Robert Michael Spanier	Graduated BSE, 1976 Employed: Illinois Central

APPENDIX XX

RESPONSE TO NSF BY THE
DEAN OF ENGINEERING AND PHYSICAL SCIENCES
27 MARCH 1974

Pages 399-431 inside

ILLINOIS INSTITUTE OF TECHNOLOGY

CHICAGO, 60616

COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES
OFFICE OF THE DEAN

March 27, 1974

Dr. John Snyder
Materials & Instructional Development Section, HES
National Science Foundation
Washington, D.C. 20550

Dear Dr. Snyder:

Paul Torda has given me a copy of your recent letter to him of March 8. I was very pleased to note the kind words included regarding the evaluation of the E^3 Program and of its potential for continued success and significant national importance.

I am taking it upon myself specifically to respond to the basic point you raised relative to IIT's ability to assume total funding for the program in what we call Year V, the 1976-77 academic year. The point is well taken and requires a clear and unequivical response. I believe most of the answers are contained within the enclosed materials relative to the establishment of the E^3 PROGRAM CENTER (E^3PC). We started upon the development of these materials immediately following your site visit last December. There were a series of discussions between Paul Torda and myself, including feedback from E^3 faculty, and, following our agreements, continued discussions with Dr. Brophy. A basic approach was tentatively approved and we were requested to produce the necessary documentation. These materials were jointly developed by Paul Torda and myself. I am stressing the "jointly" for purposes of emphasis that this is not a document casually or lightly approved by the IIT Administration. As the dates indicate, these materials have been formally submitted to Dr. Brophy. Upon his approval, a formal announcement will be made. A copy of that notice will be forwarded to NSF.

The formal announcement of the E^3PC will include all the implications of organization and conditions noted in the establishment document and in my covering memorandum. It would specifically include the funding implications which I have attempted to analyze in complete detail. As has been noted, I expect problems, but I do not expect problems any more difficult that are customarily met in our other regular activities, particularly those involving outside funding of major programs. If these materials are not sufficient for your purposes, please call or write and I will attempt to clarify further or expand upon what is presented.

I was most interested to note your estimate of direct costs of \$400,000 as compared to our propose budget of \$213,000 for Year V in Appendix I of the attachment. Your figure is based on the requested amount in our proposal which includes several items connected with the development phase of E^3. For example, evaluation, educational research, faculty internship and conferences, etc., will be carried out only if funding can be obtained from appropriate government agencies or private foundations.

Though the attached materials indicate the manner in which IIT will fund the E^3 Program adequately, they do not address themselves to another aspect of IIT's intent to continue the E^3 Program after the period of NSF support. One may well consider whether a program's continued existence is justified even though the funding support basis is assured, either in academic terms or in terms of efficiencies. Again, in my thinking, I foresee no major problem provided student interest continues to develop (and in this case it is recognized that E^3 should have the benefit of special recruitment efforts).

Academically the E^3 Program is important to IIT not only in its own right but also in terms of the stimulation it has been and will continue to be for some time for all of our undergraduate programs, be they engineering, science or liberal arts. In my view we would make a grave academic error to drop a program which is serving as a very necessary focus and catalyst for all other programs. The listing in Section 2 of the basic establishment document is not a random listing of items lightly put together. It is a listing of significant and existing developments which will have permanent effect on all of IIT's undergraduate programs.

As example, I have included copies of letters which Professor Stueben, Chairman of our Honor's Committee, recently sent to our Freshmen and Upperclassmen Honors Students. Professor Stueben has been an E^3 faculty member from the very beginning.

Another enclosure is Professor Swarson's prepared Introductory material for students in an advanced Chemical Engineering Course he is organizing for next year using the self-paced instruction mode. Last year Professor Swanson was an E^3 faculty member.

I have also enclosed a copy of Professor Leonard's proposal to his department for a major revision of the Civil Engineering curriculum which would include utilization of E^3 methodology for a significant portion of that program, particularly for advanced discipline and design components. Last year Professor Leonard was an E^3 faculty member.

In the final analysis though the basic question will be "what do the students want?" I believe our experience to date clearly indicates there is a reasonably sized component of students who want and can profit from an E^3 Program. As long as these students are there the program will continue. We have based our estimates on 100 total enrollments--but we have not explicitly stated where our low "cut-off" point may be. Nor would we wish to at this time. Such a decision is very complex and necessarily is reached through an integration of many factors. I do point to our Industrial Engineering program with a total enrollment of 44 and to our Metallurgical and Materials Engineering program with a total enrollment of 27. I do not point to these programs happily because of the inefficiencies of staffing these programs are too terrible to consider with equanimity!, but, and for a variety of reasons, these programs are still offered at IIT. Similar consideration would, of course, apply to the E^3 program.

It is recognized that starting with Year V, there will be a transition period of about three to four years for full integration of the E^3 program as an integral part of IIT. During such a transition period, special assistance, special protection, special allowances must be made. In this sense the E^3 program would not be forced to satisfy the same criteria of "effectiveness" as regular long-established programs at IIT.

In this connection the question of Director of E^3PC is quite important. As my memorandum to Dr. Brophy states, Professor Torda is slated to be the initial Director of E^3PC. The E^3 Program is, of course, being developed strongly in Professor Torda's image. Without his leadership it would necessarily be a significantly different program. During these formative years, and including the transition period starting in Year V, his leadership and his influence will be crucial. Professor Torda becomes 65 years old during Year V. At IIT retention of a faculty member on a full or part-time basis after age 65 is at the option of both parties. Presuming Dr. Torda's essential contributions to the continued development of the E^3 Program, there would be no barriers to his continued participation in the E^3PC.

I must apologize for this dissertation--it can no longer be called a letter--but I did wish to give you a complete answer to the questions which have been raised and, in addition, it did give me an excellent opportunity to organize and put down on paper a loose connection of thoughts which I have been developing vis-à-vis E^3 and its future.

E^3 is critically important for IIT. But of even greater significance is its importance in its own right as a great step forward in the evolvement of technological education and the impact it may well have on the national scene.

Thank you for your patience in getting this far. Again, in the event I have not responded completely please write or call and I will do what I can to supply any additional information which may be required.

Sincerely yours,

Peter Chiarulli

P. Chiarulli
Dean

Enclosures
cc: J.J. Brophy, Academic Vice-President
T.P. Torda, E^3 Program Director

PC/vpb

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ILLINOIS INSTITUTE OF TECHNOLOGY
INTEROFFICE MEMO

TO J. J. Brophy

FROM P. Chiarulli

DATE March 25, 1974

SUBJECT ESTABLISHMENT OF AN E^3 PROGRAM CENTER

In accordance with the descriptive material attached, I would recommend the establishment of an E^3 PROGRAM CENTER (E^3PC) as part of the College of Engineering and Physical Sciences effective the 1974-75 academic year. I would further recommend the appointment of Professor T. Paul Torda as Director of the Center. The attached materials describe in some detail the conditions under which the E^3PC would be expected to develop and the manner in which it would be integrated with existing departments and other academic centers of the Institute.

I would specifically make note the funding implications of the organization of the E^3PC. Presuming that the National Science Foundation would continue its support for what we call Year III and IV of that program, 1974-75 and 1975-76, then, other than present levels of IIT support, additional funds would not be required for those years. I would propose that the Center be assigned a regular academic salary and an expense account number for accounting purposes and over these several years I would utilize those accounts for the limited support I have been supplying the E^3 Program directly from my budgeted funds.

In Year V, the 1976-77 academic year, however, it would be necessary to make specific budget allocations in accordance with the estimates shown in Appendix I of the attached materials. I would note the questions which have been raised, particularly by the National Science Foundation staff members, regarding IIT's willingness and ability to make such a budget allocation. In essence the question resolves about the budgeting of approximately an additional \$135,000 for faculty salaries, \$35,000 for salaries of support personnel and \$12,000 for expenses.

I expect that \$135,000 will be no greater difficulty than we normally experience with the termination of any of our other major grants. We faced (successfully) problems of this order of magnitude last year when the Themis program of the Mechanics, Mechanical and Aerospace Engineering Department was terminated. I expect to accomplish it again this year when the Themis program of the Metallurgical and Materials Engineering Department will terminate. Basically the "deficiency" has been met by a combination of new grants in other areas and by increases in the faculty salary budget. Just in terms of "new" grants, for example, I note Professor Torda's recent successful application to the General Electric Foundation for \$50,000 for support of an E^3 type activity for minority high school students. Within a total IIT faculty budget of over \$5,000,000 any necessary readjustments will not be an impossible task.

What will clearly require new funds not previously in present budgets are the two items of $35,000 for salaries of support personnel and $12,000 for expenses. This approximatelly $50,000 will be "new" money not otherwise developable and must be considered the minimal commitment which would be made through the establishment of the E^3PC. I use the word "minimal" since, of course, as with all salary support for faculty from outside sources, IIT must assume ultimate responsibility for faculty salaries independent of the ups and downs of such outside support. Again I evaluate this additional funding need as one within the budgeting potential of the Institute.

PC/vpb
Attachments

1. ESTABLISHMENT

An E^3 Program Center (E^3PC) would be established in order to effect the continued development of the present E^3 Program and to administer and conduct the Bachelor of Science in Engineering (BSE) curriculum. The E^3PC staff would consist of those IIT staff members engaged in the E^3 Program. Staff positions would include a Director, two Associate Directors, one in the area of engineering and science and one in the Area of humanities and social science, and all other faculty members participating on a part-time basis in the development of the E^3 Program and in conducting the BSE curriculum. The E^3PC would have responsibility over all activities presently conducted through the support of the existing National Science Foundation grant and other IIT resources and over future activities in this area supported by IIT, continued National Science Foundation grants and/or other grant support.

Particularly the E^3PC would be initiated effective the 1974-75 academic year, Year III of the development of the E^3 Program, in order to facilitate an orderly transition between the NSF supported experimental program and the resulting IIT supported regular program in Year V. During this transition period, IIT's commitment is independent of the number of students participating in the program. Staffing and budget estimates for Year V presented in a later section are based on an approximate total enrollment of one hundred students.

As has been previously noted, when the E^3PC would become fully implemented in Year V, i.e., the 1976-77 academic year, it is projected that three faculty members will be utilizing full effort in the E^3PC, a Director and two Associate Directors. Additional to the full-time efforts there will be a faculty group of five full-time equivalents constituting approximately 15 faculty members drawn from all departments to achieve proper distribution of faculty participation among the various disciplines.

The nature of the established E^3PC, its administration and budget will parallel that of regular academic departments insofar as its responsibilities to a regularly established undergraduate curriculum are concerned. One basic difference will be that all or almost all of the E^3PC staff will have a basic appointment in some other of the regularly established departments and will participate in and have responsibility for the activities of the E^3PC in accordance with agreed upon division of effort. It would be anticipated that the Director and Associate Directors would also have an original appointment in a regularly established department, but that during the period of appointment to these E^3PC positions would be devoting all or almost all of their efforts to the activities of the E^3PC. As with all academic program units, though the Director would have responsibility for proper administration and leadership of the total group, academic policy and decisions pertaining to such academic policies constitute a basic responsibility for the group as a whole.

It should be particularly noted, however, that budgetary support for these E^3PC staff members will rest in a separate E^3PC budget and that these funds will be available to the E^3PC Director for developing suitable faculty for participation in the E^3 Program. The budget presented in Appendix I also includes standard support for administrative, secretarial and technician personnel, graduate assistants and operating costs.

As a regular academic program center, the E^3PC would participate in Institute activities on the same basis as the other undergraduate academic program centers which are administered by the respective departments. The E^3PC Director would be a member of the Department Chairman group of the Engineering and Physical Sciences College and would attend and participate in their weekly meetings on the same basis as the other Chairmen. Descriptions of the BSE program and the E^3PC organization would be included as part of the regular Institute catalog. The E^3PC would nominate and have available to it a seat and vote on the Institute Undergraduate Curriculum Committee. Other privileges and responsibilities regularly due other undergraduate academic programs would equally will apply to the E^3PC.

2. INTERACTIONS BETWEEN THE E^3PC AND OTHER IIT ACADEMIC AND ADMINISTRATIVE GROUPS

There are many ways in which the interaction activities of the E^3PC and those of the various departments and programs at IIT will be developed. These interactions will occur on several levels: student participation, faculty participation and support, and administration support and encouragement of developments along directions of E^3 methodologies. Already as a consequence of E^3's influence, several significant developments have taken or are taking place at IIT.

1. During the 1973-74 academic year, the engineering and physical science departments initiated a special project activity to enable freshman engineering students to obtain a personal, hands on experience with socially relevant engineering problems. Though the project was a voluntary effort by freshmen and staff, 25% of freshman students elected the project work and over twenty-five faculty members volunteered to participate. This experiment will be continued during the next year and it is anticipated it will be formalized as a regular part of all engineering curricula the following year.

2. During the 1973-74 academic year two self-paced courses were offered at IIT, one in science and one in engineering, the second course taught by an E^3 staff member. A senior engineering course has been scheduled for self-paced instruction in the Fall. A Curriculum Study Committee, under the Chairmanship of the E&PS Dean, is presently considering methods of introducing a range of self-paced instructional methods in engineering and science curricula.

3. During the 1973-74 academic year the Physics Department and the Metallurgical and Materials Engineering Department offered a series of mini-courses. This successful experience has lead to plans for such courses to be a regular part of elective offerings.

4. A member of the Civil Engineering Department, a faculty member who previously participated in E^3 activities, has proposed a major revision of that Department's undergraduate program which would utilize E^3 methodology for a major component of its present instruction and course work in advanced discipline material and design projects. This proposed revision would be a major departure from the present curriculum and is being studied by the Department and by the E&PS Curriculum Study Committee.

In addition to these specific items of E^3 influence over curriculum developments in the other academic programs at IIT there are a variety of other interactions which will take place between existing programs and groups. These are:

A. E^3 Program and IIT Honors Program and Elective Courses

The IIT Honors Program requires that each junior and senior participant register for at least 3 credit hours of independent study or research project work each semester. The Honors Committee has approved E^3 projects as one manner of satisfying this requirement. The honors student participates in an E^3 project as his honors activity. Since E^3 projects are multi-disciplinary, students from liberal arts and science departments are as welcome as engineers. The participation of the honors students is of considerable benefit to a project because of their high ability and specialized skills.

