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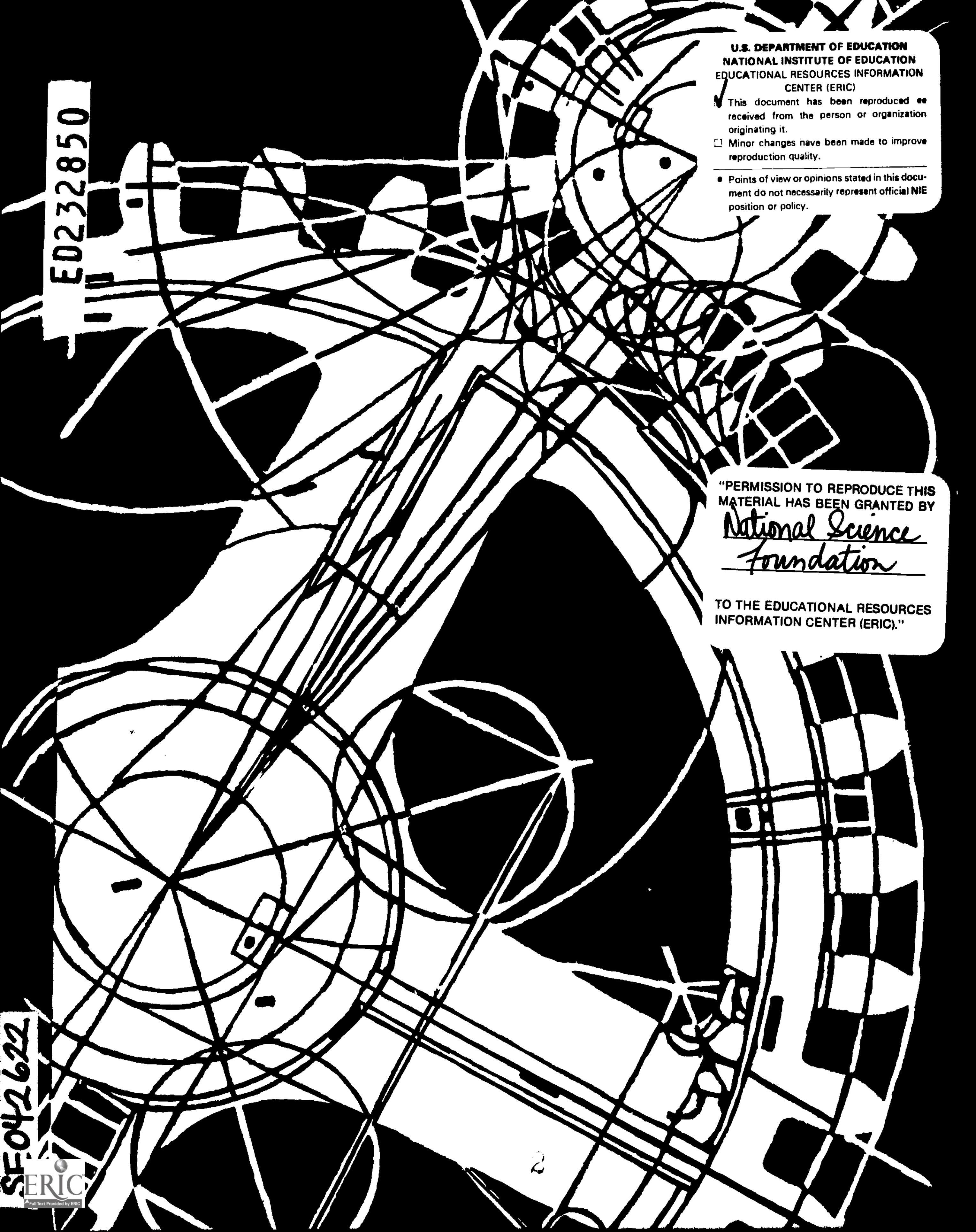
ABSTRACT

A 3-year project was developed to increase students' abilities to perform competently as professional engineers. The project sought to infuse into existing courses concern for, practice with, and development of three competencies critical to professional success: problem-solving, communication, and value clarification. Eight elementary and advanced courses, representing about a sixth of a student's total courses were modified over the 3-year period and were taught to one or more of three successive classes of students recruited for the project. This report contains an essay on developing professional competence courses and the materials actually used in three courses. It is designed to assist faculty members at other engineering schools in modifying their own courses, by providing some of the philosophical underpinings of competence development and assessment, and by providing in-depth examples of their application to the three courses. The courses described are: (1) Engineering Graphics (including course introduction, course schedule/outline, and course modules); (2) Introduction to Politics (including course introduction, summary course outline, and course assignments by week with detailed course outline segments); and (3) Environmental Fundamentals (including course introduction, technical syllabus, and course assignments and projects with competence component). The latter course focuses on air pollution, water pollution, and environmental law. (JN)

# Professional Competence Development at The Cooper Union School of Engineering





School of Engineering
The Cooper Union for the Advancement of Science and Art
41 Cooper Square
New York, NY 10003

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The Cooper Union for the Advancement of Science and Art, established in 1859, is a private, tuition-free institution of higher learning. Peter Cooper's legacy supports the School of Art, the School of Architecture, and the School of Engineering, all of which grant degrees; the Faculty of Liberal Arts and Sciences, and the Division of Adult Education, which administers the historic Cooper Union Forum. The Cooper Union is located at Cooper Square, New York, NY 10003.

This report prepared in collaboration with Educational Facilities Laboratories, a division of the Academy for Educational Development, New York, NY. Ellen Bussard is the primary author.

PROFESSIONAL COMPETENCE DEVELOPMENT AT THE COOPER UNION SCHOOL OF ENGINEERING

Course Development and Course Materials

CONTENTS

## INTRODUCTION

The Cooper Union School of Engineering recently completed a three-year project, funded by the National Science Foundation, to increase students' abilities to perform competently as professional engineers.

The project sought to infuse into existing courses concern for, practice with, and development of three competences critical to professional success: problem-solving, communication, and value clarification. Eight elementary and advanced courses, representing about a sixth of a student's total courses at The Cooper Union, were modified over the three-year period and were taught to one or more of three successive classes of students recruited for the project.

This is the third in a series of publications on The Cooper Union project. The first report, "Project Highlights," provides a brief overview of the project and the results. The second publication, "Project Report," documents the origin, design, implementation, and results of the project.

This report contains an essay on developing professional competence courses and materials actually used in three courses at The Cooper Union. It is designed to assist faculty members at other engineering schools to modify their <u>own</u> courses, by providing some of the philosophical underpinnings of competence development and assessment, and by providing in-depth examples of their application to three courses.

The Cooper Union professional competence development project was designed around a few basic ground rules:

1. Competence development would not be added as an extra or isolated subject of study.

2. The technical and academic curriculum would not be reduced to accommodate competence training.

3. Competence development would be integrated within selected existing courses, through modifications of these courses.

Faculty members who volunteered to participate in the project attended a series of workshops and received a core set of materials on developing competence-based courses. Actual modifications to courses, illustrated in the course materials in this publication, were made by faculty members independently. The course materials, then, reflect three individual efforts at application of professional competence development concepts to three very different courses.

The courses included are:

Engineering Graphics, the first part of a lower level course required of all students.

Introduction to Politics, a lower level one-semester course required of all students.

Environmental Fundamentals, an upper level, one-semester, elective seminar.

This selection is representative of the variety of the courses modified at The Cooper Union. Others included Basic Humanities; Mechanics; Introductory Physics Laboratory; Analytic Geometry, Vectors, and Matrices and Calculus; Engineering Problem-Solving and Guided Design; and Linear Systems.

Our intention is to provide guidance by analogy. The materials in this publication are not "how to" materials in a traditional sense. Faculty members at The Cooper Union feel strongly that no single course could be successfully "exported" to another school. They stress the importance of the process of modifying one's own courses, of developing ways of incorporating professional competence consciousness into the subject matter that complement one's own teaching style.

A careful reading of the materials included here should help instructors elsewhere introduce changes into their courses which will increase students' professional competences.

NOTES ON PROFESSIONAL COMPETENCE COURSE DEVELOPMENT*

The goal of professional education is to develop students' abilities to perform competently as practicing professionals in their field and within the wider social context of their field. Academic and industrial engineers agree that engineers coming out of school ought to be competent, and academics would certainly say that they teach their students to be competent. Who, indeed, would claim to train anybody for "incompetence?"

However, the relationship between academic training and sustained professional competence is anything but straightforward.

In the academic world, a competent student is often equated with a "good student" -- one who learns well and fast and gets high grades in all courses. Many studies have shown that academic achievement, per se, correlates poorly with significant adult accomplishments such as quality of research work, scientific reputation, overall performance, cultural interests, or citizenship activities. These studies claim that attributes contributing to success are others: drive, creativity, persuasiveness, leadership, problem-solving ability, oral communication, identification with the business world and with a company, skill in interpersonal relations, willingness to work, intelligence, energy, and talent. A few go so far as to say that "high academic success, to the extent that it predicts anything at all about adult experience, may be more closely associated with psychological immaturity and adaptive problems."**

Rapid expansion of scientific and technical knowledge, and increasing complexity of engineering problems pose other difficulties to the academic world. The specific subject matter that students study quickly becomes obsolete. Studies conducted at UCLA in the late 1960's*** confirmed that ten years after graduation few people use the subject matter they studied in

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* Adapted from an essay by Dr. J. LeMée, Professor of Mechanical Engineering, Project Director, The Cooper Union.

** Heath, quoted in Jacobson, R.L., "Does High Academic Achievement Create Problems Later On?," Chronicle of Higher Education, May 23, 1977, p.4.

*** Rosenstein, A., "A Study of a Profession and Professional Education," UCLA Report EFP 7-68.

school. In basic areas, the "half life" of subject matter may be as short as five years, and in the most sophisticated and rapidly developing areas technical subjects studied may be obsolete even at graduation.

Finally, the nature of professional career patterns raises questions about schooling. As the years go by, professional engineers often move from purely technological fields to positions in management or administration. Even within the technical spheres people move from field to field. Either way, it is highly unlikely that engineers even a few years after graduation will work professionally in areas corresponding to their academic training, however excellent and broad they may have been.

What, then should students be taught in school? What is the function of subject matter? How can the faculty teach students what they will need most in professional practice? If we can identify what it is that students learn through academic training -- directly or indirectly -- that is most useful in professional life, should we not seek to emphasize and cultivate "it?"

A short historical digression may sharpen the dilemma. In ancient China, examinations for the civil service tested candidates on their depth of knowledge and skill in poetry, literature, and calligraphy. For centuries the French meritocracy has been based on mathematics. The connection between the subject matter of examinations in these two cultures and the ability to later administer governments, command armies, or organize and manage businesses is not obvious.

The skills that are developed in the course of, and almost tangentially to, academic study that seem to have most long term benefit are the life-long skills or general <u>competences</u> that are transferable between subjects and situations. These are the same skills that are important to career success -- creativity and innovation, problem-solving analysis and synthesis, skills in interpersonal relations and communication, etc. For years, the study of Latin has been recommended not so much for the immediate importance of knowing the language as for its function in training people to think analytically. A wise pundit once defined competence as "what remains after you have forgotten everything."

To apply this concept to engineering: long after students have forgotten about frictionless planes, inductors, pistons, or the meaning of $\int dQ/T$, they will retain a way of looking at things or approaching problems that derives from their study of these topics. It is this lasting ability which represents competence.

The Professional Competence Development project at The Cooper Union set out to explicitly and systematically foster students' development of these competences, rather than leave them to happenstance and informal acquisition. Three broad competences which are important to professional engineers, which interrelate nicely, and which can be smoothly integrated with the subject matter of an engineering curriculum were selected as the focus of the project: problem-solving, communication, and value clarification.

## The context of competence development

These three competences are, of course, highly interrelated. For example, one cannot solve a problem without communicating with oneself, and with books or computers. The utility of solving a problem is nil if one cannot communicate it to other people. The problem solution, and indeed the approach selected, will be influenced by values of the problem-solver and the intended audience. The "elegant solution," exhibiting simplicity, order, and beauty, is itself highly valued in engineering and science. Societal and industrial values, such as profit, safety, and environmental impact, influence much engineering work. It is therefore important to keep in mind the "holistic" aspect of competence, even as specific competences can be separated for clarification and teaching.

Competences cannot be developed in a vacuum, free of content. There is a natural and vital interaction between competence and subject matter. One cannot become proficient in problem-solving without solving actual problems. One cannot be skilled in communicating without practice in communicating information to others. Neither can one truly master the subject matter without being able to know when and how to apply it, and to understand and communicate it to others.

As one of our professors put it, "It is rare for a student to be unable to solve a problem because, for instance, he or she does not know Newton's second law of motion or the formula for the moment of inertia of a sphere. It is usually because the student has not read the problem statement with understanding."

While competence and subject matter are intertwined, one can step back and focus on each explicitly. This has been lacking in most engineering courses --

the subject matter alone has held the limelight while competences have been in the shadows. A competence-based program illuminates both aspects of professional development, thus bringing forward the heretofore "hidden curriculum" of professional education.

The competence mode of teaching is not necessarily new -- it is a systematic way of addressing what may have been informally accommodated before. It emphasizes what the learner can do with the material of the subject matter: how and when to use it to solve problems, how to communicate it, and how to relate these two activities and establish perspective. It provides added emphasis on why and how we do things.

Development of courses which enhance competence development, therefore, does not necessarily require total revamping of the curriculum. Indeed, the basic premise of the Cooper Union project was that existing courses within an existing curriculum can be modified, primarily through the nature and organization of assignments (or learning experiences) and use of some class meeting time, to include dual emphasis on subject matter and competences. A common set of principles, procedures, and definitions guided the modification of courses as The Cooper Union and should prove useful to faculty members elsewhere:

** The first step in course modification is to define as clearly as possible the competences to be addressed and the level of proficiency in each competence expected of students by the end of the term.

** The second step is to devise a sequence of learning activities for the entire term which systematically provide students with the opportunity to practice and develop the competences.

** The third step is to develop means for assessing student progress through learning activities and/or periodic assessment mechanisms. This step includes defining criteria for assessment at each stage.

** The fourth step is to develop student materials which make clear all of the above -- competences, learning activities, and assessment techniques -- so that students and professors share a common understanding of the endeavor.

We shall take up each step in turn.

## Definitions of competences and levels of proficiency

The following set of definitions was used in all courses for the three competences of problem-solving, communication, and value clarification:

Definition of Problem-solving

In the context of engineering education this competence can be considered as comprised of three fundamental abilities:

Ability in analysis and synthesis. Implies the ability to select appropriate principles for the formulation of theories and models in order to arrive at an understanding, to translate situations into mathematical form and establish realistic models or to establish correspondences or links between what is under study and other known facts, theories, or views. It also implies the ability to formulate assumptions and to optimize designs.

Ability in innovation. Implies the ability to recognize a need and to act accordingly; to envision and formulate alternative possibilities and solutions presenting new and useful features to satisfy the need. It requires openness to new ideas, whether they come from oneself or others, objectivity about their practical value, and realism about their implementation. It encourages the use of techniques (brainstorming, etc.) to stimulate innovation, the cultivation within oneself of the powers of observation and curiosity, and of the desire for simplicity, beauty, and economy.

