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ABSTRACT

The major goal of the Educational Modules for Materials Science and Engineering (EMMSE) project is to experiment with a means for developing, indexing, and disseminating instructional materials in materials science and engineering. This document is the updated final report of the project. Key accomplishments discussed (presented in order of completion) include: (1) socialization--gaining of acceptance and involvement of the national/international communities; (2) a "revolutionary" model for dissemination of materials by on-site, on-demand printing from a new hybrid journal-textbook; (3) utilization of a state-of-the-art review system writing/presentations/evaluation workshops to produce clusters of modules in selected areas; (4) the beginning of adaptation of digitized production, storage, and dissemination of modules and appropriate data bases; and (5) analysis of curriculum and course content, user needs, and internal/external linkages of content. Supporting documentation, provided in appendices, includes EMMSE tasks for the third phase of the project; cumulative index to volumes I and II of the Journal of Educational Modules for Materials Science and Engineering, arranged by topic and materials class; guide for locating teaching aids in all media; priority topic list (with author guidelines); and other information. (JN)

FINAL REPORT

EDUCATIONAL MODULES FOR MATERIALS SCIENCE AND ENGINEERING

SED-7714149 SED-81-15089

1 December 1977 - 30 November 1983

This is the final report on the above referenced grant. All funds have been used up during the no-cost extension period.

In this report we have updated our submission of May 1983 making it complete with respect to modules prepared and in the pipeline. We submit only a sample of modules, newsletters and brochures, and stand ready to submit one or two complete sets (3 feet of shelf space) for NSF files if they are desired.

The module production and publication via JME will of course continue, although no novel developments can be undertaken. By combining subscription income with support from NSF and other government agencies who support conferences and some support from industry, the excellent start made under NSF-SED sponsorship will be continued.

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

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PART I—PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
The Pennsylvania State University Materials Research Laboratory University Park, PA 16802	SEDR/MAT 4. Award Period From 12/01/77 To 05/31/82	SED-7714149 5. Cumulative Award Amount $493,975.00

6. Project Title

Educational Modules for Materials Science and Engineering (EMMSE)

PART II—SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

The EMMSE Project has been funded by NSF through the completion of Phases 1 and 2 of a planned 3-phase project. We have successfully launched an integrated system to continuously make and disseminate modular educational material in the materials science and engineering (MSE) discipline. Thus there will be a permanent impact on the field.

The most successful aspects of our work are as follows:

a. The degree of socialization of the national and international MSE community to help produce and use the materials produced (the latter is still slow, but the natural time constant of the process is about 20 years).

b. Development of the first working model of what may well prove to be a truly 'revolutionary' method for dissemination of teaching materials via a hybrid Journal-Textbook with on-site, on-demand free reproduction.

c. The development of two routes to production of modules
 (i) A pre-designed cluster of 6-12 modules in one area via a one-week workshop;
 (ii) A set of magisterial pedagogical reviews by leading authorities of the major advances in the field.

With respect to usage of the system we know that this follows the typical S-curve and we have now started on the steep increase part. While we have no way by which to quantify numbers of local users of individual modules we note that our crystallography modules sell about 10,000 units a year, the polymer experiments cluster have, in a year, started to sell about 300/yr. We have some 300 subscriptions (with only 110 departments of MSE in the U.S., that's phenomenal). With respect to quality of authors we submit as evidence the names of the authors of our Frontiers of Materials Science annual cluster (see Modules 217-220, p. 32).

PART III—TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM: Check (✓)	Approx. Date
a. Abstracts of Theses	X				
b. Publication Citations	X				
c. Data on Scientific Collaborators	X				
d. Information on Inventions	X				
e. Technical Description of Project and Results		X	X		
f. Other *(specify)*					

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Rustum Roy and Bruce E. Knox		12/22/83

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ACHIEVEMENTS OF THE PROJECT TO DATE

In this section we present the work which has been completed to date in Phases I and II and indicate approximately the progress which will have been made by the time for renewal of the grant, i.e., the beginning of Phase III.

The National Advisory Committee's self evaluation is that we have made very good progress. The exceedingly complex task of welding the community together and building a total system has gone very well indeed. Module production and dissemination are now at a steady state as a result of the emergence of the journal concept for distribution and the workshop-mode for developing modules. The latter has resulted in a modification of the infrastructure of EMMSE which we believe will prove to be a positive step for the project in Phase III. (The system with proposed revisions is outlined in Appendix I.)

1 Socialization of the Community

1.1 Consciousness Raising and Constituency Development

It is clear that the first step in developing a total EMMSE system had to be the establishment of a broad base of understanding and support within the community. The Principal Investigator (PI) and many members of the NAC have spent a considerable amount of personal effort working on this aspect; we believe we have been rather successful. A national advisory committee, a module development subcommittee and several task forces are fully functional. We have the enthusiastic support of major industry, as most convincingly demonstrated by the calibre of manpower donated to the project. We have made EMMSE widely known through the different subsets of the MSE community and have started to eliminate the natural resistance and suspicions of some faculty both to considering novel teaching modes and to the particular systematic approach. We have established an excellent base throughout some dozens of universities, involving their faculty on various committees and task forces, and in utilization of the modules. Moreover, this degree of acceptance has been reached in an emerging syncretic discipline, without simple communication channels and with considerable heterogeneity with respect to style, degree of professional society development, etc. within the subfields. The means for achieving this have been manifold, and each is treated in the following paragraphs.

3.1.1.1 The National Advisory Committee

The first step in the consciousness raising efforts and constituency development of EMMSE was taken via the formation and activity of the National Advisory Committee. In the selection of the

Committee, special attention was given to make it representative in every possible way. In addition to broad geographical representation, care was taken to have the membership of the Committee be representative of the following:

(a) Both science and engineering of materials,
(b) Large and small universities and colleges,
(c) Professional societies in the field,
(d) Materials oriented industries,
(e) The major materials classes (metals, ceramics, polymers, wood, semiconductors),
(f) The Depth Committee (Heads of Materials Departments across the country), and
(g) Closely related disciplines (physics, chemistry, etc.).

It was expected that, with this plan of organization, information about the development and achievements of EMMSE would be channeled out to different segments of the whole materials community through each member's personal linkages. We recognize that the kinetics of such information diffusion is slow, but we know that EMMSE is now familiar to a large number of people in the MSE community both in the U.S. and abroad.

A distinguished group of leaders of the MSE community are serving on the National Advisory Committee (see Appendix II). As noted above, the composition of the NAC is intended to provide representation for a wide variety of constituents. By comparison with our stated intent, it will be seen that the following categories are represented in the current membership:

Materials scientists and engineers representing the fields of metals, ceramics, polymers, wood, semiconductors
Heads of materials-oriented departments
Professional societies, such as:
    Federation of Materials Societies
    Materials Research Society
    American Society for Metals
Industrial research laboratories and training centers
Representatives of related fields and smaller departments

A plan of rotation has been devised so that about three new persons will come on to the committee each year, increasing the participation as much as possible without sacrificing the advantages of continuity. Professor Charles Wert of the University of Illinois at Urbana, widely known and respected in the materials field, serves as Chairman.

The full Committee convenes twice a year and the meetings are interspersed by two meetings of the Executive Committee composed of the project directors, the chairpersons of subcommittees and two members at large.

The function of the EMMSE National Advisory Committee, due to the nature of the field, is necessarily somewhat different from some other groups in traditional disciplines. The NAC spends more of its time and effort on "community building" and somewhat less on day-to-day project matters. As will be seen later, this forms a good division of labor between the NAC and the subcommittees et al.

1.1.2 Liaison to Depth Committee, Federation of Materials Societies and Individual Professional Societies

Although MSE includes parts of several formal disciplines such as physics, electrical engineering, geosciences, etc., the faculty of the formal Materials Science and Engineering departments form a resource-core. A special effort has been made, therefore, to establish liaison - without expecting endorsement at this stage - with a continuing committee of department heads called the "Depth Committee." Since Professors Wert and Verink of our National Advisory Committee are both past chairmen of the group, we are confident that the communication channels are well established, and we expect increasingly active support as the project develops. The department heads may be able to help in supporting their faculty to write modules, but their most important help may come as they encourage the use of EMMSE products in their respective departments and join the EMMSE consortium by subscribing to JEMMSE and by designating a faculty contact person.