In a similar manner, upper classmen in the coventional curricula, outside of the Honors Program, are involved in elective courses usually with some specialization in view. Working on projects within E^3 as their elective course is also possible. This interaction is beneficial to both the conventional and E^3 programs.

B. E^3 Program and IIT Faculty

The nature of the existing method of staffing E^3 lends itself well to the dissemination of information regarding the progress of the program. Because of the close liaison between E^3 faculty and departmental faculty, an excellent form of "quality control" exists, in that the philosophy and policies of the departments are continually reflected in E^3 by work of the E^3 faculty. Naturally, faculty heavily involved in E^3 convey an awareness of the program to their departmental colleagues not directly associated with it. It is important to stress the need for this kind of interaction with other IIT faculty, and both program participants and administrators are developing effective means of properly informing the academic community of the progress of this program.

C. Direct Participation by Departmental Faculty

There are numerous activities of the E^3 Program in which direct involvement is possible. Various seminars are held, and participation in these by departmental faculty members is profitable to all concerned (the theme seminars, in which a broad and general spectrum of interests is required are one example). Similarly, specialists in the many disciplines represented at IIT are encouraged to monitor E^3 projects, both during the development of the projects and during the presentation of the project results. These observers are of great value to E^3, even though such input is not expected to be on a continuing basis.

D. Indirect Participation by Departmental Faculty

It is quite possible, and very desirable, to integrate projects in other related disciplines with those in the E^3 Program, with little effort and considerable return. This is particularly suitable in undergraduate laboratory and research type courses, especially in engineering subjects, and for Honors Program students. In this way, departmental faculty can contribute to the work of E^3 and vice-versa--through the education of their own students.

Considerable expertise in engineering education innovation is being developed within the E^3 program and this bakcground is readily available for similar efforts in other departments. The E^3 staff can act as consultants to the departments in regard to problem areas and experiences involved with the introduction of innovative teaching methods.

Faculty support for the program can only be expected, however, from informed faculty members. It is seen as an obligation on the part of both program participants and IIT administration to disseminate accurate and relevant information to all IIT faculty concerning E^3 Program activities. This may be by direct interaction within departments and/or by publication of an E^3 Program Information Bulletin, seminars, conferences or whatever other means may seem appropriate.

3. ADMINISTRATION SUPPORT FOR THE E^3PC

A. Recognition of Faculty Participation in E^3 Program Activities

From the point of view of the participating faculty member, the basic concern is that E^3 Program participation and performance be fully considered and evaluated by all administration staff involved in the recommendation and approval of promotions, raises and honors. This includes department chairmen, deans, the academic vice-president, and president. Success in achieving such full-consideration requires public recognition and acceptance by these administrators of the critical role at IIT of:

1. Undergraduate instruction.
2. The E^3 Program within the overall IIT setting.
3 Participation in E^3 Program activities by faculty holding appointments in the various departments.
4. The role played by E^3 Program activities in expanding the pedagogic skills of participants and the subsequent impact of such participation of the departments involved.

As an example of recognition of the role of E^3 Program participation in evaluation of faculty achievement, faculty who are being considered for tenure and who have two or more years service in E^3 Programs activity will have a specific recommendation from the E^3PC Director included as part of the recommendation documentation organized for the Administration. The specific four evaluative criteria noted above will be utilized in coming to decisions on promotion, tenure, salary, etc. The E^3PC Director will develop his recommendation statement in consultation with other E^3PC faculty members who are cognizant of the faculty member's E^3 Program activities.

B. E^3 Program as One of IIT's Undergraduate Program

The E^3 Program is a major innovation in engineering education in the United States and reflects greatly to the credit of IIT. It is essential to the success of the E^3 Program that it be regarded as an integral part of the undergraduate program at IIT. One important aspect of this attitude is the recognition, from the highest administrative levels downward, that E^3 students are pursuing a curriculum which has received considerable national interest, which is accepted and approved by the faculty as a regular degree program, and which is regarded as highly as other undergraduate degree programs.

In performing their assigned counseling or advising functions, administrative and faculty personnel outside the Program must be specifically cognizant of the structure and conduct of the E^3 Program, especially in those areas where it differs from other departmental programs at IIT. Such differences are particularly salient with regard to student evaluation and credit earnings, where E^3's departure from IIT patterns is considerable. As the program maintains unusually extensive records of student work and academic progress beyond those traditionally available in undergraduate programs, administrative and faculty counseling and advice when dealing with E^3 students should be based on information available in those records

4. RECRUITMENT OF STUDENTS AND FACULTY

A. Recruitment of Students

Special efforts are needed in the areas of recruitment and selection of students for the E^3 Program. Since E^3 is likely to appeal to many students who would not ordinarily enter engineering programs at IIT, a special recruitment program must be directed to gain the attention of such students. In this regard E^3 staff members are presently active on two areas.

1. Identification of those students who would benefit most from the E^3 Program.
2. Development of effective procedures for contacting these students.

B. Faculty Appointments to the E^3PC

The strength of the E^3 Program is dependent not only on the compentence and dedication of its faculty participants but also on careful planning to provide for the various needs of the program. Since most faculty will be participating in the E^3 Program on a part-time basis, it will also be important to ensure cooperation of the departments in arranging suitable appointments.

It has been determined that for approximately 100 students enrolled in the fully developed E^3 Program eight full-time equivalent (FTE) faculty appointments will be required. These will be distributed among sixteen faculty approximately as follows:

1. Full Time appointments (3FTE)
   Director (engineering)
   Associate Director (physical science or engineering)
   Associate Director (humanities or social science)

These individuals will have both teaching and administrative functions. They may have regular departmental affiliations, but during the tenure of appointments will have full responsibility to the E^3 Program Center.

2. Part-time, annual and multi-year appointments (5FTE)
Six third-time appointments for three year terms
Four half-time appointments for two year terms
Three third-time appointments for a one year term

Such part-time faculty appointments to the E^3PC will be considered to be a part of the assigned academic responsibility of the various departments as is appropriate. It will be necessary to have a spectrum of part-time appointments, both in disciplines and in time periods. The multi-year terms will provide continuity within the program and increase the sense of involvement of the individual participants.

5. RESEARCH AND SCHOLARLY ACTIVITIES IN E^3

From E^3's conception, it was planned that E^3 Program faculty and students would engaged in research activities. Two types of scholarly research are envisioned. One is of the research project type such as NSF's RANN, or of the industrial research and development type, and the other of the educational research type.

As the program develops, concerted efforts will be made to obtain sponsorship for some of the research projects from governmental agencies and from industry. Properly organized, support for research activities is available and research proposals are to be developed, not only for reasons of obtaining support for such activities but as part of the pedagogic effort of the E^3 Program.

Typical educational research projects will be in the areas of student evaluation, small group processes, computer aided, augmented, and managed instruction, etc. Presently two proposals are being prepared, one in cooperation with the Department of Psychology on "Problem Solving Processes in Small Groups," and the other on the "Uses of Computers in the E^3 Program." Other scholarly activity will be in connection with developing and publishing educational materials (e.g., monographs on problem oriented learning modules).

6. BUDGET

As with all regular program and departmental centers at IIT, the E^3PC will require specific budget allocations and commitments. In the present developmental stage the E^3 Program, with a limited number of students, is functioning through the support of the original National Science Foundation grant, including IIT contributions. It is anticipated that this pattern will continue through 1974-75 and 1975-76 academic years, at which time full responsibility for the program, both academic and fiscal, will be taken on by IIT. Appendix I presents a budget breakdown for a typical year of operation of that program. It should be noted that these budget estimates are similar in magnitude for costs of regular undergraduate engineering programs, bearing out the previously made statements that, on the basis of approximately 100 students enrolled in that program, E^3 Program costs would be no higher than costs for traditional undergraduate programs.

March 25, 1974

APPENDIX I: BUDGET

SALARIES	TOTAL	IIT	SPONSORED RESEARCH
Full-time Faculty (9 mos.)			
Project Director	$ 30,000	$ 30,000	$
Assoc. Director (M&SS)	18,000	14,500	3,500
Assoc. Director (E&PS)	18,000	14,500	3,500
Part-time Faculty (9 mos.)			
13 Faculty - 1/3 and 1/2 time			
5 full-time equivalents	75,000	75,000	
Full-time Staff (12 months)			
Administrative Aide	12,000	12,000	
Secretary	7,000	7,000	
2 Technicians	22,000	11,000	11,000
Assistants (9 months)			
Graduate (half-time)	14,000	14,000	
	$196,000	$178,000	$ 18,000
OPERATING COSTS			
Office Services	800	800	
Xerox	800	800	
Ditto	600	600	
Visual Aids	300	300	
Building & Grounds	600	600	
Telephone	400	400	
Equipment	3,500	1,500	2,000
Expendable Supplies	9,000	6,000	3,000
Promotional	1,000	1,000	
	$ 17,000	$ 12,000	$ 5,000
TOTALS	$213,000	$190,000	$ 23,000

PERSONALIZED SYSTEM OF INSTRUCTION IN PROCESS CONTROL AND INSTRUMENTATION (Ch.E. 436)

Introduction to the Course

This course will be taught using PSI. This stands for Personalized System of Instruction. The basic reasoning behind this approach is that students should be accorded the following aids to education.

1. Be informed as to the objectives of the material they are studying and how they will be tested to find out whether they have mastered the material.

2. Be allowed to proceed at their own pace and complete the material in a shorter or longer period of time as their own abilities demand. (This must be subject to the overall rules of the school.)

3. Have the opportunity to as much or as little one-to-one contact with the proctor and instructor as they find necessary. A difficult point may require repeated visits with proctor and instructor. Material you find easy may be mastered with no personal contact.

4. Be provided the means to demonstrate that he has mastered a particular batch of material (a module) whenever he is ready. In other words exams will be given on demand rather than at stated times during the course.

5. Be able to demonstrate mastery of each section (or module) as he proceeds. The next module will not be available until the student has mastered the present one. This prevents accumulated deficiencies from hampering the students understanding of later material.

6. Be provided with access to material in depth in areas of interest to him.

To try to implement these ideas we will proceed in the following manner. The first day the first thought package or module will be distributed to each student. The student will study that module in the manner described later in these instructions. The regular class scheduled hours will have both the proctor and the instructor on hand to answer questions, discuss difficult points and administer readiness tests. The normal procedure will be to bring your questions to the proctor. If the two of you cannot resolve the difficulty both of you report to the instructor. When you feel that you thoroughly understand the material contained in the module you request a mastery test from the proctor. There are several versions of the mastery test and the proctor will select one for you at random. Work the exam and report to the proctor who will grade it immediately. If he has questions as to your solutions of interpretations of the questions he can ask you right then and decide whether or not you do know the material. A grade of 95% is required to pass these exams. There is no penalty for failure to pass a mastery exam. You return to study of the module, knowing what you failed to pass in the first readiness test. When you think you have mastered what you didn't know, request another mastery exam. A different version will be selected by the proctor and you try again. When you have mastered a module the next one will be issued to you. You may proceed in this fashion as fast as you like. It is possible to complete the course in a few weeks if you find the material easy for you or it may take you longer than a semester to complete the material. Under no circumstances will you be allowed to proceed to the next module until you have mastered the present one.

Let me emphasize once more, you proceed at your own pace! If you need more time you have it. If the material in this course is easy for you, finish it off rapidly so you have more time for other courses where you may be having more difficulty. There are --- modules or thought packages required in this course (there are some optional modules which we will discuss later). With 15 weeks and --- modules you can readily see that "normal" progress will require that you complete --- modules each week. This is a pacing guide for you. Regulate your time so you do not get far behind. We will post a weekly progress chart so you may see where you stand with relation to the rest of the class. This again is a guide to help you regulate your study habits. A student who completes all required modules in 3 weeks will not get a better grade than one who completes all required modules in 15 weeks. Pace yourself!

<u>Modules</u>

The modules are intended to be thought packages. They cover all the material pertinent to that particular concept or group of ideas. They a designed to be short enough to be studied and mastered in a few days of effort. The modules will contain the following:

1. Title

2. Textbook and sections pertinent to material in this module.

3. Objectives
   This is an important section. A list of testable objectives of the module is given. These are the things the instructor expects you will achieve from the study of this module. These are also the things you will be tested on when you have completed the module. Nearly every mastery exam will have one or more questions on each objective. Thus by the end of the course you will have demonstrated that you indeed know about all the things covered in that course.

4. Text
   This material supplements the textbook. It contains additional explanation, alternative

methods of looking at the problems and supplementary material that is not covered in the text that the instructor feels is important.

5. Study questions
   These you should use as a guide in studying the material. They ask what, why and how. If you keep these questions in mind while reading the text and supplementary material and while working the problems you will be better able to see what is important and what is trivial.

6. Problems
   These may be assigned problems in the text book or additional problems stated in the module. Work these problems! They cover the same material that the mastery exams cover and are chosen to allow you to find out if you know the material. If you have difficulty, see the proctor or the instructor.

7. Reading suggestions
   These are divided into two parts. The first lists alternatives to your text book covering the same material. Some authors give particularly lucid explanations of a particular point, others offer alternative points of view.
   The second portion of the reading list lists advanced treatment of the subject matter and is intended for those seeking a deeper understanding of the material. This advanced material will not be covered in the mastery exams. Please feel free to consult the instructor if you have problems with this material.

8. Estimated study time for the module. This is actual hours of study and problem solving for an average student. It may take you more or less time depending on your abilities to assimilate this type of material.

Upon completion of the module study ask for the mastery exam. In addition to the scheduled class hours a list of available hours will be posted during which you can request mastery exams from the proctor.

Optional Modules and Lectures.

There is much more material in this area than can be covered in a single normal course. To make some of this material available we will distribute a list of optional modules. These cover material of corollary interest or side issues that we do not have time to cover. If you are particularly interested in this type of material you may ask for any of these modules. They are not part of the required modules and may not be substituted for any of the required modules. They are additional work at your option and for your own information.