Ability in relating problems to a wider context. Implies the ability to integrate new learning in its particular domain of knowledge or experience, to see particular domains of knowledge and experience in perspective with other domains in the framework of eternity (values), time (history), and space (geography), to establish unobvious and helpful correspondences and analogies between different fields by:

- widening and deepening one's interest in human affairs (values, history, geography)
- developing a sense of nuance and the qualitative (to counter the stress on the quantitative put in by the engineering and scientific training)
- understanding the relations between the engineering activity and the ecological, social and cultural work in which it takes place

Definition of Communication

It is the ability to receive and send information via oral and media presentation, nonverbal cues, written materials, and numerical and graphical representations. It implies the ability to keep the other in mind, i.e., the ability to listen and the ability to speak audibly and clearly, to the point and appropriately (to time, place, and person). It also implies the ability to make use of audio-visual equipment as may be helpful; to read with comprehension, to write legibly, grammatically, and clearly;

to make graphs, sketches, and drawings; and to use symbolism familiar to the audience.

Definition of Value Clarification

It is the ability to identify one's own values and those of others, to understand the development of science and engineering as a reflection of values, and to analyze the implications of decisions made on the basis of specific values.

In addition to these broad definitions, three levels of proficiency were identified for each competence. The progression between levels represents growth and maturity towards "professionalism." Roughly speaking, Level 1 represents "the mechanics" of the competence, while Level 3 is what is expected of a young professional like a senior student starting on his or her first job. Level 2 is intermediate; it must exhibit the beginnings of maturity and independence. These three steps are big ones. While they are conceptually easy to grasp, attempting to define and discriminate specifically presents a challenge. The "levels" are, of course, phases in a continuum rather than truly discrete steps.

Below is the set of proficiency definitions developed for use at The Cooper Union. They formed the conceptual framework for developing progressively more complex learning experiences, and they were immediately useful as criteria for assessing student progress. In addition, "Level 1" and "Level 2" became an easy shorthand for reference to a set of expectations.

Proficiency levels for problem-solving

Level 1: Demonstrate ability to formulate assumptions and identify implicit and explicit elements so as to be able to apply simple common principles and methodologies in specific situations to obtain a realistic solution.

Level 2: Analyze situations new in configuration, but similar to known ones in substance; identify relationships in a given system or situation. Recognize needs and synthesize alternative proposals and problem-solving strategies. Carry out a project within a well-defined field, interpret results, critique own and others' work in the area. Draw conclusions for further action.

Level 3: Analyze situations new in substance and configuration, with strong interdisciplinary elements. Synthesize alternative proposals and problem-solving strategies for these cases and carry out their execution. Establish relations to a wider context. Exhibit critical spirit. Show proof of imagination and innovation.

Proficiency levels for communication

Level 1: Demonstrate ability to receive and send information via oral or media presentations, nonverbal cues, written materials, and numerical and graphical representations in standard academic assignments. (Here, the emphasis is to be on psychomotor skill, coordination, poise, speech habits, voice training, and grammar.)

Level 2: Demonstrate the ability to use these skills in situations involving prepared presentations (oral papers, written reports, and participation in formal debates). Ability to keep in mind the needs and values of the audience.

Level 3: Demonstrate the ability to use these skills in actual involvement at the professional level. Creative and original use of skills.

Proficiency levels for value clarification

Level 1: Demonstrate the ability to identify one's own values and their sources as they relate to a specific situation by observation of one's own attitudes, opinions, feelings, thoughts, beliefs, goals, and morals.

Level 2: Demonstrate understanding of the philosophical, religious, or cultural or social basis of values and of the development of science and technology as a reflection of values (in different traditions and civilizations).

Level 3: Demonstrate the ability to apply in specific situations one's understanding as defined in Level 2, to analyze the implications and effects of held values.

Design of Learning Experiences

Most participating faculty at The Cooper Union approached this step by first dividing their courses into discrete topic modules (from five to twelve), and developing a set of educational objectives for each module. They analyzed which competences could best be integrated with the subject matter of the course modules.

Then, keeping in mind the anticipated level of students entering the course and the proficiency level to be achieved in each competence, they set about devising learning experiences that would permit students to practice and develop the competence skills and that would also require subject matter mastery. In devising learning experiences, faculty also tried to keep in mind that students learn differently and at different paces. This consideration requires a variety of types of learning experiences, and a degree of choice within them, to accommodate different learning styles.

The specifics of learning experiences must derive from the subject matter and faculty preference. Learning activities used at The Cooper Union included: reading assignments, problem-solving, lectures, team presentations, seminars, group interactions, structured discussions, questioning techniques, simulations, role playing, case studies, self-study using prepared study guides, laboratory work, use of study aids (audio-visual tapes, computer interaction, etc.), workshops, reports, projects, etc. It is for the learning experience designer to select whatever activities will best fit the learning of the subject material and at the same time develop the stated competences to specified levels.

In general, learning experiences required students to think more deeply and broadly, to justify what they did, to write more complete essays and answers, and to give many more oral presentations (some of which were video-taped) than the same courses had required when taught before. In addition, assignment periods were longer and students worked cooperatively in teams quite often. Many learning experiences were designed as simulations of professional situations -- seminars, professional papers, policy analysis reports, and presentations. The course materials for three courses, presented in this report, provide a representative sampling of learning experiences used in three very different contexts (elementary engineering graphics, introduction to politics, and an advanced seminar course on environmental fundamentals).

## Student Assessment

Regular faculty assessment of student performance in the three competences is critical in competence-based courses. Only through frequent observation and feedback to students can progress be achieved.

Competence assessment is in many ways analogous to subject matter grading. Students are assessed on how well they complete learning assignments, from the viewpoint of competence criteria established for each assignment. However, competence assessment is much more wide-ranging and "soft" than instructors usually claim for the grading process.

For example, in a traditional course, if a student gave a class seminar on carbon monoxide (itself a less likely form of assignment in traditional courses), he or she might be evaluated on his or her grasp of the subject matter and be awarded a single letter grade. In a competence-based course, first of all, the student would probably be required to talk about the social, political, and environmental implications of carbon monoxide pollution, a wider scope of assignment. Further, the student would be assessed not only on the seminar content, but also on presentation techniques. Assessment would cover everything from pronunciation, dress, and posture, to quality of graphic displays, organization of the presentation, and ability to interest and make the audience understand. In a traditional course, the professor would be likely to ignore these aspects and concentrate on whether the student seemed to know his or her subject. In a competence-based course, the professor is obliged to consider all these aspects. The seminar is treated as a "dry run" of a professional seminar, where all these things would count.

Further, the form of feedback a student gets in a competence-based course is much more thorough than a grade. The student must achieve a detailed understanding of what worked and didn't work, and must get helpful suggestions for improvement. A letter grade -- or its equivalent -- would not suffice. Students are encouraged to assess themselves, often reviewing, for example, a videotape of their presentation. And students can be expected to get assessment feedback from other students in the class, as well as from the professor. Peer assessment is not only useful to students being assessed; it is useful to those doing the assessment. It trains and broadens their observational skills and enhances skills of self-assessment and, ultimately, self-development.

At The Cooper Union, students were assessed during class by classmates and professors, and outside class by professors in private meetings or through written comments. Videotapes were used for self-assessment of classroom presentations. An oral communication consultant was also used to assess and coach students on oral presentation techniques. Other assessors could be used as well, although they were not at The Cooper Union. These might include school faculty members other than the course instructor, or professional engineers and others from outside the school.

In theory, assessment can be both "formative" and "summative." Formative assessment is on-going and is directed towards helping students improve at their own rate. Summative assessment is like a final exam or achievement test, and tests whether students have reached a specified proficiency level. During the Cooper Union project, only formative assessment was actively pursued. Summative assessment was attempted through use of a newly-developed standardized competence test, put out by the American College Testing Program, and administered prior to entrance in the program and again two years later. The results of this test have not yet been compiled, so we don't know whether a measurable change occurred.

The question of grades assumes some importance in a competence-based course. In the Cooper Union project, grades continued to be based on subject matter mastery alone, in part because the project was experimental and applied to only about 25% of the students in the School of Engineering. This policy was adopted to ensure comparability of grades for all students. A written assessment of competence was placed in each student's permanent file. If competence-based courses became required, then a final grade might include a component on competence. Alternatively, a certain level of achievement, provided an acceptable method of measurement were found, could be required prior to grade promotion or graduation.

Development of student materials

Although instructors of traditional courses may also strive for student development of competences, they rarely make explicit or systematic the goals, expectations, or methods for achieving competence. A common result is that students (and faculty) are left to grope in the dark and often develop conflicting expectations.

In competence-based courses the instructor must make these things publicly explicit. Materials must be developed for students which clearly state:

* the objectives of the course, the course modules, and each learning experience (both in terms of subject matter and competences);
* the expectations of students;
* methods for developing and practicing competences;
* criteria for assessing student development; and
* frequency and methods of assessment activities.

These materials should be available for student study and should be frankly discussed and critiqued in class.

The course materials presented in this report are illustrative of those developed in the Cooper Union Professional Competence Development project. (In addition to the specific course-related materials reproduced here, students were also provided with general introductory materials setting forth the philosophy, rationale, and principles of competence-based courses, quite similar to this essay.)

In reviewing these course materials, note that although they share common principles, they also reflect the subject matter and level of the course and the personality and style of individual professors. Some instructors handed out all materials in the beginning of the course, while others handed out modules serially during the course.

The course materials are presented as examples of how the general principles of competence-based education can be applied in a variety of contexts, and of how professional competences can be both integrated with academic subject matter and at the same time highlighted as legitimate topics for student and faculty attention.

# ENGINEERING GRAPHICS

PROFESSOR JEAN LEMÉE

FIRST PART OF ENGINEERING DESIGN AND PROBLEM-SOLVING I

REQUIRED OF FRESHMEN, 1-1/2 CREDITS

This part of the course emphasizes three-dimensional space concepts and graphic techniques in the context of engineering design and problem-solving.

- COURSE INTRODUCTION
- COURSE SCHEDULE AND OUTLINE
- COURSE MODULES

# ENGINEERING GRAPHICS
## COURSE INTRODUCTION

Engineering Graphics is part of the course Engineering Design and Problem-Solving I; the second part is Guided Design.

ENGINEERING GRAPHICS

Engineering Graphics is a conventional language which has evolved over the years into a very efficient means of communication. It can convey, transform, or store a great deal of information clearly and compactly; it can be used to solve complex problems, particularly those involving spatial relationships, very economically. It is, in fact, often the only method available. It has a character of universality that allows for easy communication between all those literate in its use, regardless of their natural languages. It is a powerful aid in thinking and in developing the visualization ability that is at the basis of creativity, particularly in engineering and science. It is an indispensable tool in engineering.

The purpose of this course is therefore to acquaint you with rudiments of engineering graphics and to begin to make you proficient in its use. Although an engineer is not a draftsman, he has to communicate with technicians, direct their work, and check their drawing. That is not possible without a thorough knowledge of graphics developed through practice.

Like the natural languages, the graphic language has a vocabulary and a grammar. Its vocabulary, or set of words, is a set of standards defining basic forms, items, and conventions as detailed, for instance, in the American National Standard Drafting Manual Y14. The grammar of the graphics language is the set of rules governing the relationships between different aspects and representations of a given item. It constitutes what is known as Descriptive Geometry, an elegant and powerful method of understanding spatial relationships.

As a written language, graphics lays great emphasis on its calligraphy, the penmanship required to display its statements. Like correct pronounciation in verbal language, it is indispensable to clear and unambiguous understanding. A mistake in engineering can be fatal. Lives and millions of dollars will depend on your calculations. Go over and over your work, check it, and recheck it. Develop the habit of testing things for their reasonableness. Use your mind, visualize, do not take things for granted, do not believe that someone else will do the checking for you or find the mistake.

PROFESSIONAL COMPETENCES

The subject matter of the course will be integrated with the three professional competences being emphasized at The Cooper Union: problem-solving, communication, and value clarification. A brief decription of these three competences as they relate to engineering graphics is presented here.

Problem-Solving: Ability to understand the purpose of graphic representations and to select the best approach, view, and format to serve the required purpose. Abilities in analysis, snythesis, innovation, and relations to wider context. Ability to use graphics to actively solve complex engineering problems.

Communication: Ability to send and receive graphic forms of communication, and to master the vocabulary and grammar of standardized graphic language, including lettering, sketching, drawings, and charts or graphs. Ability to explain, orally and in writing, graphic representations. Ability to recognize and address the information needs and viewpoints of the receiver of graphic representations.

Value Clarification: Ability to understand values implicit in different forms of graphic representation, and in the development of standards governing the presentation and use of engineering drawing.

For each competence, three levels of proficiency have been defined. Each of these levels corresponds to a stage in the depth and breadth of acquaintance with a subject, or the care and creativity with which it is handled. They are big steps. Generally speaking, Level 1 represents the "mechanics" of the competence, while Level 3 is what is expected of a young professional, like a senior student starting his first job. Level 2 is an intermediate stage, exhibiting the beginning of maturity and independence.

In this course, we will address Levels 1 and 2 in problem-solving, and Level 1 in communication and value clarification. The materials for each course module include specific expectations for each homework assignment and class project.

TEXT

The text for this course is:

Engineering Graphics, Third Edition
by Giesecke, Mitchell, Spencer, Hill, Loving, and Dygdon; New York: MacMillan Publishing Co., 1981

and its accompanying workbook:

Engineering Graphics Problems, Series I, Third Edition
by Spencer, Hill, and Loving; New York: MacMillan Publishing Co., 1981

The material considered in this course will essentially correspond to that found in the assigned text. In addition, from time to time, materials may be assigned from other sources[(1)]. Part One of the text will be covered, up to and including Chapter 13. In Part Two, we shall limit ourselves to the essence of Chapters 19, 20, and 21, and, in Part Three, to Chapter 26.

## CLASS FORMAT AND REQUIREMENTS

The class format will not greatly differ from the usual format of lectures and recitations except that the need to work on the competences will require more recitation time and consequently comparatively less lecturing. But the amount of subject matter covered should be the same as if the course were taught in the usual way. We shall have to be flexible, regarding time, and see how we progress during the term, making adjustments as needed.

You will receive a series of modules detailing assignments and containing information on subject matter and professional competences.

In this course you will produce drawings, sketches, graphs, and solid geometric constructions as homework. You will also produce drawings in class so that the instructor can observe and offer suggestions on the process of drawing as well as on the finished products. Students will be required to answer questions orally in class and in writing at home, both on subject matter and approach. Class discussions will pull together competences and subject matter. You will have one essay on the values inherent in technical drawings from different historical periods, and you will participate in one videotaped panel discussion on values related to applications of drawings in manufacturing processes.

It is expected that all assigned exercises will be solved and neatly presented on sheets of format as specified in course module instructions. All drawings will be kept together in a folder and brought to each class. These folders will be collected from time to time by the instructor for review. When

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(1) A comprehensive bibliography of materials related to graphics is included in the appendix of your textbook on page 806 ff. Some are available in the library; the others may be found at the other technical libraries in New York City.

you come to class, always bring your full set of instruments, drawing paper, and a notebook.

The course will have two exams, and occasional short quizzes. Examinations and quizzes will count for 35% of the final grade, classwork and class participation will count for 30%, and homework will count for 35%.

## ENGINEERING GRAPHICS
## COURSE SCHEDULE AND OUTLINE

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|---|---|
| **Week 1** | Introduction |
| **Week 2** | Module I: Concepts, Principles, and Drawing Tools |
| **Week 3** | Module II: Lettering, Sketching, and Shape Description |
| **Week 4** | Module III: Multiview Projection |
| **Weeks 5-6** | Module IV: Descriptive Geometry |
| **Week 7** | Mid-Term Exam |
| **Weeks 8-9** | Module V: Technical Drawing--Sectional, Auxiliary, and "Inside Out" Views |
| **Week 10** | Module VI: Intersections of Solids |
| **Week 11** | Module VII: Graphs for Technical Communication |
| **Weeks 12-13** | Module VIII: Role of Engineering Graphics in Design and Production of Mechanical Parts |
| **Week 14** | Final Exam |

# ENGINEERING GRAPHICS

## COURSE MODULES

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ENGINEERING GRAPHICS
MODULE I: CONCEPTS, PRINCIPLES, AND DRAWING TOOLS Week 2

1. Purpose

The purpose of this first module is to familiarize you with the fundamental concepts of graphics, the use of instruments, and some principles of geometric constructions.