In a similar vein EMMSE has opened channels of communication to various materials societies. One of these, so far, the American Society for Metals has had a member on the NAC for years. Recently we have been working more intimately with the Federation of Materials Societies (FMS) with the possibility that EMMSE will become a major focus of the educational activities of the Education Subcommittee of the FMS.

Occasional Newsletters and news articles in society magazines have been the principal means used to communicate directly with individual members of the MSE community. We have an organized mailing list of 3,000 MSE personnel. News releases and articles have been published in all the major news journals of the pertinent professional societies such as Chemical and Engineering News, Physics Today, etc.

In addition to news articles and newsletters, thousands of promotional folders about EMMSE products have been distributed. This has resulted in sales of modules, especially the Crystallography Set, and in subscriptions to the Journal of Educational Modules for Materials Science and Engineering.

2 Module Preparation

The first logical major step was to proceed with preparing what the National Advisory Committee hoped would be "prototype" modules to serve as models of examples to the wider authorship. This process and its products constitute the heart of the project in some ways. The historical sequence has raised and brought into focus many key issues for any DISE project.

2.1 Length, Level and Content

During the first two years of the project we could not physically put in the hand of an inquirer an example of a print module in the physical sciences/engineering. During this period, the staff and the National Advisory Committee debated periodically the major aspects which describe a module. It is important to note historically that, in the first year of the project, the specifications placed on such a model were rather tight, but that with time they were relaxed in nearly all directions by the NAC. We report this later-thinking on the main descriptions of a module.

First, with respect to length. At a meeting catalyzed by EMMSE which brought together over a half-dozen NSF-funded groups at "1401 Wilson Blvd." in Arlington, VA, it was agreed that the word "module" itself did not specify length, and that a prefix or suffix explicitly designating length would be valuable. At later meetings specific names have been applied to some standard lengths of modules. For EMMSE prototype modules the NAC recommended that we seek units which would correspond roughly to "one hour of instruction time," but that we allow the authors to use more than one unit for a topic if they felt it was justified.

Second, with respect to level of presentation, it was felt that the prototype modules (not the future "production" modules) could be evenly spread from the sophomore level through the advanced new material level in order to provide the maximum range of modules. (For discussion of future levels, see Section 4).

Third, with respect to content, the decision was made to attempt to be eclectic, and bring in as many fields as possible at the prototype stage, consciously sacrificing what may have been intrinsically more valuable: a single set in one area. It was reasoned that in a diverse community the latter would have puzzled or alienated some of the constituency.

2.2 Style and Format; Author's Manual

It was clear that some homogeneity would be desirable in style and format in module preparation, and that these would need to be communicated to prospective authors of the (prototype) modules. As mentioned earlier, on the basis of the literature and much discussion, the staff prepared for NAC discussion, review and revision a Module Development Manual to serve this purpose. Again, it was the first of its kind to our knowledge.

The first draft of this Manual was reviewed by the 60 or so persons who attended the EMMSE Colloquy held at Brown University in January 1975. After incorporating suggested changes, the prototype version of the Manual was published later that year in limited quantity and distributed to those authors who were selected to prepare prototype modules, to leaders of other modular projects, and to many interested persons who requested it.

Over the next 12-18 months, as a result of feedback from many prospective authors and re-evaluation by the Advisory Committee itself, the original manual came to be deemed too long and imposing, especially since it was often the first document that was received by a prospective author. It has now been rewritten in a much shorter and more flexible form. It will appear under the new title, Guidelines for Authors, and will be the first item made available to the many authors. A more detailed "manual" will also be made available on request. The Guidelines will continue to be evaluated and revised as the need indicates, but all along we have known intuitively (more or less) that the prototype modules themseles would serve as the real guidelines as far as the authors are concernd. Indeed a comparison of the original "manual" and our much looser "guidelines" will show the trend of the committee's thinking. We have moved considerably in the direction of less restrictive regulations. Our rationale is that no one knows at this stage what is best. Along with Chairman Mao we have "Let a thousand flowers bloom" but not entirely without guidance. The "manual" will likely be used by the secretaries and the EMMSE staff to modify certain submissions to make them reasonably systems-compatible.

2.3 Prototype Modules

Appendix III lists the titles of all prototype modules which were completed and distributed free of charge to the entire mailing list for field testing. The NAC decided that they should select all the prototype module authors on the basis of maximum competence and then commissioned them to write a module. Each author of a commissioned, prototype module was paid an honorarium. As shown in Appendix III, 20 prototype modules were written on a broad spectrum of topics. They included the first cluster group (a set on Crystallography). It was the enormous success of this cluster that led the NAC to conclude that this was the route to take in the future. This decision was confirmed by more recent experience.

2.4 Other Modules

Subsequent to the time of publication and distribution of the prototype modules, five Topic Area Teams (TATs) were organized for metals, ceramics, polymers, characterization, and wood, (see below) in order to develop and review a large number of additional modules in the style and format which had evolved through the prototype period. In Phase II, these other modules began to be published in the Journal of Educational Modules for Materials Science and Engineering. A cumulative index of the first two volumes of JEMMSE is shown in Appendix IV. As can be seen, some of the prototype modules were revised and republished in the Journal.

2.5 Topic Area Teams

Once the production of prototype modules was launched, the EMMSE staff and NAC set about the task of putting together another element of the developing system - the so-called Topic Area Teams (TAT). The rationale for spreading the responsibility and the activity is self-evident. Involving a steadily increasing number of the MSE community in the project was envisaged from the beginning as a key to the success of the system. Forming clusters around different universities is a natural way to share responsibility, and it corresponds to the existing talents in various institutions. Bringing together subject-matter clusters likewise draws on existing centripetal forces. All these factors provided the basis for the step of starting the TATs.

It was envisaged that, to the maximum extent possible, the responsibilities for EMMSE be decentralized. One of the functions which could obviously be separated from the headquarters was the entire "editorial" process; i.e., the subdivision of the field and selection of priority topics, the finding and recruitment of authors, and the peer review of content. The first question which arose in establishing the TATs was, again, how the subject-matter-pie of MSE should be cut. The NAC considered at length the various schemes for the subdivision and, following the reasoning of a Janus-faced strategy, finally decided to experiment with a mixture of TATs. Thus, four were chosen to correspond to materials classes and to existing societies and communities: metals, ceramics, polymers, wood; and one (characterization) to cut across these materials classes. All other topical material that might fall between the cracks was explicitly assigned to the NAC itself, functioning as a TAT.

The academic component of the membership of the TATs was recommended by the Depth Committee with the NAC adding the other members to preserve balance. In order to coordinate the work of the Topic Area Teams and maintain liaison with the NAC, Professor Ellis Verink, a member of the Committee, agreed to serve as general coordinator of the TAT effort.

The first assignment to each TAT was to subdivide its own topic area into modular size units and to start establishing certain priorities that they would wish to see in the production of modules. This task was subsequently completed and the Priority Topic List was compiled. (See below).

In the last two years, until recently, the TATs have been pursuing their other objective: seeking authors to write modules on priority topics and carrying the modules through the peer review stage until approved for publication. Success was not notable. Materials Science and Engineering faculty were in enormous demand in the research area and could not afford the time. The rate of module development fell behind schedule. Meanwhile, two things led the NAC to begin thinking along different lines. One was the outstanding success of the cluster of crystallography modules, which underscored the value of clustering modules into coherent sets or minicourses. The other was the success of the first module writers workshop on "Wood," conducted jointly by EMMSE and the U.S. Forest Products Lab, which produced a cluster of nine modules on Wood: Its Structure and Properties, the whole process being essentially completed in one week.