From time to time a formal lecture will be announced. These are not mandatory and will only serve as enrichment to the regular course material. The ideas presented at these lectures will not be covered in mastery exams and the student is free to attend or not as he or she sees fit. A list of modules that should have been covered to benefit from the lecture will be included in each lecture announcement.

Grading

The emphasis in this style of educational system is mastery of each portion of the material as it is presented. The whole course contains ---- required modules. At the end of each module you will pass a mastery exam with a grade of 95% or better. These exams will test you on each of the stated objectives of that module. Upon completion of the ---- required modules and with a grade of 95% or better on each module I have no reason to award you anything but an A. Completion of ---- of the required ---- modules with 95% or better mastery scores will earn you a B. Less than ---- modules will not be acceptable and unless this minimum number are passed you will receive an NC when the time limit expires.

There may be a final exam in the course. This will be taken from the problems on the mastery exams if it is given. If you have passed all the mastery exams you will have no difficulty with this exam. Its purpose is comparison with other styles of teaching.

In these few pages I have tried to outline the purposes and operational procedures of this PSI style course. For most of you it will be your first experience with PSI. PSI places on the student the responsibility of pacing his own study so that he can complete the required material in a reasonable time. There is no pressure (other than that you generate) to complete a certain assignment by a particular time. This allows you to take as long as you need to master a particular idea. Beware of procrastination, if you let the material slide till near the end of the semester you will have no chance to pass the course. The instructor will be in contact with you from time to time if he feels you are falling too far behind.

In exchange for assuming the responsibility of pacing yourself you are receiving a chance to go faster when your ability dictates, to go slower when you need more time to think about the problem and to arrange your study schedule to eliminate time crunches when other courses are loading you very heavily. Please do not fall into the trap of postponing this material too long. You also have the opportunity of much more one-to-one contact with the instructor, do not fail to use it if you need or want it.

That is the system, you have the first module, proceed and good luck.

FEASIBILITY OF A PROJECT COMPONENT IN THE UNDERGRADUATE ENGINEERING CURRICULUM

In recent years there have been increasing pressures on the technical components of institutions of higher education to reorient the educational process for engineers. Potential employers of engineering graduates have urged that the faculty provide within the academic environment the opportunity for students

1) to develop practical engineering experience and skills,
2) to develop managerial skills and the capability to participate meaningfully in problem-oriented team efforts, and
3) to improve their ability to communicate effectively in written, graphical, and verbal form.

Current societal problems and student perceptions of the world and their place in it have generated further impetus for change:

4) to better motivate and/or reinforce student interest in engineering careers through early exposure to engineering problems and techniques, and
5) to enhance student awareness of engineering discipline interactions and impacts on society

The five goals listed above are of special significance to IIT in its role as a private, technical, and urban institution of higher education. As a technical and urban university, IIT's role is to develop superior technologists for service to industry and society, primarily in Chicago and the Midwest. IIT must also provide the student with the means to achieve a meaningful and fruitful career and function in society. In its role as a private institution, IIT must offer an image and reality of excellence and uniqueness in order to convince students to attend IIT and thus obtain those lofty goals.

Within the traditional academic format there are a multiplicity of ways to achieve separately the goals listed previously. One alternative which leads toward the simultaneous achievement of these goals is to modify the academic class structure to include a significant amount of team-oriented project work with a "real-world" flavor. Recent programs with such an orientation have been implemented school-wide at Worchester Polytechnic Institute, in at least one department at Rose-Hulman Institute of Technology, and here at Illinois Institute of Technology in the form of the experimental E^3 program.

Serious consideration should be given to the implementation of a project component in the curriculum at IIT. In support of that proposal, an example curriculum is here presented which in this writer's opinion could be a viable scheme to achieve effectively and efficiently the five goals of developing practical experience, management and team-oriented skills, awareness of society-engineering interactions, improved communication skills, and early career motivation in students.

Table 1. Suggested Credit Assignments for Project-Oriented Curriculum

Student Semester	Project Based Credits			Course Based Credits			Total Credits		
	E&PS	H&SS	Totals	E&PS	H&SS	Totals	E&PS	H&SS	Totals
1	2	1	3	11	3	14	13	4	17
2	2	1	3	11	3	14	13	4	17
3	2	1	3	11	3	14	13	4	17
4	2	1	3	11	3	14	13	4	17
5	3	1	4	11	2	13	14	3	17
6	3	1	4	11	2	13	14	3	17
7	4	1	5	10	0	10	14	1	15
8	4	1	5	10	0	10	14	1	15
TOTALS	22	8	30	86	16	102	108	24	132

The basic concept of the curriculum outlined in Table 1 is that each student would participate during each semester at IIT in a problem-oriented project to the level of his technical capabilities. The student is introduced gradually to project work with only 17.05% of his lower divisional credits assignable to projects. The amount of project work then increases to a point where one-third of his senior year is devoted to projects. Overall, 27.73% of his credits are devoted to projects. Classroom E & PS credits which are replaced by project credits do not necessarily represent "lost" technical credits in that project work should require students to delve into technical work other than that to which they are exposed to in class.

The amount of credit assigned each semester to team project work is roughly equivalent to one course, but the project should not be equated to a course. First of all, the amount of credit per project varies from two in the first semester to four in the last semester. Secondly, there will be significant interaction between technical and non-technical aspects of problems within the project. Thirdly, the amount of student effort, the amount of individual unsupervised learning, and the amount of faculty-student interaction will vary significantly from student to student, and will in general be much greater than in an "equivalent" course. Finally, the interaction of projects with courses would be much more pronounced than is the case in course-to-course interactions. The degree of project/course interaction should be carefully monitored in order to prevent technical courses from becoming excessively "service" in nature to the projects.

The proposed curriculum differs drastically from the E^3 curriculum. In the E^3 curriculum no formal classroom credit is programmed, and the student is immediately immersed in team-project work. The proposed curriculum allows gradual introduction and increase of project activity as the student becomes more technically and socially capable of functioning in a team attack on a significant problem.

As a student progresses through his years at IIT, his or her role in project activity will shift. In the first semesters, the student concentrates (beside the non-technical aspects of the problem) on developing and contributing to the calculational aspects as well as the communication aspects (graphical, written, oral) of the project. In successive years, increased technical contributions to the synthesis and solution of problems will be made by the student. In the senior year, the student would be responsible for the overall scheduling and guidance of the project effort as well as serving as a technical expert in a particular sub-discipline of his major field of study. The faculty (and graduate assistant) roles in the projects would be as technical advisors, and as evaluators of student performance.

It is assumed in the above discussion of student roles in projects that there is a vertical mix of students in each project team, i.e. each project team would include Freshmen, Sophomores, Juniors, and Seniors. Beside the obvious benefit of differential assignment of tasks according to background, there are two added benefits. First, increased motivation is provided to underclassmen through meaningful participation in a challenging problem, and increased management responsibility is provided to upperclassmen through guidance of underclassmen. Secondly, the faculty load in advising and evaluating the project team is shared by the upperclassmen, who, perhaps, are closer to the learning problems encountered by Freshmen and Sophomores.

Included herewith are several pages of notes related to potential impacts, and the design and organization of projects. These notes are intended to provide a non-exclusive list of problems which must be addressed before a project-based curriculum could be implemented. Perhaps the most critical impacts would be on the engineering faculty as outlined in Item VI.E of Notes on Potential Impact of Four-Year Project-Oriented Curriculum. Amongst the items given in the attached Notes on Design and Organization of Projects, the most critical factors in the effective use of projects as an educational tool are the thoughtful selection (and timing of selection) of projects, and the rigorous enforcement of sanctions, rewards, and evaluation procedures.

In order to illustrate the detailed organization of a project-based curriculum for a typical engineering department, a proposed revision for the Civil Engineering Undergraduate Curriculum (Table 2) has been considered as an example. This represents only this writer's tentative thoughts on the matter and in no way reflects the opinion of the rest of the Civil Engineering Department. Also included for illustration purposes is a list of course offerings (Table 3) for the Civil Engineering Undergraduate and Graduate Programs which would be consistent with the faculty loads inherent to a project-based curriculum. (Nine full time faculty members have been assumed with outside help used for two regular courses and a majority of the evening undergraduate courses.)

Based on the curriculum outlined in Table 1 and illustrated in particular in Table 2, it appears feasible from consideration of Table 3 to implement a project-based engineering undergraduate curriculum at IIT. Before such a curriculum is implemented, the questions raised in the attached notes must be answered and careful appraisal must be made of the effectiveness of the project format as an educational tool. This is especially important in light of the potential costs and efforts which would have to be expended to make the projects something more than "window dressing" in an engineering education.

TABLE 2. REVISED UNDERGRADUATE CIVIL ENGINEERING CURRICULUM

First Semester

Math 103	4	0	4
Phys 103	3	0	3
Chem 111	3	3	4
Gen. Ed. Elect.	3	0	3
CE 101 Project	3	0	3
TOTALS:	16	3	17

Second Semester

Math 104	4	0	4
Phys 104	3	3	4
Sci. Elect.	3	0	3
Gen. Ed. Elect.	3	0	3
CE 102 Project	3	0	3
TOTALS:	16	3	17

NOTES: Chem 111 reduced to 4 credits, Chem 113 replaced by Science elective of 3 credits. EG 101-102 deleted.

Third Semester

ES 206	3	0	3
Math 203	4	0	4
Phys 203	3	3	4
Gen. Ed. Elect.	3	0	3
CE 201 Project	3	0	3
TOTALS:	16	3	17

Fourth Semester

CS 202	1	2	2
CE 305	2	3	3
ES 207	3	0	3
Math 204	3	0	3
Gen. Ed. Elect.	3	0	3
CE 202 Project	3	0	3
TOTALS:	15	5	17

NOTES: CE 214 deleted. CE 305 reduced to 3 credits. ES 206-207 reduced to 3 credits each.

Fifth Semester

CE 316	3	0	3
CE 306A	1.5	1.5	2
ES 208	3	0	3
Gen. Ed. Elect.(B)	2	0	2
CE 301 Project	4	0	4
TOTALS:	16.5	1.5	17

Sixth Semester

EnvE 402B	1.5	0	1.5
CE Hyd&HydgyA	1	1.5	1.5
CE 423	2	3	3
CE Trnsp. 1B	1.5	0	1.5
CE 318A	2	0	2
CE 318B	1.5	0	1.5
Gen. Ed. Elect.(B)	2	0	2
CE 302 Project	4	0	4
TOTALS:	15.5	6.5	17

NOTES: Mini-courses denoted by A or B -- A = first half, B = second half. CE 316 - 318 reduced to 6.5 credits. CE 306 reduced to 3.5 credits of which only CE 306A is required. General Education Elective reduced to 2 credits per semester.

(continued)

TABLE 2. REVISED UNDERGRADUATE CIVIL ENGINEERING CURRICULUM (continued)

Seventh Semester

CE 440	2	3	3
CE 414A or CE 306B or EnvE 402A	1	1.5	1.5
CE Hyd&HydgyB	1	1.5	1.5
CE Options	4	0	4
CE 401 Project	5	0	5
TOTALS:	13	6	15

Eighth Semester

ES 313 or ES 205	3	0	3
CE Options	7	0	7
CE 402 Project	5	0	5
TOTALS:	15	0	15

NOTES: ES 313 or ES 205 selected. CE 440 moved to seventh semester. Second half of CE 414, CE 306, or EnvE 402 selected. General Education Electives deleted. Electives reduced to 11 credits..

TOTAL SEMESTER HOURS = 132 credits.

NOTE: Addition of 3 credit hours to required program.

TABLE 3. SUGGESTED REVISION OF CIVIL ENGINEERING COURSE OFFERINGS TO ACCOMMODATE PROJECT-BASED CURRICULUM

Undergraduate Curriculum Offerings (A = first half of semester, B = second half of semester)

Course	Credits	Time Offered				Notes
		Fall A	Fall B	Spr A	Spr B	
CE 303	3-0-3			X	X	Service course to Arch.'s
CE 304	3-0-3	X	X			" " " "
CE 405	3-0-3			X	X	" " " "
CE 304	2-3-3			X	X	4th sem. CE's req'd
CE Hyd & Hgy A	1-1.5-1.5			X		6th sem. CE's req'd
CE Hyd & Hgy B	1-1.5-1.5		X			7th sem. CE's req'd
CE 306 A	1.5-1.5-2	X				5th sem. CE's req'd
CE 306 B	1-1.5-1.5		X			7th sem. CE's req'd } select one
CE 414 A	1-1.5-1.5	X				7th sem. CE's req'd } or EnvE402.
CE 414 B	1-1.5-1.5		X			7th sem. CE's trans option
CE 316	3-0-3	X	X			5th sem. CE's req'd
CE 318 A	2-0-2			X		6th sem. CE's req'd
CE 318 B	1.5-0-1.5				X	6th sem. CE's req'd
CE Trans I A	1.5-0-1.5			X		8th sem. CE's trans option
CE Trans I B	1.5-0-1.5				X	6th sem. CE's req'd
CE 423	2-3-3			X	X	6th sem. CE's req'd
CE 440	2-3-3	X	X			7th sem. CE's req'd
CE 409	3-0-3	X	X			7th sem. CE's struc. option
CE 437	3-0-3	X	X			7th sem. CE's struc. option
CE 438	3-0-3			X	X	8th sem. CE's struc. op
TOTAL Undergraduate Courses:		7	8	8	7	= 30 half-sem. courses = 15 courses

(continued)

TABLE 3. SUGGESTED REVISION OF CIVIL ENGINEERING COURSE OFFERINGS TO ACCOMMODATE PROJECT-BASED CURRICULUM (continued)

Graduate Curriculum Offerings (some alternate year courses)

Course	Credits	Time Offered				Notes
		Fall A	Fall B	Spr A	Spr B	
CE 514 or 409				X	X	alternate years
CE 503		X	X			every year
CE 516				X	X	every year
CE 533 or 530		X	X			alternate years
CE 531 or 532				X	X	alternate years
CE 518 or 525		X	X			alternate years
CE 520 or 560				X	X	alternate years
CE 511 or 561		X	X			alternate years
CE 557		X	X			every year
CE 558				X	X	every year
CE Soils G1 or G2		X	X			alternate years
CE 540		X	X			every year (UG trans. option)
CE 541				X	X	every year (UG trans. option)
CE 542 or 543				X	X	alternate years
TOTAL Graduate Courses:		7	7	7	7	= 28 half-semester courses = 14 courses
TOTAL CE COURSES		14	15	15	14	= 58 half-semester courses = 29 courses

Project Availability of Civil Engineering Staff (2 projects = 1 course)

	Fall A	Fall B	Spr A	Spr B	
	8	8	9	9	= 34 half-sem. projects = 17 projects = 8-1/2 course equivalents
TOTAL Staff Course Loads:	18	19	19.5	18.5	= 75 half-sem. course equiv. = 37.5 course equivalents

NOTES:

With a staff of 9 teaching 4 course equivalents per year, 36 course equivalents can be offered. Outside help for CE 414A and CE 414B and CE 542 or CE 543 would provide 2 additional course equivalents. Thus, 9 faculty could handle 38 course equivalents in the day undergraduate and the graduate programs. In order to teach the evening undergraduate courses and projects, additional part-time staff or regular staff overloads would be required. It would be highly desirable if evening projects would be taught by regular staff.