Graphics, like engineering of which it is a part, is both a science and an art. Its essence consists in reducing a three-dimensional statement to a two-dimensional one. This statement may be a simple description of an object or of a process. Often it includes specific instructions for the construction, development, or maintenance, of the object or the process depicted. Alternatively, the graphic statement may be the statement of a problem having to do with the spatial relationships between objects or processes. Projecting a spatial relationship in two dimensions, for example, may be adequate for understanding and certainly is cheaper, easier, and quicker than constructing a three-dimensional model. The concept of projection is, therefore, at the basis of graphics. Pro-jection, as the name indicates, is a "throwing forth" of the object onto a "plane of projection." This results in a "view" of the object on this plane. Inherent in this process therefore, and implicit in the concept of projection itself, is the notion of point of view. This notion is all important, though often forgotten in problem-solving.

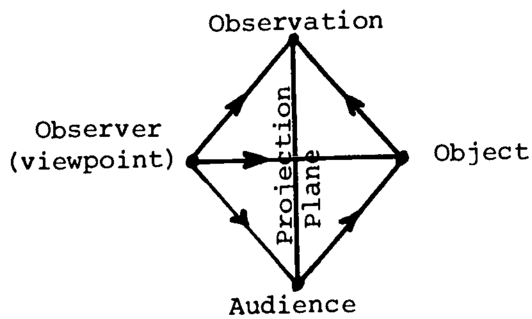
Graphics is probably the subject in which the importance of the viewpoint is best demonstrated. It is here that it becomes most evident that what we are able to see depends less on what it is we are looking at than on our "point of viewing." Indeed, most of our graphic problems will consist of finding another viewpoint of a given object by various methods, so as to yield more, or at least more pertinent, information from what is available, or to convey what we want to show more simply and plainly. Of necessity, viewpoints are partial and, literally, leave a great deal out of the picture. Hence the necessity of several viewpoints to form an appropriate image of a given object. This translates itself in graphics to "choice of views": which and how many views are necessary to convey the information most readily and unambiguously? In general, in orthographic projection drawings, three views (top, elevation, and side views) will be required; however, often, and with appropriate conventions, one or two views may suffice.

The viewpoint presented also has to be appropriate to the intended audience to convey the information efficiently and accurately. Here, in fact, is the essential point in all communication experience: the match between the speaker and the audience. As an example, a freehand sketch used to convey an idea to a draftsman is not, in general, suitable for the use of the machinist who has to build the item depicted by the sketch. Similarly, a fabrication drawing is not what the assembly man needs.

Style of expression is also important and has, consequently, to be chosen appropriately. For instance, an isometric sketch or a perspective drawing may be suitable to help the visualization of an object, but a scaled three-view orthogonal projection of the same object will be more appropriate for fabrication purposes.

The first step in graphic communication is, therefore, chosing a viewpoint. It requires you to be aware of who is posing the problem to whom: the engineer to the draftsman, to the machinist, etc., for what purpose, and in what circumstances. You must be aware of the purpose of your work, the content of your intended statement, and the needs of the intended recipient. All of these concerns require clarification of values.

An observation arises when an observer views an object. In graphics, we call "projectors" or "lines of sight" the imaginary lines connecting the observer to the object. The observation may be recorded for the benefit of an audience (who may be the observer himself) on a projection plane (reduction to a two-dimensional figure) as shown on the following symbolic diagram:



This simple diagram may help us to keep in mind the process involved in graphic representation:

* Existence of viewpoints, chosen with the audience in mind.
* Reduction of the observation to a two-dimensional view on a plane of projection.
* Recording of the observation on this plane.
* Availability of the observation to an audience who can thereby infer the object or certain of its properties relevant for a given purpose.

Note that, with a symbolic diagram such as the one above, each line has implications in problem-solving, communication, and value clarification.

Contrast a symbolic diagram such as this one to the physical diagram shown in your text (fig. 1.10, p 10).

2. Assignment

You should read:

* Chapters 1, 2, and 4 in your textbook.
* Huntley, H.E., The Divine Proportion, A Study in Mathematical Beauty, Dover pub., 1970, pp 31-34.
* Pearce, P., Structure in Nature is a Strategy for Design, Cambridge: MIT Press, 1978, pp 2, 10-11, 22-25, 32.

Some brief comments on the text chapters are provided:

**Chapter 1** is an introduction and does not include any problems. However, you should read it carefully since it will give you a feel for the graphic language and its development.

**Chapter 2**, on instrumental drawing, deserves a thorough study. It is descriptive and you may be tempted to skip a lot of it because the title on a paragraph may lead you to think that you already know all about it (e.g., sharpening your pencil). Read it nevertheless. Even though we won't be using ink, the description of ink drawing applies generally to the qualities to be aimed at in drawing. This chapter will have to be used as a reference chapter, particularly with respect to the use of conventional lines and instruments. As you develop skill in handling those tools, some statements in this chapter which may sound a little remote or too obvious at first reading will make more sense. The purpose here is to acquire skills and good habits. Among these good habits which will help you throughout your studies and later in your work are:

* Giving your full attention to the problem at hand.
* Working with maximum accuracy compatible with the purpose of the solution.
* Working with speed, remembering what your text says, "Speed is not attained by hurrying; it is an unsought by-product of intelligent and continuous work."
* Letting your work be legible, keeping the "other" in mind, giving full attention to details.
* Letting your work be neat, clean, orderly, and well presented.

**Chapter 4** is concerned with geometric constructions. You may already be familiar with some of these constructions from high school geometry. It is essential that you practice what is explained in your text as you read it. So read with pencil, ruler, and compass close at hand. Do not be content to simply "understand" the construction in your book. The purpose is to acquire skill in doing these constructions.

You should do the following drawings:

* In class, Drg 12
* As homework, Drgs 7 and 9.

In addition, you should build a three-dimensional cardboard model of each of the five platonic solids: the tetrahedron (four faces, each an equilateral triangle), the cube (six faces, each a square), the octahedron (eight faces, each an equilateral triangle), the dodecahedron (twelve faces, each a pentagon), and the icosahedron (twenty faces, each an equilateral triangle). The radius of the sphere circumscribing each of these five solids should have the same dimension.

Each face has to be drawn accurately so that it may be cut out and fitted together with the other faces of the figure. Use the methods of Chapter 4 to draw these figures as accurately as possible. In your construction, there are a number of edges that you have to glue together. Remember to leave a flap where needed.

Besides their own intrinsic beauty these forms are the basis of the shape of many things, from atoms to large scale structures. An understanding of their geometry is therefore very useful in chemistry, material science, and engineering structures. Constructing these models will familiarize you not only with geometric construction, but also with spatial visualization and the sometimes frustrating job of trying to make things stick together!

3. Expectations

You will be expected to have read the assigned material and to have completed the classwork and homework. Classwork and homework should be handed over to your instructor or his assistant when due. They will be returned to you promptly after grading. Depending on the needs, individual comments will be given.

In terms of the competences of problem-solving, communication, and value clarification, we are here just establishing the vocabulary. At this stage, it is the acquisition of skills that should be stressed: the use of instruments, the development of good work habits (attention, accuracy, speed, legibility, neatness). Practice at home! In class, as you work, you will be expected to demonstrate these habits to your instructor. If in need, ask! Do not keep repeating the same mistake on your own.

ENGINEERING GRAPHICS
MODULE II: LETTERING, SKETCHING, AND SHAPE DESCRIPTION Week 3

1. Purpose

Having begun to familiarize ourselves with the graphic language, we now turn our attention to two aspects of it. The first is lettering (Chapter 3 of your text), and the other is sketching and the problem of shape description (Chapter 5).

Good lettering is essential to legibility and neatness of presentation. As your text points out, "...ability to letter has little relationship to writing ability... [It is] always accomplished by conscious effort and is never done well otherwise."* This alone is worth study and practice. It leads, as you may discover if you practice diligently, to mental alertness.** Your text is quite complete on the subject of lettering. In this course, we shall limit ourselves to pencil lettering. Lettering will be useful in many of your other courses, particularly in laboratory reports where graphs, sketches, and drawings often must be done in ink for reproduction. Frequency of lettering practice is more important than the length of practice sessions. It is better to do 10 minutes every day, six days a week, than an hour at a stretch, once a week. Doing things at a regular time every day also helps.

Like lettering, sketching is also mostly a matter of practice. To make decent, useful, and accurate sketches requires no particular artistic ability. Like lettering, it mostly demands a conscious effort to improve. Here again, your text is quite complete about what you ought to know about the subject. In sketching, appearance is important. Though the size of a sketch may be optional, it is important that proportion and symmetries be respected.
When you pictorially sketch an object, you represent a three-dimensional object on a two-dimensional paper from a certain viewpoint. Do not change your position, or the relative position of the object with respect to you while representing it. You may, of course, manipulate the object if it is small enough, or turn it around if it is not, to better understand its features, but what you put down on paper must correspond to the view from a single viewpoint. This may sound elementary, but a lot of misunderstandings arise in the every-

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* Engineering Graphics by Giesecke, et al., p 67.

** Ibid., p 15.

day world simply from change of viewpoint that people commonly make, without being really aware of it.

This chapter also introduces the concept of "views" from specific direction. This concept is fundamental to graphic representation in engineering, and will be most important in our study of descriptive geometry. Study in particular paragraphs 5.20 and 5.29. We shall have occasion to return to this in Chapter 6, but if technical drawing is new to you, you should familiarize yourself completely with this idea now.

As we have already stated, the most important point in technical communication is:

* To know exactly what you want to convey
* To know your audience, i.e., to keep the other in mind as you elaborate your statement so as to convey what <u>they</u> need to know
* To select the most appropriate method to convey the meaning economically.

So aim at brevity (e.g., minimum number of views) without being obscure by eliminating views that may add to the readability of your drawing. (Reread in particular paragraph 5.23 in your text.) This is a process involving value clarification. To sort out what is needed by your audience (a machinist who will execute the piece you have sketched, a draftsman who details it, or an engineer who will have to incorporate it into a system), you have to know how they look at this piece from their particular professional viewpoint. The machinist will want to know about material, tolerances, machining dimensions, finish, etc.; the draftsman may be in a position to specify most of these, while all he requires is some basic dimensions and stresses to which the piece may be subjected. As for the engineer, his interest may be limited to some indications regarding the kinematics aspect that the piece will be called to perform in his system.

2. <u>Assignment</u>

* <u>Homework</u>: Read Chapters 3 and 5

  Drawings: * 1, 2, and 3 <u>OR</u> 4, 5, and 6
  * 13 and 17.

* <u>Classwork</u>: You will be handed an object that you will have to sketch.

3. Expectations

You will be expected to have completed the homework when you come to class and to do the classwork in the allotted time. Remember that speed is a matter of steady, sustained work. Find a quiet spot to work at home and, in class, respect the quiet of others.

You will be expected to demonstrate to the instructor your mastery of the material assigned. However, if there is anything that you find unclear about it, ask!

These chapters are important from the viewpoint of communication. Here, you are learning one of the most efficient ways of communicating and recording ideas and information. The time available in this course is very limited, but develop the habit of sketching what you see. Don't limit yourself to the week we can devote to it.

ENGINEERING GRAPHICS
MODULE III: MULTIVIEW PROJECTION **Week 4**

1. Purpose

This module on multiview projection (Chapter 6 in your text), lays the foundation of descriptive geometry and of the principles and conventions in the practice of instrumental technical drawing.

The concept of multiview projection has been seen previously. Here the mechanism of the "glass box" is clearly explained. Since a thorough understanding of it is the basis of descriptive geometry, you should study, with particular attention, paragraphs 6.1, 6.2, and 6.3. In our next module on descriptive geometry complete familiarity and fluency with its use will be assumed.

Sections 6.4, 6.5, 6.6, and 6.7 should also be read with care.

In particular notice the sequence in building a drawing:

1. Spacing the views.
2. Locating the center lines and constructing arcs and circles on all views simultaneously.
3. Drawing horizontals, then verticals, and finally, obliques on all views simultaneously.
4. Adding hidden lines, and heavying in lines on all views.

Note that views are built all at the same time. This practice not only saves time and leaves a neater product but it prevents numerous mistakes. Get used to it, now! It is one way of improving efficiency and speed.

Sections 6.12, 6.13, and 6.14 give useful tips about visualization and reading drawings. Making models is a very efficient way of improving your ability to mentally visualize three-dimensional objects from two-dimensional drawings and should be practiced.

Sections 6.15 through 6.32 are not only useful in giving you the intelligence of forms from a two-dimensional approach, but also introduce you to further ideas that will be elaborated on in our study of descriptive geometry. Their understanding at this point will make your understanding of descriptive geometry easier.

The rest of the chapter is taken up with more conventional practices in object representation. Notice that all aim at facilitating the reading of drawings. They are based on being reasonable rather than picky, in caring for your audience rather than on satisfying a strict adherence to predetermined rules, on being flexible rather than rigid. These are helpful values to reflect upon and to adopt. It may be interesting to note that what, at first sight, may seem to be contrary to what you have always done is, at times, well justified and, indeed, practiced by most of the world! (See in particular section 6.38 about this.) Notice the importance of the observer's viewpoint here. If his position is forgotten, it is easy to label as silly a practice such as placing the top view on the bottom, and so on. Most viewpoints are justifiable. You may want to return to Module I which considered this specifically.

We are beginning to enlarge our vocabulary of graphics and our fluency in shape description. We are laying the foundation for developing our ability to solve problems graphically. This problem-solving aspect of graphics will be emphasized in descriptive geometry. Here, it is the communication aspect of drawing that is stressed. We are, therefore, given the elements, the conventions, and a first acquaintance with the laws and principles behind technical drawing. It is important to reflect on the effect of values on the nature of these conventions and principles. Contrast, for instance, a technical drawing made in the 19th century to one drawn in, say, the last two decades. (Look in old and modern technical publications in libraries for such illustrations and make photocopies.) What do you notice? What do you think are the values presiding over the principles and the execution of these drawings? Going back further, look for an earlier technical drawing (it could be architectural) and again contrast it to the two previous ones.

Are you beginning to appreciate that forms are statements? They say and express something often beyond the purely informational content that their creator intended. Begin to realize that the man-made world of artifacts, buildings, organizations, and relationships in which we spend our lives are shaped by values and ideas of people dead long ago. Reflect on the nature of the language we speak, on how it shapes your thoughts in certain patterns without our even being aware of it.

Having secured a copy of each of the three period drawings suggested, list values that you perceive in these drawings and, briefly, write a paragraph on the effect of values on presentation of drawings (about 200 words).

2. Assignment

You should have read the section, "Purpose," of this module. Then you should proceed to read Chapter 6 in your text.

For homework, do Drawing 18 in your workbook, building models out of a suitable substance for each of the four items represented. These models should be turned in with your drawing. Having researched period drawings as indicated in the previous section, write your 200 word essay as previously outlined. This essay has to be turned in with copies of the period drawings.

In class, we shall work on Drawing 20.

3. Expectations

Your drawing, your model, and your essay with the drawing reproductions are to be turned in at the beginning of the class.

You should be ready to answer orally or in writing any question on Chapter 6 that your instuctor may ask during the class. Remember that class participation and classwork determine an important fraction of your final grade.

Remember also that, in graphics, practice is all important and that the best place to initiate practice is where help is available, in the classroom. Be diligent.