2.6 Module-Writing Workshops

2.6.1 Heritage Workshops on Wood As A Material

In August 1979, The Forest Products Laboratory at the University of Wisconsin sponsored a workshop for the purpose of introducing materials science and engineering educators to wood as a material. Nine modules were presented by their authors and critiqued by about 35 MSE educators. Constructive criticism led to rewriting and improvement of the modules and eventual publication in JEMMSE. A cluster of nine modules has been published and are soon to be republished as a cluster of modules in a single volume.

A second workshop focusing on wood as a structural material was held in August of 1980. The same format was followed, and 6-8 modules will eventually be published in JEMMSE and reprinted as a cluster. A third workshop on adhesive bonding of wood and other structural materials is scheduled for August 1981. JEMMSE will publish the revised modules and reprint them as a cluster.

Thus, from just one workshop held on an annual basis, we have a steady stream of clustered modules entering the publication system. Moreover, out of this experience a new model for production of modules has been born and is thriving.

2.6.2 NATO Module-Preparation Workshops

Based on the success of the first wood workshop, funds were obtained from NATO by our West European Coordinating Committee for the purpose of planning and running a module production workshop. A modified procedure was utilized in the first NATO Workshop, held in September 1980. The organizers met in the spring of 1980 and selected five clusters of important module topics and the authors to prepare them. First drafts were written, circulated for critique among the members of the particular cluster group of which they were a part, and rewritten prior to the workshop. At the workshop the papers were presented and critiqued. As a result five clusters with a total of approximately 25 modules were prepared. The first of these modules will soon appear in print. Funding has been secured from NATO for a second workshop to be held in 1981. Thus, another workshop model has been created and found to produce clusters of modules with relative ease.

2.6.3 Future Patterns for Module-Writing Workshops

There are three distinct types of module preparation workshops that are being and will be utilized by EMMSE to produce modules: two have been described above, and the third is a spin-off from the NATO Workshop. One particular cluster group from the NATO Workshop decided to get together at the annual meeting of the American Ceramic Society in May 1981 to continue their work in module preparation. Thus, we have concluded that some form of "workshop" is the major way that our modules will be produced. Not only are modules produced relatively quickly and with relative ease, they are clustered as well!

2.7 Module Development Committee

In 1980, a decision was made to phase out the TATs with thanks for several accomplishments: socializing the community, subdividing the field topically, and setting up procedures for obtaining modules and reviewing them. The NAC decided that to take better advantage of the cluster concept and the workshop format for producing modules, the five TATs should be re-worked into a single Module Development Committee (MDC) with representation from among all the materials classifications. Accordingly, the MDC committee was established and held its organizational meeting in September 1980. At that time it recommended that the TAT system be abandond and the new Module Development Committee replace it with provision for one representative each from metals, ceramics, polymers, wood, and electronic materials (semiconductors). (The latter was added as a replacement for characterization.) Current TAT Chairmen were asked to remain on the new committee.

It will be the assignment of MDC to build on the work of the TATs with special emphases, on the clustering of modules around certain priority topics, and on the utilization of the workshop as a mode of development and production of modules. The MDC does not have the responsibility necessarily of conducting workshops itself, but rather it is to seek appropriate opportunities (e.g., in connection with a meeting already scheduled by some society or agency) when workshops can be conveniently held and designate those who are to organize them. Some funding will be provided to defray the costs of these workshops.

3 Production and Dissemination

3.1 <u>Early Dissemination</u>

The original grant called for "automatic" dissemination of the modular products to the academic community and to all interested parties in the not-for-profit and industrial sectors. They were also to serve the purpose of familiarizing the users and authors with the nature of a module and for testing of each module and the system. Hence, one copy of each of the prototype modules and Media Index was sent to the entire EMMSE mailing list of some 3,000 persons, including virtually all MSE faculty members in the country. All departments represented on the Depth Committee were advised that, as long as supplies of the prototype modules lasted, they could obtain them for classes on the condition that they offered feedback from students and the faculty member on evaluation forms provided. In many cases, supplies were soon exhausted and hundreds of evaluation forms were received with valuable suggestions for improvements.

3.2 <u>The Hybrid Journal-Textbook: JEMMSE</u>

As previously reported, in Phase I (the Prototype Phase), all materials were distributed widely without charge. As Phase II began (the Proof of Concept Phase), the NAC realized that a different kind of dissemination must be initiated as EMMSE began to move toward a future stage of self-sufficiency (i.e., beyond funding). Hence, sales/income accounts were established for the prototype modules and for a new vehicle of distribution which EMMSE invented - the Journal/Textbook.

The Journal of Educational Modules for Materials Science and Engineering began publication in April 1979 as a quarterly and has now completed two full volumes. It is expected that JEMMSE will become a bimonthly, perhaps as early as 1982 and, eventually, a monthly.

Each issue, in these first two years, has contained about 225-250 pages, comprising about six modules, an occasional article, and some other editorial features common to a journal. Every two or three years the EMMSE Media Index will likely appear as a supplement, as it did in 1980.

The modules published in JEMMSE are designed for a wide spectrum of learners in both university and industry, ranging from the undergraduate (sophomore-senior) to the professional level. At the professional level, some are for graduate students and continuing education in industry, and some are in the nature of advanced review articles.

The special feature of JEMMSE is a policy of free reproduction rights to all subscribers. The Journal/Textbook has been designed as the most cost effective distribution mode for the new educational material produced, and, using the well established library distribution, filing, and retrieval system, it achieves the following:

- A method to provide appropriate professional recognition to authors of original and peer reviewed work on a par with those of research papers;
- A properly archived and permanently retrievable system for storage and use;
- A means to distribute a "master" from which copies can be made on site and on demand with no royalty payments, no transportation of hard copy, no tedious bookkeeping operations, and no expensive warehousing of modules.

This journal-concept is the best way of meeting a major goal of EMMSE: providing the new modules conveniently and inexpensively to faculty and students. The subscriber can simply make the copies he or she needs.

Numerically, EMMSE has met its targets. Our proposal for Phase II called for the production of some 125 modules. In fact we will have produced and/or modified (thru the final review stage) some 140 modules. Of them some 72 will have appeared in the Journal; others will be in the pipeline. In addition we will have some twenty others which have been modified after acquisition (chiefly the British Open University and the Stockholm Royal Institute of Technology).

We projected that we would have approximately 100 paying subscriptions at the end of Year 2. In fact we have 268, a mixture of institutional and individual. It should be noted that we decided not to put on a widely-based advertising campaign designed to increase readership until we had the "product" well in hand. Such a campaign is now being planned. Its results will be significant in determining our later pricing and funding strategy.

3.3 Reprinting Clusters of Modules

One of the problems of which we are aware in publishing the Journal is the need to package clusters of modules as sets or mini-courses. The success of the mini-course on Crystallography has demonstrated that this integration of modules is something that is welcomed by the potential user, and this has been confirmed by subsequent experience in producing clusters of modules on wood, etc. At this stage of JEMMSE's development, however, the NAC judged that it is not tactically sensible to devote an entire issue to one topic, since it would limit the breadth of appeal to just a relatively few subscribers. The idea of publishing coherent sets as "special editions" or supplements to the Journal is a temporary solution to this problem which is being tested with the set of wood modules. These will be available to subscribers at a discount and will be offered to non-subscribers at a reasonable sales price. This violates our long-term goal of on-site on-demand printing, but it is probably the best compromise for the next five years.

It is also clear that the Journal concept will also go a long way toward establishing EMMSE as a viable system which can be self-sustaining when NSF funding is no longer available. A base of cost-price data is now being accumulated which will be useful in the third phase of EMMSE, a time when EMMSE must begin to transform itself into a viable self-supporting system.