NOTES ON POTENTIAL IMPACT OF FOUR YEAR PROJECT-ORIENTED CURRICULUM

I. Student Body

A. Regular Undergraduates:

-- Would meet standard program.

B. Co-op Students:

-- Common first year acceptable.

-- How relate to a year-long project?

C. Evening Undergraduates:

-- Difficult to make interaction time available.

-- Could schedule evening projects which would meet two evenings per week.

D. Post First-Year Transfers:

-- Missing 4 E & PS and 2 H & SS project credits.

-- Have extra credits for graphics and science.

-- Allow maximum of 4 transfer credits for projects and add 2 credit project for transfers in first semester.

-- The special transfer projects could be the evening project.

E. Post Second-Year Transfers:

-- Majority of transfers.

-- Missing 8 E & PS and 4 H & SS project credits.

-- Have extra credits for graphics and science.

-- Have extra credits for engineering science.

-- Allow maximum of 8 transfer credits for projects and add 2 credit project for transfers in first and second semester.

F. Post Third-Year Transfers:

-- Least number of transfers.

-- Missing 14 E & PS and 6 H & SS project credits.

-- Have extra credits for graphics and science.

-- Have extra credits for engineering science.

-- Have two extra credits in H & SS.

-- Have extra 6 credits in upper division major.

-- Allow maximum of 15 transfer credits for projects and add 3 credit project for transfers in first and second semester.

G. Honor Students and Others Inclined Toward Graduate School:

-- Form research projects.

II. Administrative Affairs

A. Service Functions of Department:

-- Maintain or modify to meet new requirements.

B. Course and Room Scheduling:

-- Schedule constant 3 hr. block of time for group meetings.

-- Schedule two extra 2 hr. blocks for group work session and seminar.

-- Assign different course number to each semester.

-- Preregistration important.

C. Humanities and Social Science Faculty:

-- Reduction of 1/3 in course load.

-- Serve as consultants on H & SS aspects of projects.

-- Serve as evaluators of project reports.

-- Head seminars on theme areas for projects.

-- Would not assign H & SS faculty to project teams on a one-to-one basis.

-- Social Science aspects of project probably predominate over Humanities aspects except for communications skills.

-- Redefinition of "General Education Electives."

D. Science Faculty:

-- Slight reduction in service courses.

-- Significant consultant roles.

-- Potential for seminars on theme areas.

E. E & PS Faculty:

-- Two projects = 1 course.

-- Rely on T.A.'s to participate in project as technical advisors as well as assist in service courses.

-- Average 12 students per project.

-- Type of faculty required may require re-education and reorientation of current faculty plus new emphasis in recruitment.

-- Tenure implications in recognition of project effort vs. scholarly effort.

-- Projects differ from courses in that preparation time for projects is recurring effort as projects change from semester to semester.

F. Grading:

-- Could retain present letter system.

-- Grade based on several factors:

1) difficulty of project
2) team achievement of goal outlined
3) presentation of results
4) individual efforts re: academic level.

-- Could grade separate aspects of project

- could give Pass-NC on factors 1, 2, 3 where Pass = achieved goal.
- could give letter grade on factor 4.

-- Could assign P-NC to student for 50% of credit based on team achievement.

-- Could assign letter grade to student for 50% of credit based on individual effort.

-- Could add PD grade ("Pass with Distinction") for excellent presentation of results for difficult project.

-- Incompletes should be discouraged, if not disallowed, especially for year-long projects.

G. Relation of Courses and Projects:

-- Should be integrated. (However, courses should not be changed so as to be service courses to projects.)

-- Courses must be modified to reflect presence of projects.

-- Potential problem: homework requirements and exam scheduling may steal time from projects.

-- Could reduce homework requirements since projects are partial replacement of drill and illustrative examples.

-- Introduction of half-semester long minicourses may align exams (would have to add exam period).

-- Skills attributed to course credits deleted from program should be identifiable in project credits, e.g. first and second semester. Students should be required to demonstrate EG 101-2 skills in project work.

-- Could reduce lab/recitation times.

-- Could schedule exams uniformly, e.g. mid-term exam week.

-- Require project completion prior to finals week (give projects a clean-up week).

H. Student Advising:

-- Increase in work to advise students.

-- Each student will potentially develop different skills through project efforts.

H. Student Advising: (continued)

-- Could require minimum number and level of skills per student.

-- How evaluate? Senior exams on skills needed but not listed in course record?

-- Compile student dossiers for internal advising.

-- Generate set of "student images" for comparison (need not fit perfectly!).

NOTES ON DESIGN AND ORGANIZATION OF PROJECTS

A. Selection of Projects:

-- A theme area should be defined per year for whole institute prior to project year.

-- Desirable aspects of project selection:

1) educational benefit
2) scope of work required and duration
3) variety of skills and abilities required
4) interest to participants
5) solvable but not already solved problems
6) projects should broaden, not narrow students.

-- Aspect 1 most important.

-- Aspect 2 second most important.

-- Aspect 3 related to broadening of student's background and to exposure to variety of subdisciplines.

-- Who selects projects and when? Approval of selection?

-- Students should be active participants in selection and design of projects.

-- Aspect 2 must be completed quickly, possibly prior to start of semester. (Make selection at preregistration.)

B. Sanctions/Rewards/Evaluations:

-- "Education through failure and confidence through success." Project goals should be realistically defined and achieved in time allotted. If not achieved, a report should still be submitted at the deadline.

-- Group effort influenced by individual efforts.

-- Commitments must be made by participants, e.g. withdrawals could be damaging.

-- Special coaching and counseling on project participation should be provided as required for both students and faculty.

-- Sanctions should be provided for not meeting deadlines (both for individuals and for groups).

-- Rewards should be provided for early completion or for exemplary work.

-- Students should learn how to estimate costs and time for work proposed.

- project proposals should include cost estimates with $ assigned to time.

- job and time overruns should be penalized.

- costs of outside consultants could be included--also "learning overhead."

- perhaps performance bidding of different groups for single project problem could be used with low bid receiving project. (Could define large project with subcontracts.)

B. Sanctions/Rewards/Evaluations: (continued)

-- Could require students to earn minimum number of bonus points which would be earned either by exemplary individual effort or by successful completion of project received from bidding.

-- Outside evaluation of work.

C. Project Staffing:

-- Average 10 undergraduates per project.

-- At least 5 lower divisional students.

-- At least 5 upper divisional students.

-- At least 2 from each year.

-- One graduate assistant for each project.

-- One faculty for two projects.

-- Could define interdisciplinary projects, e.g. could require students to take at least 1 project from outside major department.

-- Could organize project teams along corporate lines, or as consulting firms (chain of command responsibility).

-- Should insist on fluctuating groupings of project teams and of responsibilities.

-- Could enlist one outside-IIT contact for each project (continuing education).

D. Scheduling of Project Effort:

-- Selection of project.

-- Proposal of work (educational benefit & work schedule and cost & effort estimates).

-- Seminars (Science, H & SS).

-- Interim reports and weekly or biweekly logs.

-- Final report and presentation.

-- Balance of one-semester and two-semester projects.

-- Perhaps two-semester project could be defined as follows:

1) first semester - prepare bid and trial design for a previously stated RFQ (performance based).

2) low bid project team(s) allowed to continue into second semester.

3) some second semester projects could be devoted to preparation of RFQ's for next year.

APPENDIX XXI

PROCEEDINGS OF THE JAPAN SEMINAR ON E^3

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PROCEEDINGS OF THE JAPAN SEMINAR ON E^3

In the presence of Professor T. Paul Torda, Program Director, and Dr. Florence Torda, Assistant Professor, THE JAPAN SEMINAR ON E^3 was held on August 23rd and 24th, 1974, at Hotel Casa Greenland, Arao-shi, Kumamoto-ken, adjacent to the Ariake College of Technology, the host. Instructors and engineers interested in engineering education were invited to participate in the event.

SEMINAR AGENDA

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August 23rd.	10 : 00 - 10 : 15 a.m.	Opening Speech by Dr. I. Todoroki	27
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	1 : 30 - 4 : 30 p.m.	Questions and Answers on E^3	39
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JAPAN SEMINAR ON E^3 COMMITTEE

Honorary Chairman: Dr. Masamitsu Kawakami, President, Tokyo Institute of Technology

Special Lecturers:

Dr. T. Paul Torda, Program Director, Education and Experience in Engineering, Illinois Institute of Technology

Dr. Florence Torda, Assistant Professor, Illinois Institute of Technology

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Dr. Setsuzo Tsuji	Dean, School of Engg., Kyushu Univ.
Coordinator:	
Prof. Tomoya Tanamachi	Ariake College of Technology

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STEERING COMMITTEE

Prof. Tomoo Kimoto .... Prof. Tomoya Tanamachi

Torda 夫妻の紹介

Lecture にうつる前に Torda 夫妻の御紹介を申し上げます。

Dr. T. Paul Torda は先程申し上げました通り，I.I.T の E^3 Program Director で，その学歴・工場経験・教育歴・研究歴・著書論文は，資料7-197ページ以下に詳記されている通りであります。また，奥様の Dr. Florence Torda は E^3 Program の Sociology 関係の Staff（資料7-139ページ）であり，その学歴・研究歴などは，資料7-195ページ以下に記載の通りであります。

Reference

0. Education and Experience in Engineering Engineering Education, p.23/27 +75 Oct. 1973
1. Proposed Outline of E^3 Seminar
2. Program Details (Report No.72-1) Part I May 1972
3. ditto (Report No.72-2) Part II, Vol.I May 1972
4. ditto (Report No.72-2) Part II, Vol.II May 1972
5. ditto (Report No.72-2) Part II, Vol.III May 1972
6. Program Details (Cover E^3) May 1973
7. Proposal to NSF Sept. 1973
8. (Introduction to E^3) (Cover illust.) 1974

PART ONE
OUTLINE OF E^3 PROGRAM

E^3 (E cube) -- Education and Experience in Engineering

T. Paul Torda and
Florence Torda

T. Paul Torda

Thank you, Dr. Todoroki, for the kind words and the introduction. I also want to thank you and Professor Tanamachi for making this Seminar possible. Particular thanks are due to President Kawakami who has so graciously accepted Honorary Chairmanship. I wish to assure you that this is an important event for the E^3 Program. Our sponsor, the Program Office of the National Science Foundation sends greetings and good wishes for success of the Japan E^3 Seminar.

I would like to thank Dr. Todoroki and his associates for the very gracious reception and hospitality extended to Mrs. Torda and myself. This is our first trip to Japan and it is already a most memorable one. We will always think of this trip as a very pleasant and important one in our lives.

President Todoroki asked me to point out the pages to which I am referring during my talk. I will try to do that as much as possible. However, I do not intend to follow the reports during my lecture. These have been very efficiently made available to all the participants by Professor Tanamachi and his associates to whom my sincere thanks go for the outstanding organization of the Seminar.

Primarily, I would like to talk about certain aspects of the E^3 Program which cannot be easily formulated in reports. I also would like to discuss these aspects during the "questions and answers" periods. I hope that you will make ample use of those periods and put questions to both Dr. Florence Torda and myself in order that we may amplify what is not sufficiently clear, or comment on additional points of interest to you.

You will notice that the reports contain duplications. This is because we have written each report with the assumption that people did not necessarily read the previous ones and we wished to maintain a certain continuity of thought.

I would like to highlight a few things, and I would also like to talk about the budget which is not in the reports, but which is, I think, available to you in the preprints. I will then ask Dr Florence Torda to talk about several issues which she feels should be brought to your attention.

Why an E^3 Program?

I would like to start out with a question and try to answer it. Why did I embark upon developing the E^3 Program? I have an engineering education, I have been in industry, carried out research, and taught for many years. I have found that there exists a great gap between what an engineer needs in the real world and what he learns at college or university. This gap is so big that, after many years of discussions with educators and engineers, I came to the conclusion that we have to do something about it. A nation like your country, like the United States of America, Germany, England, France, etc., have very highly developed technologies. Such countries need engineers who are very well trained to carry out the services which societies with such highly developed technologies require. However, there is need for another type of engineer also: The engineer whose education by intent made him aware of the broad contexts within which the problem arises and whose solutions of those problems reflect this awareness. Normally, we do not educate engineers in this manner in the conventional curricula of our colleges and universities. Many years after they enter the job market, they may reach a position where they can understand that the problem is not defined only in technological terms but also in social, legal, and economic terms. Then they will perceive that the problems are grounded in social needs. These problems need solutions which are far beyond the capabilities of the new graduates from conventional curricula. The engineer graduating from an American university suffers from another disadvantage: He is not educated but trained. He not only does not understand the problems of society, but probably does not know much about music and art, history, etc

Goals of the E³ Program

In E³, we have set out with the goal to educate engineers who are very much aware of societal needs and of their own responsibility. We also want to offer opportunities for the students during the four years at college to get a reasonable liberal education. Our goals, then, are to *educate a new breed of engineers.* However, the methods we are using and the philosophy we have embraced are certainly applicable to the achievement of other educational goals. If you want to educate, for example, a civil engineer, the same method and the same philosophy may be applied.