ENGINEERING GRAPHICS
MODULE IV: DESCRIPTIVE GEOMETRY

Weeks 5-6

1. Purpose

With this module we begin our formal approach to Descriptive Geometry. Descriptive Geometry may be said to be a formalization of the art and science of visualization. It may seem odd to us that the Greeks, with their marvelous architecture and their keen sense of geometry, and the Romans, with their extraordinary feats of civil engineering were somehow able to manage without descriptive geometry. Yet descriptive geometry was invented only at the beginning of the 19th century. The cause may perhaps be sought in a different appreciation of space as perceived by different cultures. There seems to have been a general shift of sensibility in western culture, a greater emphasis on the visual than the tactile and auditory of previous periods, which began with the Renaissance.*

The way was paved in the 15th century by the work of Leone Battista Alberti, an Italian artist, who wrote an essay on perspective. The basic idea is simple. As Ivins puts it: "When a man sees something through a window, he can get a correct image of it by tracing its outlines on the window pane, provided that while he does this he uses only one eye and does not move his head. Alberti's construction is no more than a graphic way of reducing this process to a series of interrelated measurements."* It was Desargues, a French engineer and architect of the 17th century, who made the next step, formalized by his invention of projective geometry. However, it took another 150 years, until about 1800, "When it was again taken up by a remarkable group of Frenchmen at the head of whom were Monge, Carnot, Gergonne, and Poncelet."*

Descriptive geometry as it is presented today is basically what Monge developed. From Chapter 5 and 6 in our text, we are already familiar with some of its assumptions and results. Here, we want to lay emphasis on the principles. The central idea is that of orthogonal projection of an object onto orthogonal projection planes in an Euclidian space. Essentially, it is the idea of the glass box. The idea may appear to us rather obvious, but it may be of value to reflect on the fact that what we take for granted was not

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* See the interesting essay by William M. Ivins in Arts and Geometry, A study in Space Intuitions, Dover Publ., Inc., 1964.

obvious to earlier generations. In fact, Monge's discovery was considered so revolutionary and so valuable militarily that, for many years, it was highly classified material. Its influence on the development of mathematics, the sciences in general, particularly physics, and philosophical thought has never been fully investigated.

2. <u>Assignment</u>

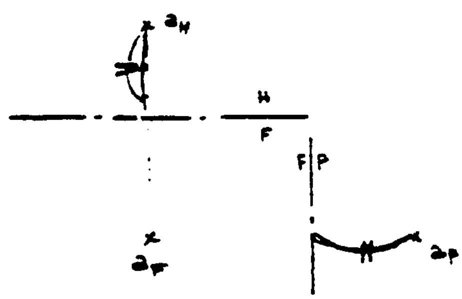
Read Chapter 19 the first week, and Chapter 20 the second week. As you read your text on descriptive geometry keep the picture of the glass box in mind. Refer to Chapter 6, particularly section 6.2, to refresh your memory. <u>Build a glass box</u> with perspex or other plastic material, properly hinged, with an additional <u>auxiliary plane</u>, unattached to the box. The box should be approximately 8" x 6" x 6" and the auxiliary plane approximately 8" x 6". Use an erasable marker to draw on your box and follow the construction in your text and in your problems. (To anticipate slightly, see paragraph 8.3 in your text on the use of the auxiliary plane in the glass box.)

<u>Some important points</u>:

* Always show the folding lines in all your descriptive geometry representations. It is not customary to show them on industrial drawings, but they must appear otherwise. It prevents confusion and errors.

* Remember the simple relationship between views: when you have at least three views (two folding lines), <u>the distance measured along the projection lines between the projections of a point and the folding line having a common letter is the same</u>.

  In the example below, the distance between $a_H$ and the folding line HF is the same as the distance between $a_P$ and the folding line FP. (The folding lines HF and FP have the letter F in common.)




Another way of saying the same thing is that <u>when you skip a view</u> (F in the present case) to go from one view (H) to another (P), <u>the distances to</u>

the folding lines remain the same. See this on your model glass box. (Make sure that you are taking your measurement along the right projection lines and with respect to the right folding lines!)

* Going through a folding line imlies a 90$^{o}$ movement in space.

* New auxiliary planes are always orthogonal to some previously established planes, the original and fundamental planes being F, H, and P.

* Since auxiliary planes can be at any angle to a given folding line (though perpendicular to one of the planes determining the folding line), any point can be seen from any direction with a maximum of three projections.

Once you understand the system of projection of one point on orthogonal planes (the glass box idea), you should have no difficulty with descriptive geometry since any figure is represented by a collection of points. Label all points carefully as soon as a projection is established. Leave your construction lines visible so that you may retrace your steps easily.

All problems in descriptive geometry amount to finding the appropriate view(s) of a given setup that will show a particular line, angle, or surface in such a way that the actual dimension of this item or its relationships with other items of the setup can be evaluated easily without calculation, by simple measurement on the figure itself. It goes without saying that precision in drawing is therefore all-important since the result is actually measured on the drawing. Do not use soft pencils which lose their sharp point readily and whose lines smudge easily.

Follow all constructions carefully with your glass box. Keep it next to you as you study and draw on it to visualize in three-dimensional space what is represented two-dimensionally on a flat sheet. Review previous material as may be useful, particularly Chapter 6.

The following drawings should be done at home:

* Drawings 55 and 59. Due the first week of the assignment.

* Drawings 62 and 64. Due the second week of the assignment.

In class, we shall work on Drawings 60, 63, and 67.

3. Expectations

With this module, it is the ability to visualize that is to be stressed. Other skills that need particular attention are accuracy, neatness, and systematic approach. (In particular, label your points carefully, and draw your folding lines and projection line.) When a problem is proposed to you, read it carefully. Understand what is really asked. Then see spatially what this implies in order to be exhibited, and finally work out the sequence of steps that will lead you to communicate what has been visualized. For instance, if you want to show that two straight lines intersect, visualize two intersecting lines in space. They have a single point in common. Consequently, this implies that the intersections of the projections of the two proposed lines must line up along the same projection lines (see fig. 19.3 and 19.4 in your text). The problem is simply to represent graphically the sequence of the changes of viewpoints that will show this. Do not work blindly. Remember that what is on your sheet is a representation of something in space.

You will be expected to have completed your homework and turned it in as specified.

During class time, as you work at your drawing, you will be expected to be able to answer orally questions on the assigned material. Bring your "glass box" and be prepared to explain geometric constructions with it. (A grade will be assigned to the glass box model.)

MODULE V: TECHNICAL DRAWING -- SECTIONAL, AUXILIARY, AND "INSIDE-OUT" VIEWS

1. Purpose

Chapters 7, 8, and 9 in our text apply some of the ideas seen in descriptive geometry (Chapters 19 and 20, Module IV) to technical drawing. They are fundamental as they introduce flexibility of representation in the graphical depiction of shapes. Their main concern is the derivation of additional views, so-called sectional and auxiliary views, given certain other views of an object. Here again, philosophically, the goal is to generate other viewpoints systematically to communicate information most clearly, economically, and reliably.

Sectional views are used to show the interior of items which cannot be clearly shown by hidden lines. This is achieved by cutting away part of the item in question by means of an imaginary cutting plane, removing what lies in between the observer and the cutting plane, and representing what remains as a projection on the cutting plane itself. Note that the result is an external view of the inside of the item. A number of techniques and conventions currently used in practice are detailed in Chapter 7 and should not present any particular difficulty.

In Chapter 8, the concept and the use of auxiliary views is well illustrated. It builds on, and perhaps makes clearer, the descriptive geometry principles of Chapters 19 and 20. It should be studied thoroughly since it is at the basis of the ability to visualize three-dimensional objects in space from any angle, and to represent the result graphically.

Of course, to view an object externally from any angle, two possibilities present themselves to the observer. He can move around the fixed object and select his line of sight, or he can turn the object itself with respect to his own fixed line of sight. The first method corresponds to the "auxiliary view method" described in Chapter 8; the second method is that of "revolution" explained in Chapter 9. The two methods yield equivalent results and the choice is mostly a matter of convenience. In both cases, the result sought will be that particular view which shows to best advantage the desired dimension, surface, angle or other detail one wants to see. Note that, by the convention to limit ourselves to orthogonal planes (i.e., right angles), an auxiliary view is always at $90^{\circ}$ to the view from which it is taken, as illustrated in fig. 8.2. (Remember: going through a folding line implies a $90^{o}$ turn in space.) Similarly, to execute a revolution, as depicted in fig. 9.6, one first has to establish a view where the axis of rotation is seen as a point (then all points of the object seen in this view will rotate by the same angle). In the adjacent view, the axis of rotation will be seen in true length and each point will appear to move during the rotation on a line perpendicular to the axis of rotation by an amount equal to the projection of the corresponding arc rotated.

These two approaches cover the useful representational aspect of multiview projection. They give the external aspect of the object; through sectioning one can expose the inside features of a particular item.

It is often useful, and indeed essential, in order to gain insight into a structure, a process, or an idea, to see it "from the inside out." No one seems to be specifically trained in this, as far as I know, in schools of engineering, though good designers and insightful scientists and engineers often have developed this ability. It is to this end that we now return to our consideration of the Platonic solids.

In our previous encounter with them, we looked at them externally. We built them by concerning ourselves with their surfaces. For the specifications of these solids and their two-dimensional representation, constructions are not always simple. The dihedral angle between two adjacent sides of a solid, for instance, is not a simple one. Examination of these solids from the "internal viewpoint," however, can simplify our understanding.

Imagine yourself at the center of a cube, as if you were at the center of a cubic room. From this viewpoint, the symmetry of the figure is striking. You are aware of the six faces equally distant from your central location and, perhaps even more, of the eight corners also equally distant from this central point. The radii joining your location to each corner determine angles and the angles between any two adjacent radii are all equal to one another by the symmetry of the figure. This angle is called the internal angle. Note that the specification of the angle, together with the length of the radius, completely specifies the cube. Indeed, it must be so for any of the regular polyhedra since, by their regularity, the internal angle[1] must be constant

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1. See footnote on following page.

for each one. It is easy to prove, and we shall see by construction, that, for the regular polyhedra, these angles are determined by ratios of the very simple numbers 1, 2, and 3. "The little matter of distinguishing among them being arithmetics," as Plato says in The Republic (VII, 522).

The "inner construction" of the five platonic solids is given in the appendix to this module.* It should be noted in passing here that these five solids are more than an interesting geometric oddity. As the material handed out with Module I showed, they constitute a fundamental scheme for the development of structures,(2, 3) from the atomic to the astronomical levels.

Indeed, as illustrated in the appendix, a methane molecule is comprised of four hydrogen atom nuclei positioned at the four corners of a tetrahedron with the carbon nucleus in the center, clearly exhibiting the Maraldi angle. Similarly, methylchloride has a carbon atom at the center, an atom of chloride at one apex, and three atoms of hydrogen at each of the other corners of a tetrahedron. Insight into these forms contributes greatly to the understanding not only of chemistry, crystallography, material science, and natural history, but also of engineering structures, such as geodesic domes. It may also be of interest to remember, for instance, that Kepler made use of these solids to determine the orbits of the planets, with an accuracy of 10 percent.

One of the remarkable features concerning these solids is their regularity. There are only five ways of dividing space equally, and these ways are regulated by the numbers 1, 2, and 3. There is great beauty in this and it is no wonder that Pythagoras and his school are said to have seen here the

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1. (Footnote from preceeding page.) Strangely enough, these fundamental angles, except in the case of the tetra- hedron, where it is sometimes referred to as the "Maraldi angle" (see D'Arcy Thompson: On Growth and Form, Cambridge University Press, 1968, p 498), do not seem to have attracted the attention of scientists, engineers, or mathematicians. To my knowledge, Mr. James Armstrong, a British engineer, is the first to have drawn attention to their structural importance (personal communication). The construction of the "internal polyhedra" included in this module is due to him.

* Appendix is unpublished notes on construction of internal polyhedra. (Not included.)

2. See in particular the beautifully produced book by Peter Pearce: Structure in Nature is a Strategy for Design, MIT Press, 1978.

3. See also D'Arcy Thompson, Op. Cit., Chapters IX and X.

beginning of creation, displaying the essence of law, order, equality, and beauty, an ideal perfection.

The five polyhedra are the only forms which divide up a sphere perfectly regularly, so that the shape and size of all edges and areas and angles and volumes are even and regular. Any further division leads to unequality. Each of the polyhedra is contained within a sphere. The corners of each of the polyhedra lie on radii moving out from its center. The even spacing of the radii produces the regularity of the appearance. Clearly, the angles between any two adjacent radii are an exclusive property of that particular polyhedron.* To describe these angles is to describe the polyhedron.

It is therefore evident that viewing the relative complexity of the Platonic solids from the "inside out" has a tremendous simplifying effect in accounting for their shape. Compare the simplicity of the view from the center to the complexity of the view from the surface in the example of the dodecahedron, for instance. Ironically, the external view is usually confused with the "objective" view.

This is not to say that the surface view is not useful. It has its merits and ranges of applications: if we want to build a dodecahedron out of cardboard, it is useful to take the surface view in order to know how to cut up and assemble our pieces. But it also has its limitations.

2. Assignment

* Read and reflect on what is written in this module the first week of the assignment.

* Study Chapters 7 and 8 in the first week, and Chapter 9 in the second week.

**First Week:**

* Do the following drawings: 23, 28, 32, 33.
  **Note:** Here again, accuracy and neatness are essential. Particularly in the construction of the internal polyhedra, the geometic construction on paper of each cell and the cutting out must be done with all the precision you can muster. Any imprecision here will be multiplied as you put the cells together. Imprecision will translate itself by warped surfaces at best, and, at worst, by the impossibility of fitting the pieces together.

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* See footnote 1 on the preceeding page.

**Second Week:**

* Draw a view of one of the five Platonic solids such that the line of sight is along a main diagonal (i.e., a line joining two opposite corners through the center). Represent the sphere circumscribing the polyhedron. (See example in appendix for the cube.)

* Construct the five regular "internal" polyhedra according to the method shown in the appendix.

3. Expectations

It is expected that you will develop the ability to see and to represent things from various viewpoints. Going through the above exercises will begin to develop this ability. However, it is a lifelong habit that has to be set up at this point. So do not limit your training to these few exercises in graphics. Find ways to apply it to other courses and in other situations.

Having studied and done the exercises assigned in this module, you will be expected to be able to execute in the time allocated any of the drawings 23 to 33 with at least a passing grade.

In terms of competences, this corresponds to a performance at Level 2 in problem-solving, and at Level 1 in communication.

For the value clarification, the essential point to notice here is the dependence of the multiplicity of viewpoints on values. See, for instance, in the context of the material in this module, how such notions as simplicity, symmetry, equality, economy, and elegance lead to the search for a more central vantage point where these qualities may be more fully appreciated. Note that it is these values which are at the very basis of theory-building in the sciences. Make an effort to see that at work in your other courses (mathematics, chemistry, and physics, in particular). See it at work in the effort to convey the maximum information most economically. See here the importance of keeping the audience in mind: To whom are you talking? What is their viewpoint? How can you address yourself to this viewpoint? What are they bound to see from there, and bound to miss? Should you try to change this viewpoint? If that is done, what are they likely to lose, and/or gain?