3.4 Digitization of Journal Copy

As a result of supplementary funding provided by the National Science Foundation during the latter stages of Phase II, EMMSE has been able to purchase electronic equipment to format and store copy for JEMMSE and other print material. Prior to this special grant, EMMSE had experimented in this area by leasing word processing equipment from two manufacturers of "expanded typewriter" systems. These were found to be inadequate to the task in an overall sense. However, with that background, it was easier to custom-make a more sophisticated system using essentially off-the-shelf components of various manufacturers. The new system has been in use for only a limited period of time, and it is too early to report on its operational success. Nevertheless, the equipment now in use certainly enhances and extends the ability of EMMSE to store the data which comprises each issue of JEMMSE, re-format it (if required) and make it available quickly and efficiently for use in unedited or edited form. It also creates the base for future dissemination of EMMSE modules by floppy disc or other electronic means. In the near future, by connecting our appropriately formatted discs to the new digital laser-printer acquired by the University Printing Services, we will be able to produce an even more "professional"-looking Journal.

3.5 Dissemination of Information About EMMSE

The primary "information product" has been the newsletter, PREVU/REVU, which has been issued occasionally. Wide distribution has been achieved (between 4,000 and 5,000), especially in the first years when a primary contact list was being developed. Mailing lists were obtained from various sources to reach not only the core group of materials science and engineering but also those in areas closely related, such as physics, chemistry and engineering in general.

Quantities of the newsletter were also distributed at meetings of professional societies, conferences and other places.

In addition to interpreting EMMSE to its constituency and updating readers on developments, PREVU/REVU has been a vehicle for experimentation in printing costs, format, the use of camera-ready copy, and so forth, which has been a useful preparation for the publication of the modules. For example, the first issue of PREVU/REVU was printed for about $.03 a copy using regular newsprint. The second issue was printed on better quality paper and employed spot color on the cover. The cost of printing it was about twice as much as the first issue but still relatively inexpensive. Format evolved over a number of issues until now a standard format has been reached which has been unchanged over the past year or so. (See Appendix VII.)

More recently, as EMMSE has entered a sales/income stage with respect to the Journal, the Crystallography modules, et al., numerous special information products have gone out on behalf of these endeavors. These have taken the form of flyers and folders to describe the products, provide price information, and so forth. These will continue, of course, as prices change and other changes become necessary.

Other methods have been used to disseminate information about EMMSE. A National Colloquy at Brown University was held. It was attended by more than 60 interested persons and provided an excellent setting to interpret the program. Several surveys were conducted: to solicit information needed by EMMSE and to offer the recipients information about EMMSE. Numerous news releases have received wide acceptance and publication by as many as a dozen journals or newsletters of materials related societies (e.g., Chemical & Engineering News, Physics Today, The American Mineralogist, MCIC Newsletter, Science Trends, Materials and Resources News, etc.). Eight or ten formal presentations about EMMSE have been made at conferences and society meetings, and three invited papers have been published in such periodicals as Journal of College Science Teaching, Nature, and Journal of Educational Technology Systems.

4 Curriculum Content and Substructure of the Field

4.1 EMMSE Matrix

Our original proposal called for us to "Experiment with means of indexing ....". This was the first intellectual task of the project. It became obvious early in the effort that this indexing and taxonomy had to be applied to existing materials already categorized by different systems and used by existing university structures strongly influenced by traditional approaches. Hence the approach to the taxonomy could not be too abstract or "first-principled" in its attempt to include some of the new holistic concepts or in a search for commonality.

In line with this philosophy we spent considerable intellectual effort within the PI institution, in the National Advisory Committee, and in the national community, developing a rational substructure of MSE as a field useful for a teaching system based on the U.S. college model. Our EMMSE matrix is an empirical heuristic model designed for this task. It has been circulated throughout the materials community by various channels and modified through numerous cycles at group sessions of the NAC, by MSE faculty at a national meeting and from individuals' comments. It is deceptively simply; it will remain to be seen if it will be as useful as we think. It has generated enough interest, however, to have the Office of Technology Assessment (OTA) fund us independently to see the relevance of this Matrix to a National Materials Information System. Other groups analyzing MSE for many reasons have readily seized upon it as a satisfactory way of subdividing MSE. We continue to refine the Matrix as a few incisive comments are received occasionally. However, it appears that the basic approach has stood the test of time, and the pattern of indexing for all modular materials in the MSE field will be based on it or a future modification of it. The current form of the Matrix appears in Appendix V.

4.2 The Media Index

In our original proposal it was our thesis that the use of innovative educational materials was limited to a large extent by the distribution system and by low social acceptance from the university teaching community. Hence ~~we believed that~~ we could obtain two simultaneous benefits by a thorough job of locating and indexing all existing educational materials in print as well as various other media. Such an index would provide a simple means for any teacher wishing to know what special aids were available for the particular "course" under preparation. And organizing the material required the selection of a particular taxonomic scheme. In this case the EMMSE matrix, described immediately above, was used. It is clear that such information was essential to our original Topic Area Teams as they developed their lists of topics and subtopics for modules to be developed. The first version of the Media Index was completed and printed as one of the EMMSE prototype products. It was a major piece of work which required months of research, compilation, correlation, organization and editing, and we believe it contributed substantially to the utilization of existing modular aids in MSE teaching. The prototype version was distributed free to several thousand persons on the EMMSE mailing list.

As part of the second phase of EMMSE (1980), the Media Index was completely revised and expanded and was distributed as a supplement of

JEMMSE to subscribers of record. It is also available for sale separately to individuals and institutions. The revised version includes hundreds of changes, additions and deletions, as well as a complete listing of EMMSE modules to date. A typical page from the Index is shown in Appendix VI.

4.3 Priority Topic List

As mentioned above, the first task of the Topic Area Teams was to subdivide its own topic area into modular-sized units and to establish the priorities for module production. These lists were compiled into a Priority Topic List which was printed and distributed to the MSE community and other interested educators. This list appears in Appendix VII.

4.4 Curriculum and Course Improvement

We have noted earlier our rationale for going slowly in this field and waiting till EMMSE was better established and known. We are sure this was wise. Our strategy has been, therefore, to engage in a modest, but gradually accelerating data- and information-gathering activity.

A preliminary survey of some key MSE academic departments was made to ascertain various concepts of the education of a MSE student. A number of MSE industrial companies have been surveyed to determine their needs and to discover the various mechanisms used by scientists and engineers to educate themselves in a new field. This was a preliminary study which will be integrated into later work.

Curriculum analysis and development will be one of the important tasks to be completed during Phase III. In accelerating this data-gathering phase we have arranged a first course and curriculum analysis gathering for August 1981. A very useful way to objectify such a study is by inter-nation comparisons. A complete, detailed analysis of the curricula in Great Britain has recently been completed. We plan to consult with the personnel involved in that study. Perhaps we can utilize some of their analytical instruments, and certainly we intend to study their results, which can serve as an objective base for comparing the variety of U.S. models for MSE curricula.

At the same August meeting we will initiate a voluntary collective review of detailed course content of a few of the common courses at the Junior-Senior level (i.e., beyond the introductory course in materials).

5 Linkages

5.1 Interlinking of EMMSE Modules

The subject of interlinking of our modules has also received only a modest amount of attention from the NAC. While no one doubts the ultimate usefulness of such a system, we have agreed that it is too early to start linking the relatively small number of modules already produced. Developing an optimized scheme for linking modules is a research task which has been done by Henley, Signell and others in other disciplines. Thus, the necessary computer software is available to interlink our modules when enough are available to provide a framework. This is an obvious task for late in Phase III.

In the meantime our own discussions of this topic have shown that for materials science and engineering by far the most important linkages are the immediate nearest neighbors. Hence the development of sets or clusters of modules becomes the most important operational decision. The interconnections and insertions of such articulated sets into courses or curricula proceed by very different rules than the ties connecting single modules. In any case our analysis along these lines led to the strong exphasis on clustering.

5.2 Interlinking to Other Module Projects

We have, from the beginning, sought and maintained active contact with other module-producing projects and have participated in the "Intermod" organizational and standardization efforts with Professor Signell at Michigan State University. Our modules appear on the data-base available on Telenet. We have consciously chosen not to attempt to innovate in this area.