The student is responsible for his education

Another major departure from conventional curricula in the United States is that, in the E³ Program, the responsibility for the student's education is placed on his own shoulders. I believe that "teaching" is the wrong word. The teacher can guide, the teacher can challenge, the teacher can point out mistakes or point to routes which lead to results But learning, the work, is the responsibility of the student.

If we accept this philosophy, then we have to do essentially three things We have to *motivate* the student. It is not enough to tell the student to learn. He has to come to the conclusion that he needs knowledge. The faculty has to create the proper environment for this. The learning has to be *reinforced*. And the student has to *continue learning*. We have to make it possible for the student to become a student in the true sense of the word. That means that he will know how to study and will have the ability to continue his education during his lifetime

E³ places students into real engineering situations

But how do we go about this? We use certain methods, other methods are also possible, but we have found these to be useful and fruitful We try to place the student in a real engineering situation It is important for the student to feel that he is not in an artificial, but in a real situation We have to make sure that the student knows that his contribution is important, that the work he is doing, while learning, is meaningful not only for himself, but also for some people whose problem he is trying to solve. That is the real situation I am referring to

Students build on knowledge they bring to E³

The student comes with certain knowledge, and we require that the work, the problem to be solved, and the result should be on a higher level of sophistication than he is capable of when he approaches the problem. But at any moment the student must know that even on his level his contribution is important and meaningful. He must understand also that what he knows is not enough, and, therefore he must learn new material to attack the problem.

Students learn how to evaluate their own work

There is another important task for us We must convince the student that he has to learn how to be his own judge. He and not the instructor, not the boss, should question whether his work is good enough. He must learn to judge his own work as well as the performance of others.

The BSE degree

I stated that we have a certain goal in mind and that other goals are possible This method of education and this philosophy of learning are valid not only for engineers, but for all professions and all fields of education. But we have chosen to educate engineers in several disciplines and our program leads to a new degree, the bachelor of science in engineering, BSE. We have to insure that this interdisciplinary curriculum is of just as high or better quality as the conventional engineering curricula We want to graduate outstanding engineers whose education has included ample attention to fundamentals, professional work, and the humanities and social sciences and who understand the social implications of technical problems. This is a much bigger task than ordinarily students face in four years.

Reinforcement of learning through application

How can this be done? We have studied this question and have found that it indeed cannot be done unless the time is used efficiently, if the student does not just repeat learning because he has forgotten the subject from one class to the other, but if his learning is reinforced as he goes along If you search your own experience, you will find that one forgets much of what one has learned, unless this knowledge is applied. We all forget. Yes, it is easier to re-learn when the material is needed again, but such "refreshing" takes time. In E³, we try to make the student learn when he needs something and then apply his knowledge. This reinforces learning. And then, next year, or a year later, he will act as a tutor and will help the less experienced student understand the material He will re-learn the same material from a different point of view Research, results show that this "double reinforcement" results in more effective retention Students retain more if the knowledge is used and is reinforced At the same time, we have to make sure that new knowledge is acquired and that the student covers all fields of engineering I will try to give you some insight into how we do this

The problems are solved by small groups....Self-paced instruction

You know from the literature which has been given to you that we have decided to create the engineering atmosphere for students by dividing them into small groups in order to attack problems The problems are new and meaningful and do not have known answers. We require these groups to either find a solution, or come to the conclusion that the problem cannot be solved at that time and with the means at hand. If the student is placed in this situation and if his knowledge is not sufficient for the task he undertook, then he has to acquire new knowledge. We use the self-paced instruction method to enable the student to acquire the knowledge he does not have. I will try to develop more fully this self-paced learning method, not because it is the most important component of the E³ Program, but because it is often a difficult step for educators who are used to the regular class format as well as for students coming directly from high school. Instead of going to regular classes, E³ students learn on a self-paced basis

Curriculum content

We have decided that the student in E³ should know as much of the basic material in engineering as any other engineering graduate Since we require this, we had to analyze the content of the various curricula We have found that different engineering curricula use some — but not always the same basic material. We want our students to know as much, but not necessarily the same material, as all graduates from conventional curricula This is roughly equal to 60 percent of the total basic or "core" material The E³ graduate will also cover 60 percent of the professional material of various fields – usually learned in the junior and senior years -- since in E³ we do not educate a mechanical, chemical, or civil engineer, but we want our graduates to be knowledgeable in all these areas In addition the students have to study in the humanities and social sciences.

Credit hour distribution

What does this mean in credit hours? The E³ student needs 128 credits for graduation (A course is worth three credits if it meets for three hours a week.) Let us call these 128 credits 100 percent. —Actually in E^3 we require the student to earn 136 credits for graduation and this is above the minimum requirement of the college.— Out of this 100 percent, 40 percent represents basic or core material (in the reports you will find this denoted by MSES Mathematics, sciences and engineering sciences). Another 40 percent will be professional and project work (PP), and 20 percent is earned by studying in humanities and social sciences (HSS). We try to distribute the credits earned within each project approximately in this ratio. You will find this better explained in the distributed reports and I will point out where specific information may be found.

Learning modules

The basic or core material is presented to the students in learning modules (LM) and these are used in the self-paced learning. (You will find LM's discussed on page 8 of the notes on the "Proposed Seminar Summary on the E^3 Program" together with specific references to parts of the main reports. The basic or core material contained in learning modules cover mathematics, physics, chemistry, material sciences, statics, dynamics, fluid mechanics, heat transfer, etc. The learning modules are parts of courses: Each course is broken down into a certain number of parts representing roughly 15 hours of learning. We have subdivided the course material, but we have departed from the usual method in which self-paced learning material covers a course in sequenced form We try to make the learning modules as independent of each other as is possible. For example, if a student is working on a problem in noise pollution, then he needs to know wave mechanics, properties of materials, etc., but he does not need to know Newton's laws of motion to approach problems in noise pollution. Another student will work on structures and will need solid mechanics, material sciences, etc. We try to make the learning modules as independent of each other as possible, but not independent of previous knowledge. Each module has prerequisites. The prerequisites and also, if there are, any co-requisites, are spelled out in the learning modules. We also define for the student the objectives of each module: What we want him to know. We also tell him how we will test his knowledge.

Mastery of learning

We give him a guided tour, so to speak, through part of a book. We tell him to solve certain problems and then we give him a sample examination. When the student tests himself on the sample examination and thinks that he knows the material covered in the module, then he signs up for an examination. The examination is similar to that he tested himself upon. If he passes to the satisfaction of the faculty, he gets the check mark which means mastery (M). If he does not pass, he is not punished. —He is only rewarded for knowledge, he is not punished if he fails —We discuss with him what went wrong, what he did not learn, and we help him to learn and to get over his particular difficulties. Then he studies more for another examination on the same learning module. If he passes that, we give him the check mark, designating mastery The new grade is not A, B, C, or D, it is better than B and means that the student knows 90 percent or more of the material. Now the student can go on and build on his knowledge If he knows less, it is not enough because he is building up gaps. This mastery is not a new concept, it is used at several other universities.

Transition from directed learning to independent study

I said that the core material has been developed in learning module form and this form of self paced learning constitutes a transition from the high school type of directed learning to independent study later on. Therefore, we decided not to write learning modules in the professional areas and learning during the project work on a higher level, but we guide the student in learning by making use of the library, books, research papers, and journals. Instead of making detailed study plans for the student, we require him more and more to study on his own because after graduation he will need this skill in his job in industry, or in graduate school. So, slowly going from core to professional material, we let his hand go. He is on his own

Humanities and social sciences are not learned in courses, they are learned during the project work under the guidance of the appropriate advisers.

You will find more detailed description of learning modules on pages 8 to 12 of the notes on the "Proposed Seminar Summary on the E^3 Program." A summary list of the learning modules is available. I will be happy to answer questions during the discussion period. Now, I would like to talk about how the projects are planned.

Projects

The project is the most important part of the E^3 Program because it is through it that we introduce students to reality. We encourage the student to recognize problems and to learn how to devise a plan to solve the problem. He has to do all these in the company of fellow students and of advisers and consultants who are faculty members.

Outside resources

In order to find real problems, we search the world outside academia. We bring in people from industry, from the city, from government, from hospitals, from research institutions, etc. We also allow, even encourage, the student to go out and find problems on his own and at places familiar to him: Shopping in the supermarket, commuting, using the train, the bus, the subway, the car, etc. If the student visits industrial plants, shops, etc., he learns that machines produce not only products but also a lot of noise, a lot of heat, and a lot of dust. There are many problems the student can find himself, but there are also problem areas he has never experienced.

An example

There were students in the first year of E^3 who wanted to work on some transportation problem If you park your car at an airport, how do you get to the check-in gate efficiently? We invited the chief engineer from the city of Chicago who was also in charge of the airport design office and he lectured to us, then we sent the students to the airport to explore it. They went to the airport as passengers. Afterwards, they found a way to get "behind the scenes." They contacted engineers in the airport operations office and these showed them how passenger traffic operated These are some of the ways we introduce the student to a problem which he defines and then writes up so that he can try to find a solution to it.

Problem definition is difficult

To find and define a problem is a difficult and frustrating process The first request the student always poses to the faculty: "*You* tell me what I have to do to solve this problem" But it is important for the student to understand that he has to find out for himself

Choosing problems

Faculty and students discuss ten or twelve different problems at the beginning of each semester Then, all sign up for different problems and discuss them in small groups. Within about ten working days, five to seven groups will form which the students and faculty members join voluntarily. These groups, when formed, stay together during the semester, or whatever time it takes to solve the problem Ideally, students from all four years and faculty members, usually an engineer and social scientist or humanist, form a team. They focus on the problem in both socially important terms and also in technologically important terms.

The preliminary proposal

As the problem is clarified, it is defined more precisely during the second or third week. At that time, the group writes the "preliminary proposal." This preliminary proposal is very important because it serves as a guide to the group: It defines what is to be accomplished and in what time scale, what are the means needed for the project. At that stage, each individual student has to define what he needs to learn during the project. He has to enumerate learning modules and professional material, and this becomes a contract between himself and the faculty, not only his advisers but the various committees which supervise the groups and make sure that, indeed, good quality work is done and progress is made.

The Review Board

The committee which supervises the projects is called the Review Board It reviews the preliminary proposal and, after this, meets with each group every second week to follow the progress made. This Review Board also accepts the final report or suggest additional work. It also distributes the credits earned by the students. We will see in a little while how the credits are assigned

The Program Design Committee

We also have another committee, the Program Design Committee. This consists of faculty members from different fields: There may be mathematics, chemistry, humanities, mechanical engineering, etc., represented on that committee but we may change the committee composition from year to year. This Program Design Committee is working with each individual student on his curriculum, his plan of studies. It has to be a meaningful curriculum which allows the student to acquire the proper amount of basic and professional knowledge in four years.

E^3 has no set curriculum

We do not have a set curriculum, since for each student we plan a program according to his developing interests. In general, the first two years are used to introduce each student to different areas of engineering: Mechanical, electrical, chemical, civil, etc., and these form the background against which we develop a theme, the theme which we define with the students for that particular year.

The group effort

Let us continue with describing the group efforts in working on projects. Each student has an assignment, a certain task in the project. One of the students is elected as a coordinator, or a leader if you will, of that particular project. He is responsible for scheduling meetings and the work of the group members. It is also up to him to make certain that the work is done in time and is of high quality. Shouldering such responsibilities allows the student to learn to work in groups instead of working as an individual as he was used to in high school. In the American high schools, individual competition is very much stressed. We try to modify this, and we try to make the student learn how to work in groups.

Final report and presentation

As I said, the Review Board meets with the groups and monitors their progress. Towards the end of the project, the final report and the presentation have to be prepared. The final report will contain not only the work accomplished by the group, but also the individual work of each student. This way, each semester the student can review his own growth with the faculty and with the other group members.

Self evaluation

You may remember that at the beginning of my talk I have said that evaluation is very important and that in E^3 the student learns how to evaluate his own work. At the end of each project, it is of great value that the student realizes whether he has done good work, whether he could have done better, and whether he learned enough.

Mastery is demanded in every effort

We require mastery on every level of performance. What does the mastery mean? It means that the report is written so that another person can understand what you want to say You can communicate. It means that the report shows that, indeed, the problem has been attacked and meaningfully worked on. We require mastery performance of students whether they write reports, or take examinations, or present the results of their project, etc. If it is not good enough, if it is not written well, or if it is not communicated well, we require more work to be done.

The evaluation procedure

We have developed a detailed procedure for evaluation. The student evaluates himself and requests a certain number of credits for what he has done. The faculty members of the group who worked with him will discuss with each student his request. They will either approve, decrease, or increase the number of credits the student requests as measured by standards accepted by the faculty.

The student's credit request form goes to the Review Board and they review it together with the students and faculty members of each group: They re-evaluate it. This way we have developed checks and balances. The student evaluates not only himself but also his peers—the other students—and their work in the group. This is a learning process. This is very difficult at first but soon the student learns how to be fair to others but at the same time not to be too generous.

I think that by now you have a reasonable picture of how the projects work and how the self-paced learning takes place. Now, I would like to ask Dr. Florence Torda to talk about certain issues and those aspects of the Program which she and her colleagues developed.

Florence Torda

I would like to express again our pleasure in being here and our gratitude for your warm hospitality and for coming so far to listen to us talk about E^3. I want to say one thing to reassure you. When I sit there and listen to my husband describing the E^3 Program, it sounds very complicated to me also.

This morning I have taken on the responsibility for talking about some of the most subtle aspects of the program, some of the things that are more difficult to write about. We call them issues of particular interest. Probably a less poetic phrase should be added because some of the issues of particular interest are also simply difficulties.