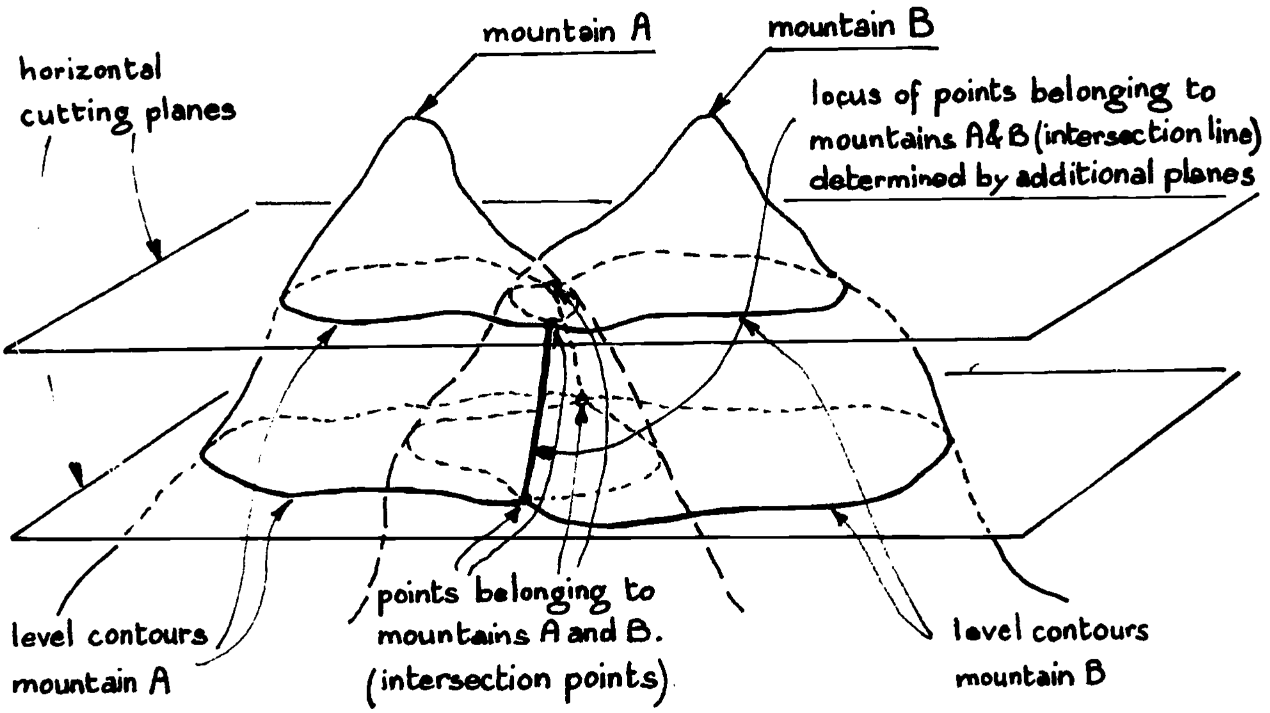
These questions may seem at first a little far removed from the problem of drawing the auxiliary view of a clip bracket; but appreciate that they are not different in essence. If you really know what you are doing when you draw your clip bracket, these are the very questions which you should be addressing: Why do you pick this view rather than another one? What is the purpose of this drawing? Who is destined to use it -- the machinist, the draftsman, your supervisor? What is the drawing to be used for -- machining, assembly? Is any part not shown clearly? May anything be a source of confusion, and what are likely consequences of confusion?

ENGINEERING GRAPHICS
MODULE VI: INTERSECTIONS OF SOLIDS Week 10

1. Purpose

Lines, surfaces and solids may cross one another. When they do, they are said to "inter-sect," to cut one another, and it is often of interest to know the form of the line along which they meet. The purpose of this module is to study some simple cases of intersecting elementary geometric figures such as planes, prisms, pyramids, cylinders, and cones. Such information is needed, for instance, in determining the line of intersection of a dam with a valley, the shape of the door in the fuselage of an aircraft, or the form of the shadow of one object on another.

The methods developed to obtain simple intersections are general and can be applied to complex situations. The principle is to simultaneously cut the two geometric entities of interest (i.e., surfaces or solids) by a series of simple, easily-generated, geometric surfaces. Typical cutting surfaces will be planes, cylinders or spheres. These cutting surfaces intersect with the proposed surfaces along easily determinable lines. The locus of the points common to these lines is the intersection line.



The solution can often be simplified or shortened by taking advantage of the geometric nature of intersecting surfaces or solids, by wisely choosing the cutting surfaces, and by using cutting spheres (fig. 21.17b) in your text).

2. Assignment

Read Chapter 21 in your textbook. In each example given, study the methods of approach. See what kind of approach is used where and why, how a little reflection on the properties of the surfaces may simplify the task. For instance, on fig. 21.21, intersection of two oblique cones, horizontal cutting planes would generate two series of eccentric circles along the axes of the cones in the top view. By choosing cutting planes passing through the two vertices, a single series of straight lines is obtained, and is much easier to handle. Before you launch into a solution, pause, consider, and reflect. A few minutes spent at the beginning may save you hours of aggravation and frustration later on. Try out in your mind several methods, visualize the situation in space, draw a perspective sketch to aid this visualization or build a rough model with some pieces of paper and a few paper clips or tape to get a better view of things. Train your imagination. Look around. The physical world is full of intersections. Surfaces meet, solids interpenetrate, and the most beautiful lines show up in the most unexpected places. Look at the facades of buildings, familiar objects in houses, pots and pans, stairways, banisters, engines; look at natural objects, shells, rocks emerging from the ground or water, the grain of wood "cut" by the surfaces of furniture pieces, etc.

The following drawings should be done:

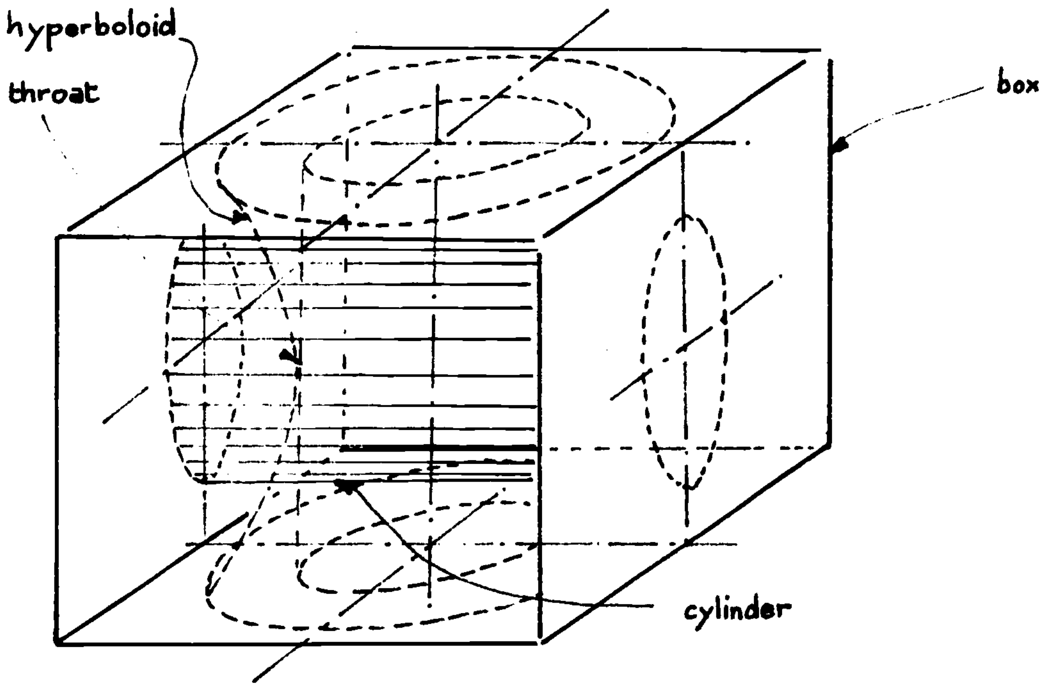
- In class: Drawing 69
- At home: Drawings 68 and 70

The following model should be made:

- Intersection of an hyperboloid with a right circular cylinder.

The axes of the two solids are concurrent and at right angles to one another. The diameter of the throat of the hyperboloid is half that of its base and the diameter of the cylinder is equal to that of the throat of the hyperboloid. Use thread to construct the surfaces. Look up your text p 624 to see how to construct the hyperboloid.

You may find it useful to use a box to build these "solids" in their mutual relationship and to study their intersection. Determine this intersection graphically and compare it to that obtained from your model.




3. Expectations

- To have completed the assigned work in time with care and accuracy.
- To answer questions orally in class on chapter 21. You should be able to explain clearly to the class, in less than 5 minutes, the method followed in any of the examples given in your textbook.

ENGINEERING GRAPHICS
MODULE VII: GRAPHS FOR TECHNICAL COMMUNICATION **Week 11**

1. Purpose

The module is concerned with graphs as defined and understood in chapter 26 of your textbook. Graphs constitute a very efficient way of presenting information that quickly "speaks to the eye," helps memorization, and facilitates mental information processing. They are therefore useful communication tools for engineers.

As your text emphasizes [(1)]:

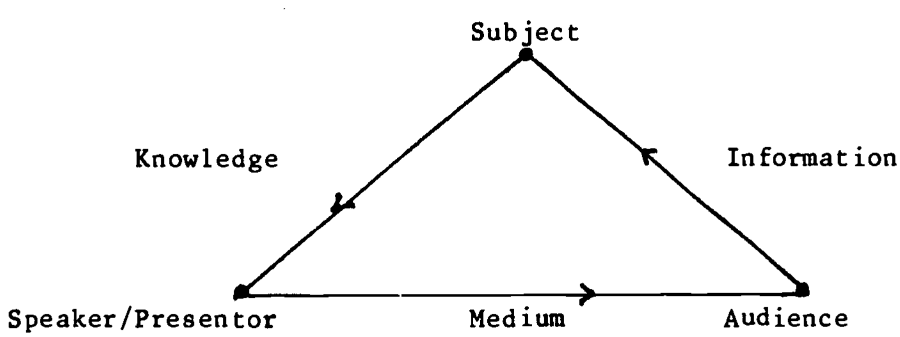
"Graphical constructions are used in three general ways:

(1) for graphical presentation of data
(2) for graphical analysis, and
(3) for graphical computating."

"The type of graphical presentation used depends upon any of the following factors:

(1) The type of reader to be reached
(2) The most efficient type of graph to help the reader visualize the significant features
(3) General purpose of graph
(4) Features of a relationship that are considered significant
(5) Occasion for its use
(6) Nature or amount of data."

In any communication event a number of factors are involved. These can be conveniently arranged on a symbolic diagram as shown below. The graph constitutes the "medium," joining the "presenter" to the "audience." This medium can be seen as regulating the flow of knowledge of the subject by the presenter to the audience.




BCOMMUNICATION EVENT

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(1) p. 711

Graphs should aim at clarity and simplicity. Like any other presentation, oral or written, they require clear knowledge of the subject to be conveyed and full appreciation of the needs of the intended audience.

2. Assignment

Chapter 26 is purely descriptive and presents no difficulty. It contains all the details you may need concerning the different formats commonly used. Read it in its entirety.

Classwork: Drawing 87

Homework: Drawing 88

3. Expectations

Given a set of data and a particular audience and occasion (e.g., technical presentation to your classmates, talk to a high school club, presentation to a potential sponsor, etc.), you will be expected to be able to chose a particular format for a graphic presentation and to justify your choice; to draw the graphs; and to explain, either in writing or orally, the significance of the information explicitly present on the graph.

ENGINEERING GRAPHICS

MODULE VIII: ROLE OF ENGINEERING GRAPHICS IN DESIGN AND PRODUCTION OF MECHANICAL PARTS **Weeks 12-13**

1. Purpose

This module is concerned with chapters 10, 11, 12 and 13 in your textbook. Its primary purpose is to allow you to understand the process of design of mechanical parts. All engineers should have some acquaintance with it, since it is at the heart of all manufacturing operations. Though you may never have to design any mechanical piece of equipment in your career, you certainly will have to use and possibly specify some regardless of your specialization. Moreover, the mental processes and the methods of approach, the use of standards, and the need for rationalization presented in these chapters are typical of industrial practices to be found in various aspects of industrial production. Eventually all engineering activity must end up in production, if it is to be fruitful.

Perhaps more clearly than anywhere else in the course on graphics, you have here an opportunity to see how problem-solving, communication, and value clarification are closely related to one another, and are three aspects of the single activity of design. The examples in your text relate to production of mechanical elements. Take them as illustrations rather than as the absolute requirements for all engineers. Computer technology, for instance, may appear at first sight quite different from automotive technology. The problems of production, however, particularly of precision mass production, that are predicated by technical, economic and societal factors, are of the same nature and are solved very much along the same lines of approach. This requires the engineer to have an intimate knowledge of shop processes, be that the heat-treating of metals or the manufacture of semiconductor chips.

Also, in both cases, the engineer needs a precise, clear, unambiguous means of communication between the shop and the design office, necessitating a specialized language under the form of standardized practices of drawing to give dimensions and other information required in the manufacturing process. The engineer needs well-defined standards and well-defined tolerances regarding the properties of materials from the mechanical, electrical or other viewpoint. Such properties include length, roughness, or hardness in a mechanical part, for instance, or resistance, capacitance, or transit time, in an electrical element. He needs a repertoire of standardized items constantly used in his field. Transistors and chips are, one might say, the nuts and bolts of electronic engineers and are catalogued, classified, standardized, schematized, and simplified, as are the nuts and bolts of machine designers in your text.

In machine design as well as electronic design precision mass production has led to similar responses. It would not be difficult to find analogous patterns in chemical or civil engineering, from the manufacture of plastic or oil products to the production of construction materials or prefab elements. Standardization has, in fact, completely reshaped the means of production from the days of Adam Smith's pin factory in 18th century England to present day calculator factories in Japan.

A reading of chapter 10, 11, 12 and 13 will acquaint you with the details of standardization in one field of engineering. You will see how machine tools have been and are still being designed and used to satisfy the requirements of precision imposed by the desire to obtain interchangeable parts; how a precise graphic language has had to be elaborated and has given rise over most of the world to influential national and international institutions such as the American National Standards Institute, British Standards Association and other professional committees and associations; how the lives of hundreds of millions have been affected by the technological answer to a seemingly simple, innocuous technical question. No doubt, volumes of analysis could be written in an attempt to clarify the values inherent in this development. But to limit ourselves to some things apparently more manageable, consider the change that has taken place in the relation between the engineer and the craftsman. As your text rightly points out:

> "The increasing need for precision manufacturing and the necessity to control sizes for interchangeability has shifted responsibility for size control from the machinist to the designing engineer and the draftsman."(1)

Obviously there must be a limit beyond which this responsibility shift cannot go. With the development of robotics, which introduces a degree of autonomy at the level of machining, it may seem that more breathing space is allowed to the task of the engineer. However, the engineer must also assume responsibility for the robot itself. (They are subject to failures, malfunction, and sabotage.) If, through Computer Aided Design and Computer Aided Manufacturer (CAD-CAM as it is known), certain aspects of drawing preparation

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1. Section 11-2, p 298

or of manufacture are mechanized,engineers will certainly have to program this mechanization and will have to incorporate into these programs details now left to the judgement of production engineers and technicians, bringing another shift of responsibility upward towards the engineer.

This is a fertile field for fresh thinking and for some basic value clarification. It would seem that every ounce of freedom gained at one end of the spectrum has to be paid for by an ounce of freedom lost at the other end and that it needs a pound of control injected in the middle to keep the balance. For instance, to allow users and customers to have available spare parts that fit and work wherever and whenever they obtain them - certainly an increase in their freedom in the use of what they have acquired in the first place - a precision of manufacturing and of control previously unnecessary had to be developed, restricting the margin of freedom of the machinist and tightening the control of the engineer. Now, who is "always" right, the customer or the machinist? And what does the engineer say and do in between? Is this not a political question involving labor, management, and the market? But why is it a question at all? The issues involved certainly lay claim to an indepth examination. It is not simplified by the fact that "machinists" and "engineers" are also "customers," "customers" are generally "machinists," and some even "engineers."

There are levels of values at play here, and values belong to frames of reference. These reference frames are dependent on viewpoints. They have, therefore, philosophical, religious, political and many other axes.