6 Establishing Connections to the International MSE Community

One of the notable successes of EMMSE has been the attraction of (parts of) the international MSE community into its activities. We have established a West European Coordinating Committee with an outstanding representation of the leaders of materials science in Europe. The group has its own steering committee chaired by Professor George Ball of Imperial College, London and run by its energetic executive secretary, Dr. Alastair Nicol of the University of Birmingham. This group has been funded by NATO for two successive years to operate workshops for producing 5-6 clusters of modules by reviewing selected topics in which the EMMSE-WECC Committee felt that there was need for good review/teaching materials. These materials are now just emerging in JEMMSE. (See Appendix VIII for a list of members.) Hence, at zero cost to NSF we have establishd a major source of modular materials written by the leaders of the field. A report of the EMMSE-WECC/NATO Workshop is attached as Appendix IX.

The second such group we have helped start is in India. Here, also, a regional committee for India has been established with Dr. D.N. Chakravorty, Director of the National Materials Science Center, chairing the effort. The Indian group is not as far along in its planning, but the first meeting which will likely produce such modules was held in February 1981.

The third group we have started to establish is one in the USSR. Here, also, we have an energetic leader in Dr. Fyodor Kuznetsov of the Academy of Sciences, Institute for Inorganic Materials in Novosibirsk. He is supported in this venture at the highest levels of the USSR Academy of Sciences. However, the change of political climate has put the brakes on this entire venture, and we will not know its future until the thaw in US-USSR relations. Preliminary contacts have been made with groups in Mexico, Latin America and French speaking groups in France and Quebec, and all such have received enthusiastic responses.

7 Digitization of Modules, Data-bases and Other Materials

Until the past year, we purposely kept away from all attempts to convert our modules and other information to digital format (except for several earlier attempts to utilize electronic typewriters and for our early use of the central computation facilities on campus for generating address lists and mailing labels). We reasoned that other module preparation groups had acquired more experience and know-how and were actively pursuing the development of such systems. We believed that when a system reached the "proven capability" stage and was acceptable to several module development groups, we would adapt their technologies for our needs so that all would be compatible.

At the end of the second year of funding in Phase II some residual funds were utilized to purchase the necessary hardware and software to begin the development of our word-processing/electronic storage-dissemination system. At the present time, all modules are being converted into digitial format. We are on the verge of being able to disseminate modules in this format, although the present cost-effectiveness of this (compared to microfiche, e.g.) is not very favorable.

Additional funds were made available by NSF to increase our capabilities to include digital graphics, especially related to digitization of phase diagrams. One of our original possibilities was to digitize a video image, compress the data and store it. However, this idea has proved to be impractical within our budgets. NASA has the capability to do this with their large computers using 32-bit words. Commercial systems are available with the required resolution; however, the costs range upwards from a minimum of about $50K. We examined the capabilities of all the lower cost systems (Digital Graphics Systems, Grinnell Systems, Colorado Video, Hammamatsu, Microangelo, etc.) and found them all too expensive for the results desired or lacking in resolution, unable to handle symbols, etc. Hence, we have made the decision to digitize utilizing a graphics pad digitizer system. Specific equipment, including a high resolution plotter, hard-disk storage with streaming tape back-up, and another 128K mainframe microcomputer (which will network with our existing system) are currently being ordered. (Note: This is also the mode of operation selected by the Phase Diagram Evaluation group at the National Bureau of Standards after their independent, extensive review.)

The data-base of high priority and interest to the MSE community is that of cataloguing all existing phase diagrams. We have developed an interactive system which will allow a user to retrieve location information on any phase diagram in existence. The software is nearly complete, and a representative sample of the data-base will soon be entered for testing and evaluation. The entire data-base will encompass 25-30,000 phase diagrams when complete.

The next step in developing data-bases is to begin to digitally store the most widely used phase diagrams and associated thermodynamic data. We will then develop software for retrieval and manipulation of any or all of the pertinent information, including the phase diagram, plotted in either mole or atom percent composition. From here, we will develop interactive programs in conjunction with the Calphad group, plus the necessary teaching modules to enable a student to learn how to extract and utilize thermodynamic information from phase diagrams, as well as how to understand them in general. This work will be started by the end of Phase II, and we envision rapid expansion of this work during Phase III. (See Section 4 for more details.)

8 Evaluation of the EMMSE Project to Date

The staff and NAC has wrestled long and hard about how and what to "evaluate" about ourselves. At one stage we established an evaluation and long-range task force. But this proved unsuited to our needs. It is our present position that evaluation while in process of one part of or a system - say some particular modules - would be totally irrelevant. As a DISE project, using the innovation impact model in Figure 1, it is our present view that the only valid evaluation is a "summative" one. That is, one that looks at the total system and its present and likely future (since we are only 'half-grown') impact on science education in the MSE field. In the following we present, therefore, qualitative and quantitative measures of the impact of Project EMMSE.

8.1 General Impact

As stated earlier, one of the primary goals of Project EMMSE has been to socialize the materials science and engineering community to the emergence of modular instructional technology and to the value of the use of modules for their own teaching. Moreover, EMMSE had to perform this consciousness-raising task for a diverse community which lacked the usual cohesive forces and regular channels of communication available in the older, traditional disciplines, such as physics and chemistry. In spite of these obvious hurdles, EMMSE has worked hard at achieving this goal and has met with substantial, even remarkable, success.

8.2 Participation by Field's Leaders

The first measure of impact to which EMMSE can point is the number and quality of participants in its leadership. We have been fortunate enough, for example, to enlist some of the most respected names in the field of MSE as members of our National Advisory Committee. Five heads of departments serve on this policy committee; four of them also serve on the executive committee. Among them they represent some of the outstanding departments in the nation in the materials field (M.I.T., Michigan, Illinois, Florida, and Massachusetts in addition to Penn State). The NAC represents a broad spectrum of materials classification (metals, ceramics, polymers). In addition, well qualified persons from industry and professional societies have served, and are serving, on the NAC.

Beyond the Advisory Committee, the number of persons associated with EMMSE was greatly increased by the development of the project's infrastructure. Twenty-five other persons from a variety of professional backgrounds served as members of the Topic Area Teams. Many others have worked in ad hoc relationships as members of task forces and committees.

The influence of all these persons on their associates at their primary place of occupation (among others) is, of course, not measurable in quantifiable terms. But we believe that it has been enormous and can be seen by the acceptance that EMMSE has had and continues to enjoy increasingly.

8.3 Mail Responses and Inquiries

Another aspect of the impact of EMMSE is the reception given to its products - both instructional and informational. Early on, EMMSE sent out a large number of the latter, ranging from newsletters to questionnaires. There was a massive effort to inform people about EMMSE and to solicit their views on matters pertinent to the project's development. The results have been gratifying. Whereas, in the beginning, thousands of communications went over what was for the time being a one-way street, now, although we continue to communicate at a high level, ours is matched by an incoming flood of mail. Literally thousands of inquiries, orders, offers of advice or help, etc. have been and are being received. One realistic measure of the impact of

EMMSE on its constituency is to look at the file of correspondence accumulated and see how the quantity of incoming mail has increased dramatically with each succeeding year of operation.

8.4 Sales and Subscriptions to EMMSE Products

By far the most important quantitative measurement of EMMSE's impact is revealed in the sales of EMMSE subscriptions modules, such as the Crystallography Set, and for JEMMSE. If our constituents are purchasing our products, it means they have voted with their wallets.

As noted earlier, EMMSE began to make a charge for its products only in Phase II. During that time, also, the publication of the Journal began on a subscription basis. Prior to that all material had been distributed free.

All prototype modules have been for sale in Phase II, and some have sold remarkably well. The two-part set on Phase Transformations in Condensed Systems has had a steady market at a somewhat lower level. However, the outstanding sales leader has been the nine unit set on Crystallography. Since its introduction on a sales basis, this nine unit set has had an annual average sale of about 10,000 units. If it continues to enjoy repeat orders at this level, as we have reason to believe it should, it will contribute substantially to the long range viability of EMMSE.