Some unanticipated good effects....Students learn how to communicate

One of the points to note first about the program is that there were some unanticipated good effects of project participation. Students have learned to do many things which are never talked about or even recognized as belonging to engineering education. Some of these things sound like very simple skills, but they are none the less important skills in everyday professional life. I will give you some examples: Students have learned to make telephone calls to industries and other offices to gather information. They have learned to write business letters. They have learned how to express themselves better in everyday communication. When they sit around a table discussing the details of a project, we ask them to communicate to their fellow-students as though they were speaking to a client, a supervisor, or some outsider to report or explain in such a way that they can be understood. These are simple things, but ordinarily they are not taught in engineering school. Our students are learning to do these things and to do them effectively.

Students accept the goals of E^3

Another outcome which is interesting, and a little more difficult to express, is that students are beginning to "internalize" the goals of the program—that is, more genuinely accept those goals for themselves. This is significant in that it means that they like the image of themselves as knowledgeable people who have studied more broadly than their fellow-students in traditional programs

E^3 students are better informed

Although some E^3 students have resisted this broader study in the beginning, by the time they have participated in one or two projects they have a vested interest in thinking of themselves as more generally informed than they would have been. Additional reinforcement derives from communication of these positive attitudes to students who are not in E^3. The final consequence is that E^3 students begin to carry on the program for us. It might be said that the students are to an increasing extent doing the missionary work for us.

Students work closely with faculty
Faculty is friend and consultant
There are many ways of approaching problems

Another effect that we did not necessarily plan on is that when a student works so closely with the faculty (not in the manner in which I am speaking with you now—I am up here and you are out there—but when we sit around the table in a small room), the faculty is reduced to human scale. The faculty member is no longer the teacher but more the friend and consultant. This is important in several respects. We have already said that all project groups have at least two advisers: One who is an engineer or someone in the engineering sciences, and a second adviser who is a social scientist or someone representing the humanities. Sometimes project advisers disagree with each other, expressing differences of opinion in professional or related matters. Although disagreement with peers is something which is part of everyday professional life in more typical situations one tends to conceal this from students. Usually we think it undesirable to let students know we do not always see, as Americans say, "eye-to-eye." But E^3 students hear us disagree. They learn that there are alternative points of view, and that we are prepared to defend our positions. We feel this is important. We do not believe there is any one right way to approach a social or technical problem And we think it is better if you learn this very early rather than four years later when you are on your first job.

Some problems in E^3

One problem in connection with working so closely with students is that we come to know them well, and when we come to know people well, we have both a greater tolerance for their weaknesses and greater knowledge of their abilities. This more complete picture often complicates the evaluation of student work in areas which require somewhat subjective estimates. "Understanding" too well may make it more difficult to demand the quality of achievement commensurate with a student's ability. Awareness of this paradox, however, helps to guard against the problems it presents.

Close student-faculty interaction also enables the student to know more about his professors. The student is able to perceive the faculty member in a wider variety of situations or roles, thus increasing the opportunity for social as well as professional learning—if, indeed, the two can be separated.

Demands on faculty time

Another difficulty with E^3 is that in the beginning a great deal of time is required from the faculty. The faculty must be prepared to be present at the project meetings with students, of course, but we also have much need (because it is a new program) to communicate with each other to discuss our problems, our future plans, to evaluate where we are and where we go. So in the beginning, E^3 requires more time of the faculty than at a later point and you must be prepared to recognize this at the outset.

Faculty as resource persons

Faculty must be flexible

E^3 makes other somewhat unique demands on the faculty. In the capacity of project advisers, we must operate not so much as specialists in our respective areas of competence, but rather as general resource persons and guides. If I were teaching sociology to you this morning, I would know exactly what I want you to know, and it would be my responsibility to tell you what I expect of you. This is not the way we work in E^3. Nor is it a privilege in E^3 to work in one's special areas of interest unless these coincide with the needs of a particular project. E^3 requires that the faculty be flexible and prepared to learn something new. You may have to seek out a literature with which you are unfamiliar. You may be in a situation where students read the literature and inform you. We think such faculty openness to obtaining new knowledge is good for all concerned, and this emphasis may also be a strong point in recruiting faculty who are especially interested in furthering their own knowledge of technical and social problems. Not all faculty will share this inclination. Professors whose central concern lies in pursuing a very narrow area of specialization may not always be appropriate for a staff such as an E^3 type program requires.

Faculty has to have the right temperament

This leads to a third point in connection with faculty. It is essential that faculty have a temperament for this kind of program. You cannot always determine this in advance, for some people who we predicted would not be compatible with the program have become valuable members. Although judgment of faculty should be cautious in the beginning, people who do not after some experience endorse or embrace the general philosophy should not be involved in such a program.

Emotion and intellectual understanding

A related point is that many people think they understand the philosophy of the program but they do not. In reality, it is something one has to understand at the emotional level, as well as at the level of printed words. This distinction is crucial in that the attitudes and behaviors required for successful participation can be sustained only when commitment is supported by inner knowledge grounded in personal experience.

Integration of the humanities and the social sciences into the E^3 Program

Now I imagine that those of you who are here in the capacity of educators in the social sciences or the humanities wish to know more about how we bring the humanities or the social sciences to E^3. We have talked about this for at least four years and we are still talking about it and improving our strategies. We sincerely believe that unless a problem has some components which seem broader than the immediate technical problem, it should not be taken up as a project. As a matter of fact, we go beyond this and maintain that all problems have social implications in the sense that they emerge and are defined in a specific cultural context. This suggests various paths of study for enlarging the project members' understanding and approach to what may have been conceived originally as a purely technical matter. A project adviser must have the imagination to see these paths and help the students arrive at some plan for broader study.

Students work with a range of professors during four years

This plan will differ with each project and with each discipline. The disciplines are not all represented on each project; however, by the end of four years, each student will have worked with a range of professors in the humanities and social sciences whose influence will have been brought to bear on each project in some way. The integration of engineering with non-engineering study may seem less than ideal for some projects—and this has been a matter of concern—yet, lack of perfect fit does not justify failure to view the problem in larger context. This afternoon, during the period set aside for questions, there will be an opportunity to give you examples of the kinds of social science studies we have undertaken in connection with various projects.

American engineering students resist liberal arts

One more problem, already alluded to, is that American engineering students tend to resist courses in the liberal arts. They do not know why such study is necessary. In the beginning, one must be prepared to insist to E^3 students that the liberal arts are important for them, not only as persons but as engineers, and then, as I explained earlier, through their own efforts they will come to realize this themselves. Any program which is initiated along the lines of E^3 should anticipate some resistance on the part of students, for this is a very different kind of education with respect to both content and methods.

Evaluation of students on his own level

Finally, I wish to make some comments about the evaluation of students. It is necessary to evaluate each student in terms of his own class standing, that is, to assess his performance in terms of the knowledge and experience he has accumulated. A sophomore will be expected to do work of more difficult nature than a first year student and to assume the responsibility for acting on this expectation. But it is also the responsibility of the project advisers to be alert to the student's maturation, both early in the project as tasks are chosen and at project completion when formal evaluation occurs.

Evaluation taking account of individual differences

Another concern connected with evaluation revolves about the fact of individual differences. Some students are superior in certain respects to other students—they may have more intrinsic ability, interest, or background in certain areas of study, and E^3 advisers become aware of this through close interaction with students. Should we require more of students whom we know to be exceptionally capable, regardless of whether they are freshmen or seniors? In the social sciences and humanities, this question is especially pertinent because the criteria for mastery are more subjectively defined in these areas.

Faculty differs in student evaluation

Self knowledge is important

A problem, which is by no means confined to E^3, is that faculty members differ in their evaluations of students. There is nothing new about this. I am sure each of you would evaluate the same student from a slightly different perspective, depending on your knowledge of that student and your personal definitions of teaching and learning. And so we have differences of opinion among faculty members. We try to discuss and resolve these when we feel there is injustice to a student or that differences reveal inconsistent interpretations of program goals. But students must also be helped to learn that judgments by others are inevitable and, at best, arbitrary. Throughout life, self-knowledge should become the means through which students confront and appraise themselves.

In closing, I wish to say that I know E^3 sounds like a very difficult program to organize and to implement. In many ways that is true, but we have found that the difficulties can be surmounted if you don't let yourselves feel too overwhelmed by them in the beginning. That is why we prefer to talk freely to interested outsiders about the problems we have faced and how we have solved them, and to admit that there are areas in which we too are still developing and working to insure the full expression of the basic philosophy. Thank you.

T. Paul Torda

Difficulties students face

Well, indeed if the Program seems to be complicated, as soon as one starts working in it, one finds that not only does it have a strong internal consistency, but that it is also very different from other programs. Probably this is the reason why it sounds complicated. It simulates life outside of academia and that is not as simple as going to class. We have talked about some of the difficulties, but we also have to discuss the students' experiences. The first difficulty the student encounters is frustration because he is facing problems which have no known answers. He cannot look these up in a book and say, "Yes, I solved the problem correctly." But we face the same situation in life. We do not know the right answers of even the simplest problems we encounter.

The second difficulty shows up very soon, probably by the end of the first semester. The student is not used to working in groups and he also likes to be told what to do. If he cannot get used to working with others and cannot shoulder the responsibility for his own education, he will want to transfer out of the Program. Naturally, we help him to transfer to another program. If the student transfers out early, he loses little. But transferring from one program to another in academic life is always associated with some loss because the student did not take the "right" courses.

How to transfer to other curricula

When a student transfers out of the Program, we certify what he learned. In the basic sciences, it is very simple to correlate the knowledge the E^3 student learned with actual courses or parts of them. The student will get credit for those courses. In professional and project work we face a somewhat more difficult situation, because in conventional curricula, students encounter project and professional work later in their studies. The question is, what sort of credit should we give for professional and project work in the first year? However, this is becoming less and less of the problem because E^3 and similar programs start to influence other curricula and many engineering colleges today have a freshman design course. So the student can get credit for some equivalent work which would be in the particular curriculum he transfers into.

In humanities and social sciences, the student gets credit assigned by the appropriate faculty member in the same manner as he would get in regular classes. Thus, the faculty is able to assign a certain number of credits for a transfer student.

We developed several transcript forms and these are available for your inspection outside of this room. I also brought some sample transcripts of students who transferred out of the Program. You will be able to inspect the forms and see how we give credit and how we list what the student has learned. We try to do this in sufficient detail so that other people can understand it, other professors, the recorder, and also people in industry.

Students who leave E^3 are not dropouts

When students leave the Program, they are not dropouts because they transfer to other curricula in IIT. Out of 56 students originally applying the first year, we accepted 29. Out of this we lost two students as dropouts. So, less than 10 percent of the students participating dropped out of IIT, while ordinarily the dropout rate at IIT is 33 percent of the freshmen. This shows that our students do better than those in conventional curricula.

How students transfer into the Program

Transferring out or transferring in are two different processes. Transferring in is very simple because we accept anything the student knows, and we ask him to build on it to acquire additional knowledge and additional experience. We evaluate his transcript and discuss his plans with him We work out a study plan, a special curriculum for him He may join an appropriate project group and continue his studies. At times, he may find that the has to review some of the material he learned earlier and got credit for, but this is usually not a difficult task.

Cost effectiveness

Now I would like to talk about the last thing I mentioned. The budget. The E^3 Program, as any experimental and developmental program, is not cost effective and outside support is necessary In our case the National Science Foundation supplied the additional funds needed. However, if the program is successful when developed, it has to stand on its own. it has to be cost effective.

Until now, we did not devote much effort to recruiting because we had to work out other details of the Program. Also, we had little or no help from the IIT recruiters because the usual recruiting methods and the conventional standards set by IIT do not necessarily yield successful E^3 students However, during the past two years, we obtained some experience in understanding what kind of attributes will make a successful E^3 student and recently we began concerted efforts to recruit students into the Program.

Student/faculty ratio

We have roughly 30 students now and we wish to have between 100 and 140 students when the Program is fully developed. The thirty students and the eight and one half full-time equivalent faculty members yield a poor student to faculty ratio in academic life, it makes for a costly program However, when the Program is fully developed, we will still have between 8 and 9 full-time equivalent faculty members. Then, with the 100 to 140 students the student to faculty ratio will be between 12 to 1 and 15 to 1. Considering the financial aspects one finds that the tuition of between 55 and 60 students would cover the yearly E^3 budget based on the estimate that tuition pays between 55 to 65 percent of each department's budget. The tuition fees of 100 students will pay for 100 percent of the cost of the E^3 Program. Therefore, based on 100 to 140 students in the four years of E^3, its cost effectiveness is far better than is that of other departments at IIT.

Advanced E^3 students are tutors and models for lower classmen

How can we achieve this? Why are we more effective than other curricula? Because in E^3 the student is participating in the teaching of the less experienced students. He is working with them as tutor on modules and in projects. This is not done in order to make the program more cost effective, but in order to make the education, the learning more effective. E^3 just happens to be cheaper than ordinary curricula. I think that this is a very hopeful sign, that indeed we will have not only a high quality curriculum, but also E^3 will cost less than other curricula.

Faculty is on a part time assignment

I have said that E^3 has 8 to 9 full-time equivalent faculty members. However, besides those who carry heavy administrative duties, all faculty members in E^3 are assigned on a part-time basis. The reason for part-time faculty in E^3 is that we need a great variety of competence in the Program We need mathematicians, physicists, chemists, a variety of engineers, humanists, social scientists, etc These faculty members work one-third in E^3 and two-thirds in their own departments.

It is important for E^3 to have the variety of faculty, but it is also beneficial for faculty members from various departments to have the experience of working in an entirely different teaching environment. By rotating faculty, they transfer the "message" to the different departments. E^3 faculty should also be in contact professionally with their own disciplines.

During the development of the Program, each new year poses a "start-up." Therefore, we do need much greater number of faculty than the Program ordinarily would. For instance, we had to develop over five hundred learning modules in the different disciplines. Not only did we develop those, but we are rewriting them and improving upon them as we find them lacking in usefulness to the students.