One can see over the years a progressive elimination of the machinist's work. There is a greater and greater formalization of his task, a "paperization" of the mental side of it, while the physical is taken over by mechanical devices, and responsibility is more and more assumed by the engineer. The social consequences of such a shift are tremendous.

At this point, you should become aware of the existence of these issues and their relationship to the nature of the engineering solution given to a particular problem, itself generated, defined and constrained by certain "desires" appearing as "values," and ultimately as "needs," in the society at large.

2. Assignment

**First Week**

Chapter 10: Read the entire chapter. Visit the workshop in the basement of the engineering building to see lathes, drill presses, and other machine tools if you have never seen any. Get a sense of the relationship between mechanical design and machining. In particular, reflect on the "Do's and Don'ts of Practical Design" shown in your text section 10-32. Understand the reasons for the preferred shapes.

Homework: Fig. 14.104 (p 471) in your text shows the perspective drawing of a gate valve. As a homework, answer the following questions:

a. What is a gate valve and its function?

b. Consider the valve body (item 1):

- By what main process is it made? Briefly describe the sequence of steps in this process.
- What is the material used?
- Why is this particular shape chosen?
- Describe the sequence of machining operations that have to be specified to complete the valve body.
- Are additional machining operations, not suggested by the appearance of the drawing, needed before the valve body can be used?

Classwork: Answer the following questions concerning fig. 14.49, p 430 in your text:

a. What is a drill press base and its function?

b. By what main process is it made? Briefly describe the sequence of steps in this process.

c. What is the material used?

d. In light of the "Do's and Don'ts of Practical Design," would you suggest any improvement in the proposed shape? Why?

e. Describe the sequence of machining operations that have to be specified to complete the base.
You may be required to present your answers orally.

Chapter 11: **Read** the entire chapter. In particular note section 11.44 (p 330 ff) on the "Do's and Don'ts of Dimensioning." Note in particular what the text says: "The student should check the drawing by this list before submitting it to the instructor."

Classwork: Drawing 40
Homework: Drawing 41

**Second Week**

Chapter 12: Read up to and including section 12-12.

Classwork: Drawing 42
Homework: Drawing 43

Chapter 13: Omit sections 13-11, -12, -13, -17, -18, -22, -29 up to and including -32.

In our practice, we shall use the simplifiea representation of threads only.

Classwork: Drawing 45
Homework: Drawing 47

Value Clarification Exercise: In view of our discussion of values and their effect on the solution of technical problems in the first section of this module:

- List, in order of what you perceive as the importance of their effect, as many "values" as you can which have shaped the design of standards in general.

- Consider the same question for particular standards of Surface Quality discussed in your text section 11-42.

These lists, clearly written out or typed, should be handed in with the homework on Chapter 13.

3. Expectations

Having studied and worked out the exercises assigned in this module, you should have at your command a more precise graphical language. Note that it is the method and the structure of that language which are important, giving you a glimpse into the world of production engineering and of its relation to society. But to get to know method and structure, you have to get down to specifics. You will therefore be expected to know the assigned specifics well.

The problem-solving aspect of these assignments is minimal, since it is mostly a matter of developing skills in using a new vocabulary, a new repertoire of notations to convey specific information. It is therefore more in the nature of a communications exercise at level one. The value clarification exercise is also elementary and concerned with level one.

To stimulate your thinking in breadth and in depth concerning issues that should be of great interest to engineers, video-panel discussions will be organized according to a schedule given to you in due time where you will be invited to participate in considering topics related to the valueissues raised in this module. Typically, you will be given about 15 minutes to organize your thoughts on a given subject. It is therefore imperative that you become familiar with the ideas to prepare yourself for this panel discussion. The best way may be for you to hold, among yourselves, a series of informal "bull sessions" to thrash out some of the concepts involved. You may also, of course, talk to the instructor in and out of class. The panel presentation itself will be formal. In addition to the soundness of the ideas presented, the quality of language, and the individual manner of presentation, the dynamics within the group and the overall group impact will be assessed.

# INTRODUCTION TO POLITICS

PROFESSOR ANNE GRIFFIN

ONE-SEMESTER COURSE, REQUIRED OF SOPHOMORES, 3 CREDITS

This introductory course in Political Science focuses on the study of power relationships in public affairs. It is designed to provide a basic understanding of political behavior, of the institutional structures which are the setting for political activity, and of some of the political issues -- perennial as well as current ones -- that we face. Although the readings deal specifically with the American system, many of the concepts encountered have a more general application and will be considered in a broader context wherever possible.

- COURSE INTRODUCTION
- SUMMARY COURSE OUTLINE
- COURSE ASSIGNMENTS BY WEEK AND RELATED DETAILED COURSE OUTLINE SEGMENTS

# INTRODUCTION TO POLITICS
## COURSE INTRODUCTION

COURSE DESCRIPTION

The purpose of this course is to introduce you to the study of power relationships in public affairs. Our work this term will focus on both political behavior and political structure. A major emphasis of this course will be on learning to think politically. Who gets what, when, and how? What are the implications of a given choice or action for the distribution of power within the community -- whether local, national or international? A second focus will be on the structure of power. We will review the formal design of political power as presented in the constitutions of the United States and other modern nations. We will contrast these models, where appropriate, with evidence of other sources of power. Although the assigned readings deal specifically with the American political system, many of the concepts encountered have a more general application and will be considered in broader context.

One of the first things we will do in this course is to learn to think politically. This means learning to recognize the political aspects of human interactions. What is political, for example, in Ronald Reagan's Inaugural Address? What are some of the forms of political communication employed in the speech? How and why are they compelling to the listener? How does President Reagan demonstrate his ability to wield political power in this address? Another type of political analysis involves the use of various formal strategies. This is, in a sense, politics "from the inside out" -- the rules or set of rules by which a person involved in politics makes the decisions most likely to produce a desired outcome. A third way of looking at politics is through the window of political philosophy. In this view, descriptive analyses of politics are incomplete unless they also deal with those "forms of political action that are considered 'acceptable' or 'functional' and those political forms considered to be deviant and worthy of rejection."*

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*(Kenneth L. Deutsch, "Competing Visions of American Politics," in Alan Shank American Politics, Policies and Priorities, 3rd Ed., Boston, Allyn and Bacon, 1981, pp 6-19).

A somewhat more comprehensive view of politics is offered by both power models and constitutional models. The existence of elites and masses, on the one hand, and interest groups, on the other, has been described by various political scientists in an effort to explain the political "process" or "system." By constrast, the U.S. Federal Constitution was drafted not for the purpose of describing or explaining an existing power structure but to establish a new one.

Opinion is divided on the extent to which the Constitution reflects the society which produced it; it is perhaps a more defensible proposition that the Constitution has produced a society which reflects it. In this sense, the Constitution offers yet another framework for understanding the workings of the American political system.

Each of the approaches outlined above deals with the exercise of power, which is at the heart of the political transaction. Each approach will be considered in class before we begin our survey of the American political system. In this way the dynamics of power which animate the American political process can be better understood.

This part of the course not only deals with approaches to the study of political institutions, but also includes political communications, political strategies, and political values. Politics relies, to a very significant degree, on these competences. A successful politician must be highly skilled at communicating. He must also demonstrate a flair for solving a variety of problems, some of which are routine, some of which defy definition. In addition, the skilled politician must be able to understand both his own values and those of his constituency. He must be adept at value clarification to be able to discern which political choices are consistent with these sets of values and which are not.

By examining how political communications are made, how strategies are formulated, how new situations can be understood, and how one's values remain consistent within a political context, you will continue to develop your own competence in each of these important areas. The study of politics offers some very interesting models for these three competences.

COMPETENCES

By the start of this semester you should have reached level 1 in problem-solving, level 2 in communication, and level 1 in value clarification.

This means that when you start the class you should be able to do the following:

Problem-Solving: Demonstrate ability to formulate assumptions and identify implicit and explicit elements in order to apply simple common principles and methodologies in specific situations to obtain a realistic solution.

Communication: Demonstrate ability to receive and send information via oral and media presentation, nonverbal cues, written materials, and numerical and graphical representations in standard academic assignments. (Here the emphasis is to be on psycho-motor skill, coordination, poise, speech habit, voice training, and grammer.)

Value Clarification: Demonstrate ability to identify one's own values and their sources as they relate to a specific situation by observation of one's own attitudes, opinion, feelings, thoughts, beliefs, goals and morals.

By the end of the term you should also be able to demonstrate your competence at level 2 in problem-solving, level 3 in communication, and level 2 in value clarification. This means that you should be able to do the following things as well:

Problem-Solving: Analyze situations new in configuration but similar to known ones in substance and identify relationships in a given system or situation; recognize needs and synthesize alternative proposals and problem-solving strategies; carry out a project within a well-defined field, interpret results, critique your own and others' work in the area; and draw conclusions for further action.

Communication: Demonstrate the ability to use these skills creatively and originally in actual involvement at the professional level.

Value Clarification: Demonstrate understanding of the philosophical, religious or cultural and social basis of values and of the development of science and technology as a reflection of values (in different traditions and civilizations).

## ASSIGNMENTS AND INSTRUMENTS

There are two types of assignment for this course: reading assignments and learning instruments. For each part of the course, you will be asked to read a specified number of pages in one of the four required texts, or one of the assignments included in this study guide. The learning instruments consist of a series of activities, frequently involving a written presentation, which you will be asked to complete. There are nine of these assignments. In the beginning, they tend to be briefer and fall closer together; toward the end of the course they require more preparation and are spaced further apart.

The learning instruments have been designed to serve two purposes. The first is to help you develop your competence in problem-solving, communication, and value clarification. The second is to assess these competences to find out how well you are able to satisfy this aspect of the course requirements. You will be graded on both content and competence. You will usually have at least two assignments at each level of competence. When you progress to a new level, you will be given a written or oral assessment of your work, but only when a competence is repeated at that level will your assessment involve a grade. The exception is that when you have already attained that level in a previous course, you will receive a grade as part of your first assessment. This procedure has been designed to help you move through the levels of competence with minimum stress and maximum speed. By incorporating feedback into the assessment process, we intend to involve you as an active partner in your own education.

# INTRODUCTION TO POLITICS
## SUMMARY COURSE OUTLINE

I. Models of the political system

- A. The nature of politics
- B. Political strategy: naive and sophisticated
- C. Philosophical models
- D. Power models
- E. Constitutional models

II. American politics

- A. Interest groups
- B. Pressure groups
- C. Political parties
- D. Congress
- E. The presidency
- F. The executive branch and the bureaucracy
- G. The federal judiciary

III. The structure of power in America: public and private

- A. Corporate power and American politics
- B. Corporations and political accountability

IV. Political power at the local level

- A. The theory of stratification and community power
- B. Alternative exlanations of community power
- C. New Haven 1957
- D. New York 1981
- E. Ideology and power in American cities

COURSE TEXTS:

Shank, Alan, ed; American Politics, Policies, and Priorities, 3rd Edition, Boston: Allyn and Bacon, 1982

Ingersoll, Thomas G. and O'Connor, Robert; Politics and Structure: Essentials of American National Government, 2nd Edition, Boston: Duxbury Press, 1979

Nadel, Mark V., Corporations and Political Accountability; Boston: D.C. Heath, 1976

Polsby, Nelson W.; Community Power and Political Theory, New Haven: Yale University Press, 1980

# INTRODUCTION TO POLITICS

## COURSE ASSIGNMENTS BY WEEK AND RELATED DETAILED COURSE OUTLINE SEGMENTS

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INTRODUCTION TO POLITICS **Week 1**

Detailed course outline segment:

I. Models of the political system

A. The nature of politics

- Interaction between two or more people
- Power, choice, and freedom
- The polis
- The use of force
- Politics as talk

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Instrument #1:

This assignment looks at communication as an important ingredient in politics: how arguments are presented and how visual images and words are used as emotional symbols.

**READ** the article, "Personal Scripts and Political Dramas"*

**WRITE** a brief definition of a "linear" argument and an "agglutinative" argument. Both types of arguments are used in politics; you will, indeed, find both types in Reagan's inaugural address.

Next, **VIEW** the tape of the Reagan inauguration. In order to examine the various techniques of political communication used here, you should:

1. Take notes on each of the ideas touched on Reagan in his speech. Underline each idea that seems to you to be repeated. Which ideas seem to stand out?

2. Look over your notes again. Do you see examples of both "linear" and "agglutinative" arguments? Briefly outline them, using as few words as possible. Which type is more persuasive? Look again. Do the arguments merge? How?
3. Take any two statements made by Reagan in this address. What is he saying? Now translate each of these statements: What does

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* Bruner, Jere. "Personal Scripts and Political Dramas: Demonstrations as Imitative Magic." Paper delivered at Annual Meeting of the American Political Sciences Association, the New York Hilton Hotel, September 3-6, 1981.

he make you feel? Do you find that he is actually encouraging you to think of something else? This is called latent content, and the use of latent content is a very powerful tool in political communication.

INTRODUCTION TO POLITICS **Week 2**

Detailed course outline segment:

I. Models of politics

B. Political strategy: naive and sophisticated

- Some ironies and paradoxes
- Playing to win: vote strategies in a general election
- Politics and the individual

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Instrument #2:

Politics is not only a form of communication; it is also a strategy of power. The savvy political actor must make the appropriate choices if he is to succeed in politics. (Political success means either a) achieving one's goals or b) remaining in power so as to participate in future decisions, or both a) and b).) One of the most common things politicians do is get elected. Since in order to be elected a politician has to get at least a plurality of the popular vote, one of the first things a smart candidate will do is try to find out how the people feel about certain issues. Then, if his conscience will let him (and it probably will), the candidate will probably try to take positions on issues which will correspond with the feelings of the electorate What happens if all the candidates decide to take the same position? Does this mean that the election will be decided on the basis of who has the fullest head of hair, the bluest eyes, or the most reassuring smile? Not exactly. Elections are sometimes decided on the basis of factors other than the issues, but it's even less likely that all candidates will decide to take the same position on every issue. For one thing, voters represent a variety of interests and political positions on issues, and each candidate will have an easier time getting certain people's votes than others'. The trick is, if a candidate is to get elected, to put together a winning coalition.

One of the people who has studied this aspect of politics in some depth is Steven J. Brams, Professor of Politics at New York University. The reading assignments for this part of the course are drawn from two of his works.

For this assignment, **READ** the chapter, "The Primaries: Who Survives the Hurdles?," from Steven J. Brams, The Presidential Election Game, New Haven: Yale University Press, 1978.

**BE ABLE TO DISCUSS** the following questions in class:

1. Why is the Presidential election process called a "game?"

2. If we were candidates, what is the first thing we would need to know?

3. What do the following concepts mean?

| | |
|---|---|
| unimodal | median |
| bimodal | mean |
| symmetric | "band" position |
| nonsymmetric | salience |

4. What main assumptions must be understood, if Brams' theory is to be judged sound?

5. How does the picture change when a third candidate enters the race? Why? What happens when a fourth candidate enters? Why?

6. How does a candidate deal with the problem of multiple issues?

For the second part of this assignment, let's assume that our candidate has been successful, and that he has been elected to Congress. He has now become involved in a number of political strategies. One of the first things he learned, as a freshman Congressman, is that procedures often determine outcomes. In certain cases, the result is quite the opposite of what he might have expected. This phenomenon has been called by Professor Brams "The Paradox of Second Best."

To understand this "paradox of second best," let's digress for a moment. We normally think of rational behavior as meaning that we choose the most-preferred alternative available to us. However, in certain situations it is best to choose a less-preferred alternative. Why? Look at the following example.