The Journal of Educational Modules for Materials Science and Engineering has been on a subscription basis from its inception, although during the first year of publication we were also sending free sample copies to all heads of departments and their counterparts in industry. The reception of JEMMSE by the MSE community has exceeded our most sanguine expectations. We projected the number of subscriptions in the first year to be 75. It turned out to be 167. We have now completed two years of publications and the subscription list stands at 271. There have been only 8 cancellations. A breakdown of the list reveals an interesting distribution. The total in the U.S. is 191. Of this number, 117 are primary or institutional subscriptions (86 from universities and 31 from others, mostly industry). We have been very pleased to note that 81 subscriptions have come from foreign sources. Of these, 20 were from the British Isles, 15 from Canada, and the rest from widely scattered places (a number from Western Europe, and one or more from the Soviet Union, Yugoslavia, India, Australia, Mexico, Brazil, etc.) The rest (74) are secondary, or individual, subscriptions.

These statistics, we believe, are an indisputable demonstration of the wide and effective impact of EMMSE on the MSE community.

8.5 The International Acceptance

The number of subscriptions from foreign sources - almost all of them from universities or libraries - is only one indication of EMMSE's outreach to those outside the U.S. The most impressive datum here is the number and quality of the scientists in Western Europe (and in India) as listed in an earlier section who have become associated with EMMSE. (See Appendix VIII.) Clearly if scientists of this eminence are willing to participate they are signifying a reasonably high level of approval of our achievements.

8.6 Summation of Achievements and Impact as an Evaluation of EMMSE

Since this is a project to produce and disseminate modular material it is perhaps appropriate to close this section on achievements by a summary of our status in these areas.

First, on dissemination: We have established a means of distributing to a very widely dispersed clientele print modules at a cost of somewhat less than $0.02 per conventional text page to the user. (Two pages of the Journal can be copied on to an 8-1/2 x 11 sheet.) The journal-textbook hybrid is effective and may prove to be the only cost-effective way to achieve dissemination of modular material anyway.

Second, on production: Some hundreds of modules have been processed to varying degrees by our system. We have prepared a master list of these modules in the following table which shows that there are about 250 modules involved. We note that EMMSE's involvement is not the same in all these modules. For the majority we have been responsible for selecting stimulation, production, dissemination; for some we have contributed mainly in dissemination; for others in stimulation and production, but yet await an auxiliary distribution mode. This list shows that there is plenty of good material being produced and disseminated. It also shows that the rate of its production is increasing, and the costs to NSF per module are going down steadily. Hence our qualitative projections of self-sufficiency are not fanciful.

We believe these several lines of argument support our contention that EMMSE has had a strong impact on its constituency both in the U.S. and world wide. Furthermore, it is clear that the pace of the impact has increased greatly in Phase II and that, momentum continues to increase in the recent past.

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIAR DISTRIBUT MODE
1. Materials for Fiber Optical Communication: Part 1, Optical Properties of Transmission Media	W. French Bell Labs					1:2	X	
2. Materials for Fiber Optical Communication: Part 2, Fiber Fabrication	W. French Bell Labs					1:2	X	
3. Point Defects in Stoichiometric Ceramic Materials: Part 1, Solid Solutions	R. Davis NC State U.					2:4	X	
4. Point Defects in Stoichiometric Ceramic Materials: Part 2, Schottky and Frenkel Defects	R. Davis NC State U.					2:4	X	
5. Introduction to Dislocations in Crystals	C. Hartley U. of Fla.					1:3	X	
6. Surface and Bulk Defects in Solids	C. Hartley U. of Fla.						X	
7. Selection of Crystal Growth Methods (semiconductors)	H.C. Gatos MIT					1:2		
8. Selection of Crystal Growth Methods (insulators)	R. Roy Penn State U.					1:2		
9. Nucleation	M.E. Fine Northwestern U.					2:2		
10. Growth of Phases	M.E. Fine Northwestern U.					2:3		
11. Blow Molding: Procedures and Equipment	B.T. Morgan Phillips Petrol.					2:2		
12. Molecular Orientation in Polymers: Pole Figures and Orientation Functions	E.S. Clark U. of Tenn.					1:3		
13. Free-Radical Polymerization Kinetics by Dilatometry (A Lab Experiment)	E.M. Pearce et al. PINY					1:4		
14. Free-Radical Copolymerization (A Lab Experiment)	E.M. Pearce et al. PINY					1:4		
15. Emulsion Radical Polymerization (A Lab Experiment)	E.M. Pearce et al. PINY					2:1		
16. Cationic Polymerization (A Lab Experiment)	E.M. Pearce et al. PINY					2:3		
17. Anionic Polymerization (A Lab Experiment)	E.M. Pearce et al. PINY					2:2		
18. Bulk Polycondensation and End-Group Analysis (A Lab Experiment)	E.M. Pearce et al. PINY					2:3		
19. Interfacial Polycondensation (A Lab Experiment)	E.M. Pearce et al. PINY					2:4		
20. Polycondensation and Curing of Epoxy Polymers (A Lab Experiment)	E.M. Pearce et al. PINY					2:4		

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIARY DISTRIBUTION MODE
21. Dilute Solution Viscometry of Polymers (A Lab Experiment)	E.M. Pearce et al. PINY					3:1		
22. Light Scattering by Polymers in Solution (A Lab Experiment)	E.M. Pearce et al. PINY					3:2		
23. Characterization of Polymer Tacticity by NMR Analysis (A Lab Experiment)	E.M. Pearce et al. PINY					3:4		
24. Differential Scanning Calorimetric Study of Polymers (A Lab Experiment)	E.M. Pearce et al. PINY					4:1		
25. Gel Permeation of Polymers (A Lab Experiment)	E.M. Pearce et al. PINY					3:3		
26. Thermogravimetric Analysis of Polymers (A Lab Experiment)	E.M. Pearce et al. PINY					4:2		
27. X-Ray Diffraction of Polymers (A Lab Experiment)	E.M. Pearce et al. PINY					4:3		
28. Czochralski Growth of Large Oxide Crystals	C.D. Brandle					1:4		
29. Electrical Behavior of Solids	D.D.L. Chung					2:4		
30. Electrometallurgy: Industrial Practice - Part One: Plant Equipment	D.J. Robinson et al.					2:1		
31. Introduction to Online Searching of Bibliographic Databases	L.M. Wert					1:2		
32. Low Energy Ion Scattering	H.F. Helbig A.W. Czanderna					1:2		
33. Modern Ion Beam and Related Techniques for Materials Characterization	R.J. Blattner C.E. Evans, Jr.					2:1		
34. Modularization of the Introduction Course in Materials Science and Engineering	C. Hartley					1:1		
35. Nucleation and Atomic Kinetics	K.A. Jackson					2:3		
36. Reduction Processes in Extractive Metallurgy: Thermodynamics of Oxide Reduction	G.A. Smiernow L. Twidwell					1:2		
37. Simplified Procedure for Constructing Pourbaix Diagrams	E.D. Verink, Jr.					1:3		
38. Wood Anatomy and Ultrastructure	R.J. Thomas					2:1		
39. Wood: Its Structure and Properties	F.R. Wangaard					1:3		
40. Wood and Moisture	H. Tarkow					2:3		
41. Wood-Based Composites	J.J. Zahn					2:3		
42. The Growth of Magnetic Garnets by Liquid Phase Epitaxy	S.L. Blank					2:2		