Evaluation of the E³ Program
Student internship

I want to conclude this part of the seminar with a few remarks on the evaluation of our Program by experts outside E³. We were visited by a very competent staff of evaluators last November because the National Science Foundation was to give us the final go-ahead for the last two years and also the needed funds. Besides these visitors, twenty-two of our proposals were sent out by the National Science Foundation to top level academic, governmental, and industrial people for evaluation. Apparently, the E³ Program received high marks by these evaluators as well as by the visiting team, since we received full support from the National Science Foundation. Incidentally, one of these evaluators was the recruiting manager of one of the largest industrial organizations in the United States. He told the National Science Foundation that if our graduates will be able to fulfill only part of what we say they will be able to do, he wants all of them in his own organization. This, as well as other indicators, make us confident that our graduates will not have any difficulty finding jobs. I am also quite confident that they will perform excellent work whatever they undertake. In order to facilitate their acceptance by employers, we are establishing internships for the students. The students will be able to work in different organizations during summers, or during a semester or so, and this will be a part of their education. We plan to give credit for this work if it can be proven that their experience was a continuation of the student's education. This, of course, establishes also communication between E³ and industry. Employers and engineers will get to know our students and the Program, and our students will be able to test reality and their own competence in comparison with others in industry.

If you still have a few minutes patience I would like to show a few slides which I have brought along in order to give you some feeling of the informality of the program we are running.

(slides)

Thank you very much for your attention. (Applause)

QUESTIONS AND ANSWERS ON E³

Tomoo Kimoto

Q: What do you mean by E³ experience? Please explain it concretely in comparison with conventional curricula.

A: We want to give the students real engineering experience in problem recognition and problem solving. For us, experience includes many other activities as well. The investigation of the history of the problem, where it arises, what has been done before, comparison of the present with past relevant technology, what new knowledge is needed to solve this problem, what is the new approach which best fits this situation—go to the library, search the literature, determine new applicable technologies, etc. In short, we would like to engage the students in work on real problems and their ramifications and substitute this for the usual classroom approach. This is one major difference between E³ and conventional curricula and this is what we mean by experience

Q: At what stage do you give your students the tasks of fundamental practice, shop work and drawing prior to the problem solving projects?

A: Fundamentals, drawings, etc., are not studied prior to project work but are integrated with it Each project is divided by the students themselves into several tasks. These tasks are coordinated by one student, but each task is performed by different group members. The particular task of each student requires study, work, and coordinated effort with the others. The student responsible for completing his task has to study in depth, and this is where his learning occurs on a mastery level.

Michio Araki

Q: Please tell me the details of transfers into/from the E[3] Program.

A: What happens to those transferring in is very simple. We discuss with each student what he knows, and then plan his continued learning. Those who transfer out of the E[3] Program receive a very detailed transcript enumerating what they have learned and what roles they played in the projects in which they participated. Naturally, the credit distribution they earned in E[3] is also stated.

Q: What counseling did you give to the transfer students?

A: We try to find out the student's goal, what he wants to do after graduation, and we try to work out a program according to this need. For example, one of the students who transferred from chemistry wants to work in the field of biological engineering. A natural project for him was the man-made lake project which he joined. He has a good chemistry background but no background in biology and he could study biology on that project.

Q: Why did some students transfer out?

A: Most students entering engineering curricula do not know what engineering is. When they begin to understand what engineering is, some think that it is not a career for them. They transfer to other curricula. Others want to continue in engineering but they think that the regular class routine suits them better. We try to understand their problems and advise them to transfer to the particular curriculum which suits their goals. All our faculty members help students to clarify their plans.

Dr. F. Torda

When students indicate that they are not happy with the Program, we ask them to think about it very carefully, and we make ourselves available for discussion. We do not try to keep students in the Program if we feel that it is better for them to leave, we help them to understand what their own needs are.

Dr. T. P. Torda

When students find it difficult to work with others in groups, they may transfer out. When students find it difficult to pace their own studies, when they prefer classroom, homework, and more conventional examination situations, they may also wish to leave the Program These are the major reasons for transferring out in addition to the general discovery of being in the wrong field, as cited earlier.

Yasutaka Nakamura

Q: You stated the E[3] students are supposed to take 136 credits for graduation Are all the credits taken in E[3]?

A All the credits are earned in the E[3] Program. If a student wants to work in fields which we do not offer in E[3], to take music or some courses in the arts, he may earn those credits in regular classroom work outside E[3].

Q: Do you accept those credits which transfer students have already earned in the conventional disciplines?

A: Any credit which is accepted by the Illinois Institute of Technology is accepted by us. What happens often is that a student has finished all the mathematics requirements before he comes to E[3]. All those credits are accepted by E[3], but he may have forgotten some of the material and in that case he will need to review it. We help him if he has difficulties. We cannot give additional credits because he puts in additional work. Here is an interesting problem which may help you to understand why we put so much emphasis on learning when the need arises. A transfer student may have received a "C," or several "C's" in mathematics. Having legitimately passed the course or courses, we gave him credit in E[3]. Now there is a contradiction when the student needs to apply the material and he does not know it. He has to learn more. And so, eventually, he achieves mastery in that part which he relearns.

Koichi Uesaki

Q: You won't succeed in E^3 Program if the students are not so bright, will you?

A: Those students who go into engineering at Illinois Institute of Technology are pre-selected for their ability to succeed in the usual engineering subjects, and E^3 students must have met these admission requirements. However, there is great variation in aptitude among those students who are accepted by IIT. Within this variation, attributes other than intellectual abilities contribute to success in E^3. This program is not just for the students who score highest on traditional selection measures.

Q: According to the E^3 materials you gave us, the load of faculty seems to be very heavy

A: No, this is not really so. At the beginning any experimental program means extra work and we have more faculty members now than we will have once the program is fully established. Then, the assignment to E^3 will mean the same as in other departments. If I may elaborate on this, it will work as follows At IIT, the total commitment by faculty members is approximately forty hours a week. This is not all teaching, but includes committee work, research, and writing papers, etc., also. So one-third assignment of teaching means roughly thirteen hours per week Now let us see what is a faculty member's time devoted to one project and what are his other commitments in E^3? On each project, all project members (students and faculty) meet for one hour each week. During this time, they discuss what went on last week and make plans for next week. Each of the faculty members will work with students separately for another hour each week. This means that the engineer will work for one hour with the students on the project in his field, and a social scientist will meet for one hour with the students to discuss the social problems of the project. Therefore, a faculty member works on a project for two hours each week. However, at times work will accumulate Therefore, let us allow three hours per week for each faculty member for each project

In addition to project work, we have Monday Open, and a weekly faculty meeting. These represent three hours per week. Therefore, a faculty member assigned to E^3 on a one-third basis may easily work on two projects (6 hours per week) and participate in the weekly student meeting and in the weekly staff meeting (3 hours per week). This is a total of 9 hours per week commitment instead of the 13 hours per week assigned time. So there are four hours each week for increased load, if any. If a faculty member works on some other tasks, for instance, he gives a seminar or writes modules, then he will work only on one project So there is ample latitude for participation on this basis.

Q: Isn't it difficult for students to obtain systematic knowledge on a project basis? I am afraid they cannot be successful if they deal with real problems alone.

A: It is not difficult for students to obtain systematic knowledge in E^3 if the projects are planned properly. Such planning, of course, is the task of the participating faculty. In addition, the Program Design Committee makes sure that each student acquires systematic knowledge necessary for graduation.

Your question brings up another important point, the difference between the content of the curriculum and the knowledge the student acquires I would like to discuss the learning-forgetting process. The student learns before the examinations and then forgets most of what he learned—we all do. Then, new material is learned and most of that is forgotten also. In regular courses, the semester examination arrives, and the student re-learns all the material but forgets most of it right after the examination. The argument is always advanced that examinations are good because the student reviews the materials. I think that the examinations are only good for making the students anxious. The learning-retention process has been studied by many educators and it has been found that application of the learned material reinforces retention. If you learn and apply it, you don't retain all the material, but at least that part which you are using. You learn new material and apply that and retain more. And so on. If you do not use this knowledge, again you forget, but if next year you are the proctor and you help a new student who learns this material, then the learning and retention will be increasing.

Masao Seki

Q: Professor Torda's story is drastic and interesting, I think, to most of us whose education is conventional. But you go in a sense too far in saying the retention of what a student has learned drops to zero in conventional education. Why don't you take motivation of students and educational content in conventional curriculum into consideration?

A: First, I wish to point out that my own education was along conventional lines also. Then we have to consider the learning-retention function. As I have tried to point out, we learn something and it is stored, more or less, in our mind, but forget what we learned unless we are using the knowledge We apply it. This, of course, happens in conventional learning situations (classroom, laboratory, etc.,) as well as in E^3. However, in conventional curricula, subject matter is taught "per se"—learn it now, use it later—and in E^3 we try to learn when we need to apply the knowledge (first reinforcement) and somewhat later we help another student to learn it (second, more sophisticated reinforcement). In this manner, the student has a better chance for retention than in the conventional method, and this has been proven by research. The results of such research are available in the open literature. I did not want to imply that a student does not learn anything in a conventional course situation, I only wanted to point out that a student has a much better chance for retention of what he learned if his learning is reinforced. I also wanted to make the point that, in our experience, problem generated motivation is more effective than teacher generated motivation—learn this subject because you will need it later—.

Dr. F. Torda

E^3 does not prevent students from learning in the more traditional way. If the student is enthused over his studies, we would hope, and it turns out that it happens this way, that he is motivated then to pursue the particular subject in greater depth and with greater intensity. What we are trying to do is to instill or cultivate a positive attitude toward learning so that one is a perpetual learner or a perpetual inquisitive person. If a student says at the end of a traditional course or at the end of an E^3 project that only now does he begin to realize how much he does *not* know, then we should all congratulate ourselves as teachers.

--- five minutes' recess ---

Shoichi Karoji

Q: I will ask you one question about the employment of E^3 graduates. As the E^3 Program is specific, don't you think the employment will be also specific or limited to some area because of their courses or subjects attained? What is your prospect?

A: I don't really understand what you mean by "limited," since we are trying to educate people who are much broader than ordinarily graduates from a mechanical engineering, or a civil engineering, or another curriculum. We feel that the graduate from E^3 will have broader knowledge. Would you please then define what you mean by "limited?"

Q: Those students will not gain a job in any fields but some special fields.

A: Well, I don't really think so. Of course I am only guessing since we have no graduates as yet

Q: What do you think the percentage of the students in E^3 will be who would like to continue to study in the graduate course, or are you recommending them to do so or urging them to do so?

A: In E^3 we try not to make recommendations in general terms but try to find out the needs and interests of each student. We discuss with him possible ways to achieve his goal and let him decide whether he wants to go to graduate school or not. I have said that we have no graduates as yet, so we can only make guesses. One of the students who transferred from another college and will be senior next year is very bright, and he came to IIT because he wanted to go to graduate school in aeronautical engineering. Recently, he came to my office and asked my advice how he could explore graduate schools for study, not in aeronautical engineering but somewhere where he can serve society. I do not know whether this answers your question. At least two students have indicated that they will go to graduate school, but we have only three seniors next year. This would indicate that two out of three will go to graduate school, but it is really impossible to make predictions about trends at this stage of the Program. However, we are sure that they will have no difficulties in getting accepted in graduate schools.

Kenji Sekiguchi

Q: Mr. Torda, I have several questions. One is, how many projects does a student cover in one semester or in one academic year? And are these projects which one student chooses related to each other?

A: In this program, duration of a project does not necessarily coincide with the semester, but roughly it is the semester. So in four years a student will participate in a minimum of eight projects. If a student has special interests, he can work on additional projects parallel to the main project or during the summers. He has three summers at a minimum, so he can do eleven to fifteen projects Your second question is a very important one. We discourage students from working in the same field, particularly during the first two years, because we want to introduce him to different areas of basic knowledge during the first half of his studies. If a student then shows particular interest in a special area, he may specialize during the third and fourth years of study. We make this possible, but in general we discourage specialization.

Q: Let me ask one more question. You said that some students may be interested in subjects which are not included in the E^3 Program, for example, biology, history, or literature. If one particular engineering student wants to study literature or philosophy, what do you suggest? I mean, do you have any good advice for those students who want to learn anything which is not prepared in the E^3 Program?

A: We encourage students to take classes in those areas which are not covered by E^3, because those do not interfere with performance in the Program. We have representatives from the humanities in the Program and the student has a good opportunity to explore his interest, how best he can follow it, and which courses to take in addition to his work in E^3.

Dr. F. Torda

In reality, a student is very busy in the E^3 Program, and this includes the responsibility for completing the liberal arts and humanities components of the projects. Although we certainly encourage them and are very pleased when students express a wish to augment their education, we must add that, in reality, not many students elect to do this because of time pressure. They work very hard in E^3.

Hatta

Q: Before the intermission, Mrs. Torda pointed out that one of the main objectives of this program is to educate students so that they become very curious people. I think that is a very important objective, and most people will agree that that is a desirable target of any education. However, I suspect some people may fear that students who don't have their solid education in some specific disciplines like mathematics or physics or a sub-branch of engineering may get lost, if they go to the problem solving program directly. Some of the questions asked before the intermission expressed such apprehension. I presume, however, that few people will have such fear if students get problem-solving oriented education at the graduate school level after obtaining solid education in some specific discipline in undergraduate level This system seems to me especially promising since students with different specializations can collabolate in problem solving. So, my question is this. What would be the advantages and disadvantages of that kind of program compared with your E^3 Program?

A: A very silly answer to that question would be "Why waste four years?" But seriously, why not start with the freshman instead of delaying the process until graduate studies? I cannot speak about Japanese educational processes because I really do not know the curricula sufficiently. So I have to answer this question in terms of the American system. We usually re-learn in graduate school most of what we have learned during undergraduate years. In other words, the graduate student has forgotten what he learned and cannot recall subject matter in a different context. This is unfortunate, but it is true within my experience and I am sure all of you have had similar experiences.