In the 1948 Presidential election, there were three major candidates, the Republican (Dewey), the Democratic (Truman), and the Progressive (Wallace). A number of democrats favored the Progressive candidate, Wallace. Nevertheless, they voted for Truman because they felt that Wallace had no chance at all. If enough people voted for Wallace, Dewey, the Republican candidate would win. "Thus a vote for their favorite candidate ironically increased the probability that the one they favored least would win. To avoid the latter outcome, they voted for the candidate ranking in the middle of their preference ordering."

Is this rational behavior? Did the Democrats who voted for Truman, even though they favored Wallace, act rationally or irrationally? The answer is that rational behavior <u>may</u> mean choosing a "second best" alternative. The conflict between preference and choice is called the paradox of second best.

Something similar to this occurs when people or groups of people vote on bills. In the next part of this assignment we can see the influence of voting procedures on outcomes.

**READ** Brams, Chapter 1, "The Paradox of Second Best," in Paradoxes in Politics: An Introduction to the Nonobvious in Political Science, New York Free Press, 1976.

**READ** the following paragraphs:

The Reagan administration has introduced a bill to reduce taxes by 10% a year for the next three years. Do you support the bill, oppose it, or would you prefer to see some intermediate step taken - perhaps in the form of an amendment requiring that these cuts be linked to cuts in spending?

To begin this assignment, take a position. You will favor the original bill (O), oppose it (N), or want an amended version (A).

Now assume that the bill is about to come to the floor of the Senate for debate and passage. Before the vote on the issue, there will be a vote on the procedure to be followed - that is, on whether the Senate will vote first on the original bill, and that failing, on the amended one; or first on an amended version, and that failing, on the original one; or first, on a motion to table the bill. Let's assume also that each voter has complete information, and that he is voting sincerely.

Which voting procedure is most likely to produce the outcome you wish? Which two are most likely to produce an amended version?

**DRAW** a tree indicating the outcome and explain your answers.

INTRODUCTION TO POLITICS

Weeks 3 and 4

Detailed course outline segment:

I. Models of politics

C. "Philosophical" models

- Ideals of democracy
- Platonic versus Aristotelian models
- Public and private redress

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Instrument #3:

Assignment: **READ** the selection from Aristotle, handed out in class, and Charles A. Reich, "The New Property," Yale Law Journal, 1973, pp 733-787. Pay particular attention to the difference between public and private.

**WRITE** 300 words about the difference between what is public and what is private. How do these two "realms" differ? What is the basis for distinguishing between the two? Do you feel this distinction is important and why? Give examples, whenever possible.

Your answer will be graded on the following:

**PROBLEM-SOLVING:** Dealing with unstructured, open-ended questions.

**COMMUNICATION:** Level 2. Developing an idea. Organizing an argument.

**VALUE CLARIFICATION:** Level 1. Identifying and defining one's own values.

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Instrument #4:

Having read two contrasting selections on the nature of the public and private "realms," we have proceeded to drafting our own definitions of these terms. In defining "public" and "private," we have, most likely, based our distinctions on a set of values. It is helpful to reflect, briefly, on what these values really are. Do we, for example, agree with Aristotle's belief that the "public" realm, being more advanced teleologically, is inherently better? What bases are there for this distinction?

This assignment has to do with the application of these "value-definitions" (as they can appropriately be called) to a specific situation.

**READ** the following scenario:

Professor Urban Grandier teaches at an inner city college. There are approximately 2,500 students in this state-supported school which, because of its tradition of excellence and demanding curriculum, is highly competitive. Students are accepted on the basis of a rigorous examination from throughout the Metropolitan area.

Because of a freeze on State funds, there are no dormitory facilities at the College. Many students commute at least one hour in each direction by bus. Some require a number of changes, which can lengthen the trip to nearly two hours. The area in which the college is located offers little in the way of suitable living space. The neighborhood has fallen victim to urban blight in recent years, and the residential buildings, once four- and five-story tenements, stand vacant. Most of the windows have been boarded up to prevent use of the buildings by derelicts, and this strategy appears to have been successful. Interspersed with these abandoned tenements are a number of warehouses and commercial buildings, a meat packaging plant, a bakery, an experimental art gallery, a film makers cooperative, and a cheese outlet.

Professor Grandier teaches several courses in planning and one in alternative technologies. Recently it occurred to him that one of these abandoned buildings could make an ideal laboratory for his alternative technologies course. The students could design a dormitory facility, with assistance from the instructor, in which they could live until graduation. Other classes could design and construct similar spaces for themselves as more vacant buildings became available to them. What is more, these buildings could be bought at auction from the city for virtually nothing.

Victor Helmsman, a successful builder and developer, has recently established a fund for supporting innovative urban beautification and urban renewal projects. He is enthusiastic about Grandier's project, and is willing to fund it. Thus, nearly all of the construction costs will be underwritten. Furthermore, the President of Grandier's institution is eager to see the project get underway. Although he cannot officially endorse it, he knows it will be highly beneficial to the school, and he looks forward to increased informal contact with his old college chum, Helmsman.

* * * * * * *

Imagine that you are a student in Grandier's class. The required funds have been earmarked and set aside. An air of excitement pervades each class meeting. In the middle of the semester, Professor Grandier bursts into the classroom 45 minutes late. "It's no use," he cries. "They won't give us any leeway." City regulations now require that each unit in a multiple dwelling be equipped with its own shower and toilet facility. They further specify certain minimum dimensions for each bedroom, thus effectively eliminating any possibility for common living and kitchen space. But that is not all: certain materials which are essential if the students are to carry out the project themselves cannot be used under existing codes. In short, the whole project is in jeopardy because it does not conform to certain pre-existing regulations.

Having committed three to four hours per day for the last two years, you are understandably upset. True, the project does not conform to existing regulations, but it is different. It is not being offered to the general public, but to a small number of students, whose requirements are quite different. It is being designed and constructed under the watchful eye of an instructor with degrees in engineering, architecture and urban planning. It is privately funded. You skip your next class and walk over to the site - only 2 blocks away - to brood and stew over the matter. What right do they have, you ask yourself, to interfere in this project? The area had gone to the dogs. The project would only have helped. Now there will be nothing.

**THINK ABOUT IT.** What right does government have to intervene in private matters such as this one? **WRITE** a letter to your closest friend, explaining your position on this issue. **ASSUME**, (for the sake of this exercise) that your friend has read your first essay on public and private. Have you had to modify your definitions of public and private somewhat? If so, be sure to say how.

**N.B.** Please return your "public and private" essay along with this exercise.

INTRODUCTION TO POLITICS **Weeks 5 and 6**

Detailed course outline segment:

I. Models of political system

D. Power models

- Power and powerlessness in America
- Elites. C. Wright Mills and the "power elite." The idea of "democratic elitism"
- The iron law of oligarchy
- The irony of democracy
- Assessing competing models: problems of value clarification

E. Constitutional models

- The American Constitution
  - genesis
  - idea of mixed government
  - separation of powers and alternating power bases
  - idea of limited government
  - checks and balances
  - federalism
- Some other constitutional formats
- Federal systems

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**READING ASSIGNMENT:**

**Week 5:** Shank, Democracy and the American Political System. Chapter 1; Article 1 (Deutsch), Article 2 (Dye and Ziegler). Chapter 2; Article 3 (Roche), Article 4 (Smith), Article 5 (Madison).

**Week 6:** In Shank reader, Chapter 4, "Federalism," Articles 12 (Riker), 13 (Leach), 14 (M. Reagan), 15 (Sutton).

Instrument #5:

Assume that you have been asked to speak before a 9th grade class on the power structure of the United States. Prepare 2-3 pages of notes, such as you would use in your presentation. Be sure to incorporate all the power models used in class. You may also use graphics or diagrams.

Your assignment will be graded on the following:

**PROBLEM-SOLVING:** Level 2a. Analyze situation familiar in substance but uncharted in configuration. Identify relationships in a given system.

**COMMUNICATION:** Distinguish between information from different sources and synthesize information from diverse sources. Clarify message through establishing context.

INTRODUCTION TO POLITICS **Weeks 7 and 8**

Detailed course outline segment:

II. American politics

A. Interest groups

- Characteristic features
- Impact on American politics
- Interest groups and public policy

B. Pressure groups

C. Political parties

- Their "place" in the American Constitutional system
- Historical aspects of the party system
- Political parties and "mainstream" politics
- The future of party politics in America

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**READING ASSIGNMENT, WEEKS 7 AND 8:**

In Shank reader, Chapter 5, "Interest Groups," Articles 16 (Madison), 17 (Schattschneider), 18 (Lowi), 19 and 10 (Williams); Chapter 6, "Political Parties," Articles 21 (Keefe), and 22 (Broder).

Instrument #6

Found a new national political party which will offer a real alternative to the republican-conservative mandate of the 1980 general election. Which groups will it appeal to? How will it hope to put together a winning coalition? Find out the approximate number of voters in each of the major groups.

Your assignment will be graded on the following:

**PROBLEM-SOLVING:** Level 2. Analyze situations new in configuration but familiar in substance. Identify relationships in a given setting. Recognize needs and synthesize alternative proposals and problem-solving strategies. Carry out a project within a well-defined field.

INTRODUCTION TO POLITICS **Weeks 9 through 12**

Detailed course outline segment:

II. American politics

D. Congress

- Functions and powers of Congress
- The legislative process
- Party politics and pressures from outside
- The committee system
- Proposals for reform

E. The Presidency

- The office and its powers
- The growth of Presidential power
- Terms of office and succession
- Elections

F. The Executive branch and the bureaucracy

- The nature of bureaucracy and large-scale organizations
- Executive departments
- Independent executive agencies
- Independent regulatory commissions
- Government corporations
- Problems of the civil service and proposals for reform
- Relations with constituents and with other branches
- Implications for the citizen

G. The Federal Judiciary

- Scope and nature of American law
- The structure of the judiciary
- The role of the Supreme Court
  activism versus restraint
  leading constitutional decisions

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**READING ASSIGNMENTS:**

**WEEK 9:** In Ingersoll and O'Connor, Chapter 2, "The Congress"; in Shank reader, Chapter 9, "Congress," Articles 34 (Business Week), and 35 (Szulc).

**WEEK 10:** In Ingersoll and O'Connor, Chapter 1, "The Preidency"; in Shank reader, Chapter 8, "The President and Bureaucracy;" Articles 27 (Lammers), 28 (Cronin), and 29 (Barber).

**WEEK 11:** In Ingersoll and O'Connor, Chapter 3, "The Federal Bureaucracy"; in Shank reader, Chapter 8, Articles 30 (Herbers), and 31 (Congressional Quarterly).

**WEEK 12:** In Shank reader, Chapter 3, "The Bill of Rights," Articles (cases) 6 through 12, (U.S. Supreme Court); Chapter 10, "The Supreme Court;" Articles 36 (U.S. Supreme Court), 37 (Abraham), 38 (Totenberg), and 39 (Becker); in Ingersoll and O'Connor, Chapter 3, "The Federal Judiciary."

Instrument #7

Prepare for a 20-minute, videotaped round-table discussion dealing with the questions:

- Is the present constitution reflective of the existing power structure?
- Is it an appropriate instrument for maintaining the existing system?
- Is this function - system maintenance - compatible with the preservation of democracy?
- What changes, if any, should be made in the present constitution?

Two discussion leaders will be chosen. The discussion leaders will then, in consultation with one another, choose the members of their respective groups, and the results will be announced in class.

The two groups will present their round-table discussions separately, during one of the regularly scheduled class periods. In fairness to the group whose discussion is being recorded, the others will be asked to wait outside the classroom. After both groups have finished their presentations, the class will review the videotape together for constructive comment and discussion.

**PROBLEM-SOLVING:** Level 2. Analyze situations new in configuration but similar to known ones in substance. Recognize needs and devise alternative proposals and problem-solving strategies.

**COMMUNICATION:** Level 1. Demonstrate ability to receive and send information via media presentation, within the context of a standard academic assignment.

**VALUE CLARIFICATION:** Level 2. Demonstrate understanding of the philosophical and social basis of the value, democracy.

INTRODUCTION TO POLITICS **Weeks 13 and 14**

Detailed course outline segment:

III. The structure of power in America: public and private

A. Corporate power and American politics

- Factors in the quest for corporate power
- Corporations in government
- Corporations as government

B. Corporations and political accountability

- Should corporations be politically accountable and why?
- Problems in establishing accountability
- Possible reforms and suggestions

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Instrument #8

**READ** Nadel, Mark V., Corporations and Political Accountability

You are going to videotape a 5-minute guest editorial for television, expressing your views on the following problems:

- Is corporate nonaccountability a problem in the United States?
- How serious a problem is it?
- What problems are there in establishing accountability?

Before taping your presentation, make a list of alternative proposals and strategies for dealing with the problem. From this list, identify the most feasible and work them into a coherent program.

Conclude your videotaped presentation with recommendations to Congress and the administration for appropriate reforms.

Your assignment will be graded on the following:

**PROBLEM-SOLVING:** Level 3. Analyze situations new in substance and configuration, with strong interdisciplinary elements. Synthesize alternative proposals and problem-solving strategies. Establish relations to a wider context. Exhibit critical spirit.

**COMMUNICATION:** Level 2. Use skills in situations involving prepared presentation. Level 3. Use these skills within the context of a professional addressing a professional audience.

INTRODUCTION TO POLITICS **Week 15**

Detailed course outline segment:

IV. Political power at the local level

A. The theory of stratification and community power

B. Alternative explanations of community power

C. New Haven, 1957

D. New York, 1981

E. Ideology and power in American cities

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Instrument #9

**PART ONE** (Assignment given in Week #1; due week #15)

Find out when the Community Board in your area is scheduled to meet.

Attend one of the scheduled meetings.

**WRITE** a one-page summary of the issues dealt with at the meeting, the apparent power groups, and the factors which determined how the issues were resolved. Be prepared to discuss it in class during the last week of the term.

Your assignment will be graded on the following:

**PROBLEM-SOLVING:** Level 2a. Analyze situations new in configuration but similar to known ones in substance. Identify relationships in a given system or situation.

**PART TWO**

**READ** Nelson R. Polsby, COMMUNITY POWER AND POLITICAL THEORY, 2nd Edition, Chapters 1 through 7.

**NOTE** the different approaches to the study of community power. Which of these would seem most appropriate to the community board you wrote about? Are there any other approaches that might help you to explain what you observed? What conclusions can you draw?

What is stratification theory? How is it used to explain the mechanics of power in Muncie, IN; Newburyport, MA; Philadelphia, PA; Atlanta, GA; Baton Rouge, LA; Ypsilanti, MI; and Seattle, WA? How well does it explain who gains and who participates, and who prevails in decision-making matters? How well does it explain the dynamics of power in the community meeting you attended?

What is the "pluralist alternative?" How well would it explain things that are not explained by stratification theory? How well would it explain the power mechanics of the community meeting you attended?

Be **READY** to discuss these and other implications of COMMUNITY POWER AND POLITICAL THEORY at the last class meeting.

# ENVIRONMENTAL FUNDAMENTALS

PROFESSOR JOHN BOVÉ

ONE SEMESTER COURSE, UPPER LEVEL SEMINAR, 3 CREDITS

The nature of the environment -- air, water, land and solar radiation interrelationships. Demographic trends, material and energy demands and the environment. Sources of environmental pollution and legal activities toward their control. Facts affecting pollutant levels in the atmosphere.