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIAR DISTRIBUTI MODE
43. Economic Appraisals of Corrosion Control Measures	E.D. Verink, Jr.					3:2		
44. Polymer Morphology	P.H. Geil Case Western					3:1		
45. Thermoforming	J.L. Throne Amoco					1:1		
46. Fracture Mechanics (two modules)	S. Antolovich U. of Cinn.					2:2		
47. Thermomechanical Processing of Steel	L. Cuddy U.S. Steel					1:4		
48. Packing: The Crystal as an Assembly of Spheres	K. Jackson et al. Bell Labs							X
49. The Packing of Spheres of Different Sizes - Interstitial Space	K. Jackson et al. Bell Labs							X
50. Unit Cells and Space Lattices	K. Jackson et al. Bell Labs							X
51. Miller Indices: Representation of Planes and Directions	K. Jackson et al. Bell Labs							X
52. The Seven Crystal Systems	K. Jackson et al. Bell Labs							X
53. The Fourteen Bravais Lattices	K. Jackson et al. Bell Labs							X
54. Introduction to X-ray Diffraction	K. Jackson et al. Bell Labs							X
55. Laue Patterns	K. Jackson et al. Bell Labs							X
56. Powder Patterns: The Debye-Scherer Method	K. Jackson et al. Bell Labs							X
57. Corrosion Kinetics of Metals in Aqueous Solutions, Part 1 - Electrode Kinetics	W. Schultze Tech. Hogeschool					3:3		
58. High Temperature Oxidation of Metals	Hans de Wit U. Utrecht					3:2		
59. Processes for the Production of Ceramic Materials	J. Briggs Morganite Refr.					3:3		
60. Structural Wood Systems	D. Percival U. of Ill.					3:2		
61. Properties of Wood Building Materials	J. Haygreen U. of Minn.					3:3		
62. Mechanical Properties of Wood	A. Schniewind U. of Calif.					2:4		
63. Laboratory Tests	M.E. Criswell M.D. Vanderbilt Colorado State U.					3:4		

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIARY DISTRIBUTI(MODE
64. Lumber	R.J. Hoyle Wash. State U.					4:1		
65. Timber	R. Wibbens Am. Inst. of Timber Const.					4:1		
66. Panel Products	H.M. Montrey Weyerhaeuser Co.					4:2		
67. Environmental Factors	D.E. Lyon Mississippi State					4:2		
68. Portland Cement: Constitution and Processing, Part I - Cement Manufacture	D. Roy Penn State U.					3:4		
69. Properties, Bonding and Classification of Materials	C. Hartley							
70. Viscoelastic Behavior of Polymer Solids	T.W. Huseby						X	
71. Fibrous and Stressed-skin Composites	D.K. Rider						X	
72. Principles and Applications of Adhesives	D.K. Rider					4:4		
73. Thermodynamic Activity, Activity Coefficients and Changes in the Solid State	W.O. Philbrook							X
74. Phase Diagrams and Microstructure	British Open U. Course Team					3:3		
75. Fibre Reinforced Cements in Context	A. Kelly							
76. X-Ray Topographic Techniques for Electronic Characterization	G.A. Rozgoni D.C. Miller							
77. Current Growth Techniques	D.J.T. Hurle							
78. Heat Sealing of Plastics	F. Starr et al. E.I. duPont							X
79. Weathering of Plastics	F. Starr et al. E.I. duPont							X
80. Fiberglass Reinforced Plastics	F. Starr et al. E.I. duPont							X
81. Rubber Elastomers	F. Starr et al. E.I. duPont							X
82. Polysulfide Elastomers	F. Starr et al. E.I. duPont							X
83. Blow Molding	F. Starr et al. E.I. duPont							X

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIAR DISTRIBUT MODE
84. Foam Construction	F. Starr et al. E.I. duPont							X
85. Solubility Parameters	F. Starr et al. E.I. duPont							X
86. Corrosion	F. Starr et al. E.I. duPont							X
87. Foams in Packaging	F. Starr et al. E.I. duPont							X
88. Microwave Curing	F. Starr et al. E.I. duPont							X
89. Silicone Elastomers	F. Starr et al. E.I. duPont							
90. Stress Analysis	F. Starr et al. E.I. duPont							
91. Nuclear Magnetic Resonance of Polymers	F. Starr et al. E.I. duPont							
92. Rheology of Polymer Melts and Solutions	W. Graessley Northwestern U.							
93. Crystal Geometry and Crystal Structure	C. Hartley U. of Fla.							
94. Molecular and Ionic Crystals	C. Hartley U. of Fla.							
95. Amorphous Structures	C. Hartley U. of Fla.							
96. Crystal Structures of the Elements	C. Hartley U. of Fla.							
97. Characterization - Selection of Methods	C. Evans U. of Ill.							
98. Characterization - Theory	R. Ogilvie MIT							
99. LPE of 3-5 Semiconductors	G.B. Stringfellow							
100. Advances in Transmission Electron Microscopy	VanderSande							
101. Cellular Phase Separation	M.E. Fine Northwestern U.							
102. Precipitation Hardening	M.E. Fine Northwestern U.							
103. Metals and Ceramics of Antiquity	Fine, Northwestern J. Westbrook, GE							
104. Materials in Europe to 17th Century	Fine, Northwestern J. Westbrook, GE							
105. Materials and the Industrial Revolution	Fine, Northwestern J. Westbrook, GE							

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIARY DISTRIBUTI[ON] MODE
106. Modern Metals and Ceramics Industries	Fine, Northwestern J. Westbrook, GE							
107. Metallurgical Factors Affecting the Toughness of Steels	L.F. Porter							X
108. Continuous Casting	J.E. Hatch							X
109. How to Select Tool Steels	E.B. Evans							X
110. Superplastic Alloys	F-W. Ling D.E. Laughlin							X
111. Electronic Properties of Materials. I. Introduction to Quantum Mechanics	R.E. Hummel					4:1		X
II. Electrical Properties of Metals, Semiconductors and Dielectrics						4:5		
112. Metals - Physical and Chemical Properties	J.P. Allen							X
113. Thermodynamics, Definitions and Basic Concepts	A.W. Nicol							X
114. Metals - Structure and Properties	K.E. Borst					4:3		X
115. Corrosion in Brief	R.L. Shady							X
116. Basic Chemical Thermodynamics, I-Definitions and Concepts	A. Nicol Birmingham U.							
117. Basic Chemical Thermodynamics, II-The First Law and Thermochemistry	A. Nicol Birmingham U.							
118. Elementary Thermodynamics of Solutions	M. Onillon U. de Bordeaux							
119. Thermodynamics of Imperfections	B. Steele Imperial College							
120. Lithium Nitride and Related Materials: Case Study of the use of modern solid state research techniques	A. Rabenau Max-Planck-Institut					4:3		
121. Dimensionality in Structure and Properties of Inorganic Solids	P. Day Oxford U.					3:4		
122. Corrosion Prevention by Electro-deposited Metallic Coatings	K. Tostmann Fachhochschule							
123. The Mechanism of Protection of Steel in Concrete	Hans Arup Korrosions-centralen ATV							
124. Initiation and Propagation of Corrosion of Steel in Concrete	Hans Arup Korrosions-centralen ATV							
125. Properties of Electrode Surfaces, I - Impedance Measurements	Stuart Leach Nottingham U.							

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIARY DISTRIBUTI MODE
126. An Introduction to Morphological Characterisation of Sintered Structures	A. Mocellin Ecole Poly.					4:2		
127. Influence of Processing on the Microstructure of Silicon Carbide Ceramics	H. Hausner Technische U.					3:2		
128. The Development of Microstructure in Silicate Ceramics	K. Schuller Rosenthal AG					4:3		
129. Chemistry of Cement Hydration	H. Taylor Aberdeen U.					3:3		
130. Overview of Cement Kiln Chemistry and Process	D. Roy Penn State U.					3:4 5:3		
131. Overview of Mechanical Properties	H. Hilsdorf U. Karlsruhe							
132. Overview of Cement and Concrete Performance and Reliability	G. Idorn Naerum							
133. Physical Principles of Fracture	K. Pascoe Cambridge U.					3:4		
134. Why Not Charpy?	A. Demand Open U.							
135. The Measurement of K_{1c} and Standards	K. Williams							
136. Fracture in Ceramics	G. Weaver Open U.							
137. Processing Theories	Starr et al. E.I. duPont							
138. Crystal Structure	Starr et al. E.I. duPont							
139. X-Ray Analysis	Starr et al. E.I. duPont							
140. Injection Molding	Starr et al. E.I. duPont							
141. Plastics NDT	Starr et al. E.I. duPont							
142. Size Exclusion Chromatography	Williams							
143. Design with Plastics	Erwin							
144. Introduction to Polymer Processing	Erwin							
145. Fiber Reinforced Composites	Caruso							
146. Recycling of Thermosets	Ashar							
147. Thermal Analysis	Starr et al. E.I. duPont							
148. Principles of Adhesion - Bonding in Cement and Concrete	D. Tabor Cambridge U.							