The interdisciplinary approach to solving engineering problems really does not have to be delayed until graduate school. I don't think that the manner in which subjects have been learned in undergraduate school is helpful for such purpose. Up to now, graduate study has been directed toward research in America. During the last four or five years this has been changing, and there is a bifurcation in graduate studies toward engineering or toward research. But there are no real indicators that graduate engineering programs emerge similar in intent to E^3. Also, since the student has not been prepared during his undergraduate years for solving real problems, as a graduate student he would face the same difficulties as our freshman faces in the first year of E^3. To sum it up, I don't see any advantages in delaying this process if your goal is to achieve our type of education.

Dr. F. Torda

The current movement in education seems to be to push this type of approach to learning back all the way to the earliest years—the so-called schools without walls, or the programs in the early years which now mix students from all levels and stresses the fact that they can complement each other, that they each have something to give to the other So in a sense the tendency is to go in the opposite direction, to start very early. And one can even say that technical education is really in this respect behind the larger movement in education which is to incorporate life or reality with schooling from the very outset.

Dr. T. P. Torda

I would like to mention in this connection that we have last year established an experimental program for high school juniors which lasted eight Saturdays and was devoted to problem solving Next year we are going to establish this on a regular basis. I hope that we will be able to extend such opportunity to high school sophomores and introduce them to problem solving. The goal is to allow students to make choices of engineering or sciences as careers more intelligently. By the time they come to a university or college as freshmen, they will have much less difficulties in understanding what the problem solving process is and what engineering is all about.

Q: But does it mean that students really don't need a systematic education, say, mathematics, independent from any other project-oriented courses? I would think that students who want to learn, say, topology, would certainly need analysis before that. He simply needs one-year full courses in analysis and, before that, he will probably need elemental calculus And I think there has got to be some systematic education, at least along with this kind of program.

A: I agree with your statement about the prerequisites for, say, topology But I do not think that analysis, or calculus, or any other discipline *has* to be learned in courses. However, I want to state quite emphatically that E^3 is systematic as are all good educational systems. I pointed out earlier that the prerequisites are spelled out in each learning module. We build on what the student knows and if we are successful, *and we are successful*, then we lead the students to the recognition that they have to learn more in all subjects, in mathematics, physics, chemistry, etc., but that does not mean that they have to learn these in class Again and again I wish to state that I do not think that telling the students "You learn this because you will need it" is more effective than if the student comes to the recognition. "I want to solve this problem. I need some tools: help me find the material I need and I will learn it." I do not think that our student will learn less mathematics, or learn it less well, than any other engineering student. I think the contrary is true

Dr. F. Torda

I want to go back again to the broader case in education. Many American colleges are beginning to abandon the standard survey course. I don't know what the Japanese equivalent of that course is, but it is the one in which you teach an introductory course in a specific discipline, with the hope that in that course you give the students a bird's eye view, and from there they can begin to take courses in more substantive areas. Now we start to feel that theory in the social science disciplines can be approached directly from any subject matter so that a beginning student who feels that he does not want to take a course called "Introduction to Sociology," but rather that his interest is captured by a title of a course, perhaps called "Juvenile Delinquency," will still, if he has a good teacher and a good learning experience, be led to the important theoretical material despite his lack of previous knowledge.

Shimizu

Q: Is there any certification system for professional engineers in your country? If there is, what plan do you have to get students to prepare for the examination?

A: In America, there is the certification for professional engineers which is given by the Society of Professional Engineers, or by different states.—Each state has certification examinations.—This certification is needed only if an engineer performs public works and also in some very specific other areas. If an IIT graduate, the graduate from conventional curricula, wants to get a certificate, he has to study specially for that. He is not prepared to take the examination, based on his learning in a conventional curriculum alone. Therefore, if an E^3 graduate wants to take a certification examination, he will also go to the same course as the IIT graduate from mechanical, electrical, and other engineering departments.

Q: After transferring out?

A: No. this is an extra course (the course preparing a student for the professional examination This does not belong to any curriculum. But this question came up in Latin America also last year when we visited several countries, and there the certification is required by the state. There is absolutely no difficulty in preparing an E^3 student for the examination. It is not more difficult than learning mathematics or physics or chemistry on your own.

Matake

Q: Can you get easily right resources enough, after you have selected the theme and drawn up the curriculum for it?

A: Yes, but usually every school has certain limited resources. We also have limited resources at IIT. So we have to live within these and if a student wants to study astronomy, we cannot give him much help, he has to go to another school. Within the limitations, which are pretty broad, we can help the student to fulfill his needs in any special area. The theme helps to introduce the students to certain areas of learning which they have not encountered before and has to be compatible with available faculty competence.

Q: The theme changes every year, and so you look for new resources when you come to a new theme?

A: The answer is both yes and no. We are rotating faculty. We needed more faculty from the areas of thermodynamics, heat transfer, etc., last year than we will need next year. So usually we can anticipate the need and enroll the type of faculty we will need. This also helps the different departments in their own planning.

Dr. F. Torda

However, the project group is not limited to the capability of the project advisers. It is the responsibility of the project advisers to direct students to all of the resources on the campus Theoretically, every faculty member on the campus is available to IIT students. Sometimes students may be reluctant to seek out this help, but it is an important aspect of their education that they learn to overcome this reluctance and approach the people who are capable of helping them in specific technical areas.

Kaita

Q: Wouldn't you find it rather difficult to carry out the E^3 Program in our educational circumstances with limited faculty?

A: In referring also to your written questions, I want to answer them in a broader sense. I think that in certain aspects you are lucky, and in others you are struggling as a beginning college Let us hope that your resources will be increasing as the demands require. If you want to establish a new program, it does not matter what the new program is, it is not very good to "jump in" and do the whole thing in one step. I can recall experiences in this respect in the United States. There are great difficulties if a whole college is going over immediately to a new program, no matter how good the new program is. As we are using the student's resources, he brings some knowledge with him and we build on that—so we have to use the resources of the available faculty, whatever we have. If we cannot teach philosophy because we do not have a philosopher, then, of course, the student will be the poorer, will have a less rounded education, but he will probably be better in aesthetics, or in whatever other field faculty is available.

I stated at the very beginning that if you accept the philosophy that motivation to learning is better than ordering people to learn, within certain limits, what you teach, or what your program is is really less important because the student will be able to learn on his own if he is motivated. I would like to say that if you have limited faculty resources, you have to use the limited faculty and try to enlarge it in the future as the need arises. I see it as a disadvantage, but not a deterrent. Does this answer your question?

Q: Thank you very much.

A: But I think you had another question, at least in writing, and that refers more to numbers. The question was that there are 600 students in three departments with a small faculty. I imagine it would be difficult to detach faculty to establish an E^3 Program. If any school wants to establish an E^3 Program, or any other new one, my recommendation would be to start on a small scale. Take a few students from the different years and two or three interested faculty members, and start two or three projects only. Do not take 600 students and try to start fifty, sixty, or seventy projects. That will kill your efforts. Take a few, and if you are successful, go on and enlarge the program. Such enlargement will go on automatically, for more students and more faculty will become interested, and administration will have to help in hiring additional staff. I hope that your other question is answered also.

Dr. F. Torda

In response to the same question, a very small core of dedicated faculty members can have a very significant impact on the students. I would like to stress again that the quality of the student-faculty relationship is very different, that the authoritarian relationship to the student is absent in E^3. When a faculty member has an opportunity to interact on such a small-scale basis with students, the nature of his particular discipline may be secondary to the quality of what he represents. What he teaches may be less important than what he expresses in other ways.

Tsugawa

Q: Your program seems to me to tend toward chemical engineering, such as fluid dynamics, statistical mechanics, and thermodynamics, but I think students do not necessarily want to study such engineering alone. Some students will feel they are forced to do projects, because they want to study, for example, electrical engineering, or architectural engineering.

A: E^3 is designed as a multidisciplinary program. We do not want to compete with the other departments. So, if a student comes to E^3 and says "I want to become an electrical engineer," we send him to that department. But if an E^3 student in the third year says "I would like to know more about communication, or medical instrumentation, or whatever," then he can specialize in those areas. If a student wants to study other specialties in his junior or senior year, let us say electrical engineering, then we assign as his adviser the professor from electrical engineering. By taking three or four additional courses, the student can get two degrees simultaneously: The Bachelor of Science in Engineering and the Bachelor of Science in Electrical Engineering.

Q: Do you accept credits of those students who transfer into your Program from other colleges or universities than IIT?

A: This is a very important question which has to be answered in two parts. The direct answer is yes. It does not matter where he comes from, we in E^3 accept his credits. However, IIT may not accept all the credits from another college, and we have no control over this.

Up to now, I had no opportunity to point out one very important constraint and I wish to state it now. I said that for graduation a student needs certain number of credits. But a hundred thirty-six credits, or hundred twenty-eight credits, or whatever the number is do not make an engineer. All the students in E^3 know that they have to prove to the faculty that they are qualified to get a degree, and that this does not depend on the number of credits they accumulated.

This is a very important difference between our program and other engineering programs at IIT

Q: And do you accept their humanities credits also?

A: Yes, as long as IIT accepts these. I did not want to say that we accept his credits and IIT does not. IIT first has to accept the student. Only then may we accept him. But IIT may not accept all the transfer credits, and we cannot accept more than what IIT does.

Dr. T. P. Torda

I will be glad to accept additional questions in writing—as long as they are in English—and will answer them in writing. At this time I would like to thank Mr. Matsuo very much for the very tiring and difficult task he has done so excellently in acting as an interpreter. I think that his job was the most difficult one this afternoon, and certainly we should give him a big hand (Applause) I would also like to thank you for your very interesting and incisive questions which are most important for us in the further development of the E^3 Program. Thank you very much

QUESTIONS AND ANSWERS ON E^3 IN WRITING

Seki

Q: How much is the cost of education in an ordinary program and in E^3 Program each for a student per year at IIT? And what does the cost consist of?

> **Note:** I mean by the "cost" not what a student pays you for his education, but what you spend to educate him

A: Presently, the average tuition of a student pays for between 55 percent and 65 percent of the actual cost of his education. This means that between 35 percent and 45 percent of the cost has to be made up by contributions from industry, by state and federal subsidies, and from other sources. The average student-faculty ratio at IIT is 11 to 1 The projected budget for E^3 during the fifth year of implementation—the first year beyond outside support—is such that 55 to 65 students will have to be enrolled in order to match the prevalent cost effectiveness of other programs. Since we anticipate more than 100 students in the Program, E^3 will be far more cost effective than other programs at IIT Incidentally, the projected student to faculty ratio in E^3 will be between 13 to 1 and 15 to 1.

Q: What are the research funds for E^3 staff (especially faculty members), independently from the E^3 Program implementation? That is, what are their research conditions?

A: Presently, no research activity exists within E^3 other than the ongoing educational research Part-time E^3 faculty members continue to carry out (or not) research in their own departments as they have done previous to being assigned to E^3

Q: About learning modules, e.g., those of dynamics. What is the fundamental learning matter of dynamics? And from what point of view do you select the fundamental matter?

A: All learning modules follow the contents of accepted books in the IIT undergraduate curriculum

Q: You say professional education is carried out in project work in E^3 Then do you think that student who wants to learn, e.g., mechanical engineering can in principle obtain systematic knowledge of mechanical engineering? If possible, please explain the reason in detail

A: At IIT, E^3 is designed as an interdisciplinary curriculum leading to the BSE degree. If a student wants to study mechanical engineering, he is referred to the Mechanical Engineering Department However, I wish to state again that the philosophy and methodology of E^3 are applicable to education in special curricula also, for instance, mechanical engineering, etc. Our particular curriculum is, however, interdisciplinary

Q: I would like you to give me a more concrete example of integration of the humanities and social sciences into project work

F. Torda

A: I will illustrate with a project which was concerned with a system for tornado detection and warnings to persons in immediate danger The students debated the technical merits of installing an electronic device in individual households making it the responsibility of household memto be alert to danger signals. In addition to examining the possibilities for mechanical failure, it was necessary also to investigte the likelihood and variability of human compliance with emergency warnings and the basis on which such a device should be installed, as a voluntary or as a government responsibility. The question of human compliance led to study of the literature on disaster research and involved philosophical considerations related to conceptions of destiny. The issue of distribution led to discussng of the political and economic implications of each strategy. The students learned that solving the technical aspects of the detection system would be naive without a better understanding of the social forces which would prevent effective adaptation to it.

Q: Why is it that there are three political science faculty and three humanities faculty, while you have only one sociology member in your HSS staff? And by what principle did you decide to have six faculty in mechanical engineering, three in electrical engineering, and very few in other fields in your engineering?

A: In the reports, the lists of participating faculty are cumulative and those named from the same departments do not necessarily work on E^3 simultaneously. For instance, one electrical engineering faculty worked at a time and not three, etc. Faculty members are recruited according to anticipated needs and within the constraints of strengths and weaknesses of respective departments. Incidentally, at HIT, history, linguistics, philosophy, literature, and science information are all designated as "humanities" and this may contribute to misunderstandings about faculty distribution.

Tamano

Q: To what extent [illegible] the final reports carried out in content compared with the graduation thesis in conventional courses?

A: There is no document in conventional curricula corresponding to these final reports of E projects. The latter are similar to those issued in research projects. "Graduation thesis" does not exist in conventional curricula at HIT.

Q: I think it would be more appropriate for the E^3 Program if sometimes students could work thoroughly centered about one theme area. What is your opinion, Dr. Jorda?

A: If I understand the question correctly, it suggests that each student should work on projects in one theme area throughout his studies. E^3 being an interdisciplinary program, we insist that each student should be learning as much as possible in the various engineering disciplines.

PART TWO

PANEL DISCUSSION

Cochairmen:

Dr. Masamitsu Kawakami — Dr. Koji Nakamura

Panellers:

Professor Kenichi Iijima	Electrical Engineering Member of Japanese delegation to U.S. - Japan Joint Seminar on Engineering Education, 1973
Professor Tominaga Keii	Chemical Engineering
Mr. Shingi Saito	Humanities President, Tsuruoka College of Technology
Professor Masao Seki	Research Institute for Higher Education, Hiroshima University
Professor Tomoe Kimoto	Mechanical Engineering Reporter of "The Comprehensive Practice Center" at Ariake College of Technology