- COURSE INTRODUCTION
- TECHNICAL SYLLABUS
- COURSE ASSIGNMENTS AND PROJECTS WITH COMPETENCE COMPONENT

ENVIRONMENTAL FUNDAMENTALS
COURSE INTRODUCTION

The technical syllabus, the course material dealing with the concepts and principles of environmental fundamentals, will include:

- general considerations of air pollution (e.g., carbon monoxide, nitrogen oxides, hydrocarbons, sulfur oxides, particulate matter, trace metals, trace organics, etc.)
- water pollution (e.g., comparison of polluted and unpolluted water, oxygen-demanding wastes, pathogenic organisms, plant nutrients, synthesized organics and inorganic compounds, oil, radioactive substances, heat, etc.)
- introduction to environmental law (e.g., Air Quality Act of 1967, the Clear Air Act Amendments of 1970, the Federal Water Pollution Control Act, and the Rivers and Harbors Act of 1899, Air Quality Criteria and Standards, and Pollutant Analysis).

In addition to the technical syllabus, this course will endeavor to sharpen the students' competence skills of problem-solving, oral and written communication, and value clarification. It should be noted that this is an elective course usually selected by upper-level students, and therefore, will build on course work and competence skills earlier experienced.

To accomplish the integration of the three competence skills with the normal course content, the course has been structured so that some of the teaching responsibility will be delegated to individual students. For example, a part of the course content will be covered by out-of-class reading; individuals in close consultation with the instructor will deliver some of the class lectures and seminars; and a scheduled number of class assignments will make use of the case-study learning approach.

The case-study approach will outline problems for solution to students. These should, in most cases, serve two purposes. On one hand, the assignment will introduce the class to new technical material or will enhance information already covered; and on the other hand, it will also serve as a teaching instrument to strengthen the competence skills. There will be no traditional examinations in this course.

This course will provide students with follow-up experience in dealing with a number of professional competences. Students will be placed in small work groups to work on open-ended problems. In this setting they are encouraged to think, collect data, communicate ideas and information, and finally to decide on a reasonable solution to a problem posed.

A written statement of the problem, including any information the instructor may wish to include as part of the problem, will be given to the student, and the assessment of the solution will then follow. The instructor will be available to act as a consultant, but will avoid steering the student.

## Assessment Categories

Course assessment will fall into two main categories. In the first category will be placed the traditional course material that one may label as "concepts and principles." These concepts and principles will be assessed in the usual way (i.e., quizzes, and hour exams). In the second category will be placed the three competences that will be included as part of the syllabus for this course -- problem-solving, communication skills, and value clarification. Listed below are the competences with a definition of respective levels of achievement.

## Problem-Solving Levels Defined

The problem-solving skill will be examined at two levels. At the first level the student should be capable of defining problems, selecting potential approaches to their solutions, and, finally assembling the necessary information and data for their solution. At the second level the student should exhibit an ability to select wisely from the list of proposed solutions. Here, a more sophisticated input to the problems solution might include economics, politics, ethics, etc.

## Communications Levels Defined

The communication skills will be defined and assessed at three levels. At the first level the student should be capable of communicating his thoughts and feelings in writing (e.g., letters, memos, technical reports), given reasonable notice and preparation time. At the second level, the student, in addition to his ability to write clearly, will be expected to stand on his feet and deliver an oral summary of a previously prepared written report. It is understood that reasonable notice and preparation time will be given to the student. At the third level the student should be capable, with litle preparation time, of putting together a written and/or oral presentation (using material and data he has previously examined).

Value Clarification Levels Defined

The competence of value clarification will be addressed at only one level. Here the student will be asked for a given situation, to identify and list his values and to then compare them with those of others.

Assessment of Competences

Unlike the technical syllabus, the student will not be assessed a letter grade for competence skills. Students will be evaluated as satisfactory or unsatisfactory, with further comments such as good, poor, or fair associated with portions of the assignment.

## Problem-Solving Assessment, Level One

Purpose

At this level the student is assessed for his ability to define problems, to select solutions, and to place the necessary information and data together to formulate an answer.

Method(s)

To demonstrate his ability to deal with problem definition, solution selection, and data collection, the student is evaluated through a series of tasks he is asked to perform. These assignments will be selected so that the earlier ones will pose fewer difficulties.

An early assignment might consist of the preparation and delivery of a 30-minute seminar on a topic included in the course syllabus. This assignment should bring the student in contact with a number of competences. He will initially be engaged in problem definition. For example, if the seminar to be delivered is on carbon monoxide pollution, the student will be faced with making a number of decisions. He will have to decide if carbon monoxide pollution is characteristic of the urban or suburban environment (or both), he will have to decide on the major sources of pollutant, he will have to familiarize himself with some of the chemistry (origin and sink) of carbon monoxide, and certainly he will be faced with the task of an extensive library research. Finally, the student will soon find out that a great deal has been published about carbon monoxide, so that he will ultimately have to edit the material and illustrations he will wish to include in his 30-minute talk.

Clearly, this assignment contains elements that will give the student practice at levels one and two of the communication skills and it might also contain some relevance for value clarification (e.g., the automobile versus mass transportation).

Criteria for Assessment

Level One: The criteria for judging the successful completion of level one should include the following:

(a) the student's ability to restate the problem (e.g., in the case of the carbon monoxide seminar assignment, successful completion of this portion of the assignment will be trivial).

(b) the student's ability to gather information and/or data needed to successfully attack the problem (this should include sources of information and reliability of information - in the instance of the carbon monoxide assignment, this criterion might be satisfied by preparing a comprehensive bibliography).

(c) the actual gathering of the information (part of a successful completion of this criterion should include a listing by importance of the material included and also the material excluded (e.g., in the case of the carbon monoxide assignment, the time constraint of 30 minutes will help dictate what material will be included).

Level Two: The criteria for judging the successful completion of the second level of the problem-solving competence will include the student's ability to compare and evaluate from his list of alternate solutions. These solutions will be judged for their elements of time, economics, ease of implementation, etc.

Feedback

Student evaluation and feedback will take a number of forms. In one instance peer evaluation and feedback will be used. Here, in a classroom setting, the student's peers will be called upon to critique the student's work, and, finally, to provide suggestions for improving his competence skill.

In another instance the instructor will provide evaluation feedback. This feedback might be in writing, where a student's report might contain the instructor's comments in the margins, or it might be oral.

## Communication Skill Assessment, Level One

Purpose

At level one the student should be capable of communicating his thoughts and feelings in writing. It is understood that sufficient notice and preparation time will be given.

Method(s)

Different modes of evaluation will be used. For example, the student might be called upon to write a speech, or he might be asked to construct intra and interoffice memos, or he might be called upon to write a comprehensive technical report. These activities will provide the practice the student will need to improve his level one communication skills, and it will also provide the evaluation instrument for assessing this competence.

Criteria for Assessment

Judgement for the student's arrival at level one competence, will include the following guidelines:

(a) The student will be expected to write with clarity, using proper spelling, punctuation, and grammar.

(b) The student will be expected to exhibit clarity in his thinking, being able to distinguish his own observations and feelings from other sources of general and specific information.

(c) The student will be expectd to structure a report properly (i.e., dividing the framework of the writing into the introduction, the body, and the conclusion).

Feedback

Feedback shall be provided to the student by the instructor through regularly scheduled conferences. If, in the opinion of the instructor, the student is in need of remediation, extra help will be recommended.

## Communication Skill Assessment, Level Two

Purpose

At this second level, the student in addition to writing well, will be expected to orally communicate with an audience. Reasonable notice and preparation time will be included along with assignments.

Method(s)

Several categories of assessment will be applied. In one type, the student will prepare a short talk at the audio-visual center, and will replay the tape later for self-assessment. In another instance, the student might be asked to present material to the class. In this case, the assessment will come from both the class and the instructor. In addition, periodic personal conferences will be scheduled. Finally, whenever the student or the instructor deems it necessary that extra help is needed, the student will be directed to the communications clinic for assistance.

Criteria for Assessment

The following judgement criteria will be included in level two evaluation:

(a) the ability to speak on one's feet with minimal use of notes

(b) the ability to organize material and conveyone's thoughts clearly

(c) the ability to reach one's audience via delivery techniques, including proper articulation, voice projection, personal appearance, etc.

(d) the ability to make use of visual aids such as overhead transparencies, charts, etc.).

Feedback

Feedback will be supplied from many sources. In the self-assessment mode, the student will depend on himself for feedback. Whenever the speaking is done in class, both the student's peers and his instructor will supply classroom feedback. In addition, during the student's personal conferences, he will be supplied with feedback by his instructor.

## Communication Skill Assessment, Level Three

Purpose

At the third level the student should be capable, with little preparation or notice, of putting together a written and/or oral presentation on material that is familiar to the student.

Method(s)

The methods employed will be similar to those used in levels one and two. The distinguishing characteristics of this level is the restriction of preparation time. For example, the student might be asked to respond to a request of information from the Mayor's Office to deliver an impromptu talk to a group of visitors.

Criteria for Assessment

The criteria for judging this level will be similar to that cited for levels one and two - preparation time and advance notice providing the only differences.

Feedback

Feedback will be supplied by the instructor during the student's regularly scheduled, personal conferences.

## Value Clarification Assessment

Purpose

The purpose of this competence assessment is to help the student to collect and define his values, and during the course of such an exercise to compare his values to those surrounding him.

Method(s)

Through a series of "case studies" the student will be exposed to a number of situations where he will have to superimpose his own values.

Criteria for Assessment

Through the "case study" approach the student will be asked to compare his personal values with those surrounding him.

Feedback

Feedback will be accomplished by class discussions and personal conferences.

# ENVIRONMENTAL FUNDAMENTALS
## TECHNICAL SYLLABUS

I. AIR POLLUTION

- A. Sources and Types of Air Pollution ................... Week 1
- B. Carbon Monoxide ....................................... Week 1
- C. Nitrogen Oxides ....................................... Week 2
- D. Hydrocarbons .......................................... Week 3
- E. Sulfer Oxides ......................................... Weeks 3 and 4
- F. Particulate Matter .................................... Weeks 5 and 6
- G. Miscellaneous Pollutants .............................. Week 7
  (trace metals, organics, etc.)

II. WATER POLLUTION

- A. Polluted and Unpolluted Water ......................... Week 8
- B. Categories of Water Pollutants:
  Oxygen-Demanding Wastes, Pathogenic Organisms ......... Week 9
- C. Plant Nutrients ....................................... Week 10
- D. Synthesized Organic and Inorganic Compounds ........... Week 11
- E. Oil ................................................... Week 11
- F. Radioactive Substances ................................ Week 12
- G. Heat

III. ENVIRONMENTAL LAW

- A. River and Harbors Act of 1899 ......................... Week 13
- B. Federal Water Pollution Control Act ................... Week 13
- C. National Environmental Policy Act of 1969 ............. Week 14
- D. Air Quality Act of 1967 ............................... Week 15
- E. Clean Air Act Amendment of 1970 ....................... Week 15

ENVIRONMENTAL FUNDAMENTALS
COURSE ASSIGNMENTS AND PROJECTS WITH COMPETENCE COMPONENT

**WEEK ONE**

| | |
|---|---|
| Assignment #1: | "Take home final" assigned: |
| Due Week 14 | Write a proposal to the federal government requesting matching funds for expanding and running a local environmental agency.<br><br>The agency currently has funding of $2.5 million, $1.5 million from its own treasury and $1 million from the state government. Write a proposal requesting an additional $2.5 million from the federal government.<br><br>The proposal is to include a historical scenario describing the present agency, and the current general pollution problems and ambient pollutant concentrations. The proposal is to include a detailed description of how the agency would allocate an expanded $5 million budget and preliminary justification of the proposed budget.<br><br>(This was a full-semester class project. The instructor appointed one student as project manager, and it was up to the students to decide how to split up and coordinate the work. The result was expected to be a single, professional-quality proposal with all necessary substantiation.) |
| Assignment #2: Tape ready for review Week 3 | Prepare a 5- to 10-minute videotape dealing with New York City air pollution problems and describing the functions of a hypothetical, newly-formed city air pollution control agency. Your audience is a group of community residents (who lack technical expertise) and your goal is to solicit community approval and support. |
| Assignment #3: due Week 3 | Write an interoffice memo to your boss detailing technical and nontechnical qualifications for a candidate seeking the job of Commissioner of the new pollution control agency. |
| Assignment #4: due Week #9 | Read Jeremy Rifkin's book Entropy:A New World View, New York: Viking Press, 1980. Select a chapter of interest to you and write a critique his arguments. Whether you choose to agree or disagree with Rifkin, quantify your arguments using additional information you have researched on your own. |
| Assignment #5: due throughout semester | Select one aspect of one of the syllabus topics, in consultation with the instructor. Prepare 20- to 30-minute seminar for class presentation. |

**WEEK TWO**

Assignment #6 due Week 8 — Prepare a written report and oral summary presentation dealing with four elements of the new pollution control agency: methods that should be used by the agency to handle and analyze data, types of monitoring instrumentation that should be purchased, a comparison study that the agency might wish to use to determine if it preferred telemeter stations to non-telemeter stations, and, finally a history of the New York City carbon monoxide problem (if one exists).

(Students could choose to undertake this assignment individually or to work in groups of four or five.)

**WEEK THREE**

Assignment #2 (5- to 10-minute videotape on pollution and new agency) reviewed and assessed in class. Assessment was conducted at several levels. After tapes were viewed, the presentor made a self-assessment, fellow students and then the instructor and communications consultant made assessments.

(Students concluded this assignment should be repeated later in the semester.)

Assignment #3 (interoffice memo re Commissioner qualifications) collected.

**WEEK FOUR**

Assignment #3 assessment (interoffice memo)

Assignment #7 due Week 5 — Read the article by Lester R. Brown, "Global Food Prospects: Shadow of Malthus," Challenge, Jan.-Feb. 1982, pp 14-21. Be prepared to participate in class discussion of value issues in this article.

**WEEK FIVE**

Class discussion, based on assignment #7 (journal article).

Assignment #8: due Week 10 — Tabulate and compare carbon monoxide and sulfer dioxide data for New York City for the years 1967 and 1970. These data are to be located by visiting local and federal agencies in New York. The goal of this assignment is to see whether 1967 and 1970 federal legislation made an impact on ambient air pollution values. Collect the data and write a short report.

**WEEK SIX**

No assignments

**WEEK SEVEN**

Two student seminar presentations. (Topics were "catalytic convertors" and "wet scrubbers.")

**WEEK EIGHT**

Oral presentation of group reports for assignment #6 (four elements of new agency) videotaped for later assessment.

Written report for assignment #6 collected.

**WEEK NINE**

Two student seminar presentations. (Topics were "gasohol conversion" and "Tap Water Supply in New York City: Source and Purification.")

Assignment #4 (book report) collected.

**WEEK TEN**

Two student seminar presentations. (Topics were "Petroleum Refineries: Pollution Control" and "OD and BOD in Water Quality.")

Assignment #8 (comparison of NYC pollution, 1967 and 1970) collected and discussed in class.

(This assignment fortuitously contained a valuable lesson in as much as the data gathered from one of the governmental agencies had internal inconsistencies.)

Assignment #9 due Week 11 — Read the article by Richard T. DeGeorge, "Ethical Responsibilities of Engineers in Large Organizations: The Pinto Case," Business and Professional Ethics Journal, 1981, pp 1-14. Be prepared to participate in class discussion of value issues in this article.

**WEEK ELEVEN**

Two student seminar presentations. (Topics were "Pesticides: Water Systems" and "Sewage Treatment and Large Scale Methane/Alcohol Production.")

Class discussion, based on assignment #9 (journal article).

Assignment #2: due Week 13 — Repeated

**WEEK TWELVE**

Two student seminar presentations. (Topics were "Nuclear Pollution" and "Generation of Electricity From Waste Products, e.g., Hempstead Plant.")

**WEEK THIRTEEN**

Repeat of assignment #2 assessment process.

**WEEK FOURTEEN**

Oral communication consultant made asessments of assignment #2 repeats.

Assignment #1 (class proposal for pollution agency funding) collected.

WEEK FIFTEEN

Class discussion and assessment of assignment #1.