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIAR DISTRIBUT MODE
149. Biomaterials - Bone	D.O. Northwood et al.					4:3		
150. Biomaterials - Teeth	E.A. Monroe					3:4		
151. Characterization of Metallic	T.R. Anantharaman Banaras Hindu U.							
152. Heterophase Glasses	D. Chakravorty IIT							
153. Ferrites	B.K. Das Nat. Phys. Lab.							
154. Infrared Materials	P.S. Gopalakrishnan Nat. Aero. Lab.							
155. Inorganic Glasses	K.J. Rao Ind. Inst. of Sci.							
156. Neutron Techniques in the Study of Materials	N.S. Satyamurthy Bhabha Atomic Res. Centre							
157. Solar Energy Materials	A.P.B. Sinha Nat. Chem. Lab.							
158. Ferroelectrics and Related Materials	E.C. Subbarao IIT							
159. Layered Materials	G.V. Subba Rao IIT							
160. Advances in Surface Characterization	C.N.R. Rao Ind. Inst. of Sci.							
161. Strength and Microstructure	G. Higgins IIT							X
162. Injection Molding	F. Starr E.I. duPont							X
163. Crystalline Order in Polymers	P. Geil et al. Case Western							X
164. Extrusion Theory	F. Starr E.I. duPont							X
165. High Temperature Fatigue	J. Weertman Northwestern U.							X
166. Single Component and Binary Phase Diagrams	J. Hilliard Northwestern U.							X
167. Ternary Phase Diagrams	W.B. White Penn State U.							X
168. Strength and Deformation of Solids	N.H. Macmillan Penn State U.							X
169. Introductory Metallography of Steels	D.J. Mack U. of Wis.							X

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIARY DISTRIBUTI(MODE
170. Transmission Electron Microscope: Specimen Preparation	Dodd, U. of Wis. G. Maxwell, SUNY							X
171. Microstructures	R. Moll U. of Wis.							X
172. Scanning Electron Microscopy of Wood	I. Sachs FP Lab							X
173. Products Liability (several modules)	H. Piehler Carnegie-Mellon							X
174. Procedures for Calculating Heat Losses Through Furnace Walls (in SI Units)	D.J. Whittemore U. of Wash.							X
175. Error Analyses for Measurements of Fractional Density	T.M. Hare NC State U.							X
176. Error Analyses for Measurements of (Dilatometric) Firing Shrinkage	T.M. Hare NC State U.							X
177. Mining, Beneficiation and and Utilization of the Clay Minerals	M. McLaren Rutgers U.							X
178. Glass Transition	D. Pye Alfred U.							X
179. Materials Design	J.J. Tietjen RCA Labs							X
180. Overview of Adhesive Bonding.	FPL Workshop					4:5		X
181. Fundamentals of Adhesive Bonding	FPL Workshop					4:5		—
182. Adherends and Their Preparation	FPL Workshop					4:6		
183. The Adhesive System	FPL Workshop					5:1		
184. The Bonding Process	FPL Workshop					5:1		
185. Evaluation of Adhesives and Bonded Products	FPL Workshop					5:2		
186. Durability of Adhesives and Bonded Products	FPL Workshop					5:3		
187. Applications and Needs for Wood Bonding	FPL Workshop					5:5		
183. Applications and Needs for Bonding Plastics, Metals and Other Inorganics	FPL Workshop					5:3		
189. Structure/Property Relationships	T. Alfrey Dow Chemical							
190. Processing Variables on Performance of Thermoplastic Polymers	T. Alfrey Dow Chemical							

TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JEMMSE VOL. #	PROTOTYPE OR OTHER	AUXILIARY DISTRIBUTI[ON] MODE
191. Strong Materials	British Open U. Course Team							
192. Electrons and Waves	British Open U. Course Team							
193. Architecture of Solids - Ideal Solids	British Open U. Course Team							
194. Architecture of Solids - Real Solids	British Open U. Course Team							
195. Electrons in Solids	British Open U. Course Team							
196. Solids Under Stress	British Open U. Course Team							
197. Processing Materials - How and Why	British Open U. Course Team							
198. Review and Revision	British Open U. Course Team							
199. Milk Bottle	British Open U. Course Team							
200. Solar Cell	British Open U. Course Team							
201. Car Body	British Open U. Course Team							
202. Transformer Core	British Open U. Course Team							
203. The Skin of Concorde	British Open U. Course Team							
204. Porcelain	British Open U. Course Team							
205. Pulse Echo Ultrasonic Testing	R. Maxwell							
206. Principles of Materials Selection	J. Morral							
207. The Effects of Mechanical Processing on the Structure and Properties of Thermoplastic Polymers	T. Alfrey							
208. Mechanical Processes of Thermoplastic Polymers	T. Alfrey							
209. Polymeric Materials - A Historical Review	T. Alfrey							

	TOPIC	AUTHOR	FIRST DRAFT	REVIEWED	LATER DRAFTS	REVIEW AND FINAL FORMAT	JME VOL. #	PROTOTYPE OR OTHER	AUXILIARY DISTRIBUTION MODE
210.	The Influence of Metal Oxide Morphology on High Temperature Metal Oxidation	J.H.W. de Wit					5:1		
211.	Dynamic Compaction and Shock Conditioning of Powdered Materials	Robert F. Davis Hayne Palmour III					5:1		
212.	Amorphous Semiconductors: From Selenium to Silicon	J. Mort					5:2		
213.	Materials Processed from Powders. An Introduction to the Field	R.L. Meyer					5:2		
214.	The Powder Metallurgy Industries	R.L. Meyer					5:2		
215.	An Iterative Method for Determining Equilibrium Compositions in Complex Vapor Transport Systems	Y.K. Rao M. Donley H.G. Lee					5:2		
216.	Viscoelastic Behavior of Polymer Solids	T.W. Huseby					5:3		
217.	Defect Chemistry of Alloy Compound Semiconductors	F.A. Kroger					5:4		
218.	Structure-Property Relations in Intercalated Graphite	M.S. Dresselhaus					5:4		
219.	Electrical Properties of Dislocations in Semiconductors	Hans-Joachim Queisser					5:4		
220.	The Thermodynamic and Physical Modeling of Alloy Phase Diagrams	R.E. Watson L.H. Bennett					5:4		
221.	Slags and Slag Cements	M. Regourd					5:5		
222.	Engineering with Ceramics. The Weibull Model	G. Weaver					5:5		

APPENDIX I

EMMSE SYSTEM IN PHASE III

NATIONAL ADVISORY COMMITTEE

Tasks:

To oversee the Project;
To make recommendations to the Principal Investigator(s), PSU and NSF on the policy and operation of the Project.

MODULE DEVELOPMENT COMMITTEE

Tasks:

Determine areas of need, topics and content;
Select authors;
Recognize potential workshop opportunities;
Organize workshops;
Provide review mechanism;
Provide reviewed modules to the EMMSE Staff for publication.

EXECUTIVE COMMITTEE

Tasks:

Recommend policy to NAC;
Provide direction to EMMSE Staff;
Analyze content of materials produced;
Provide direction for future production;
Act as liaison between NSF and the NAC;
Make decisions for the NAC between meetings.

EVALUATION, NETWORKING & MODELING COMMITTEE

Tasks:

Evaluate the materials produced;
Analyze the utilization of product materials;
Develop interfield networking links to other NSF projects;
Provide technological models for future operation;
Provide economic models for future operation;
Provide direction for implementing these models.

EMMSE STAFF

Support Tasks:

Overall management of the Project;
Budget preparation and fiscal management;
Act as publisher of JEMMSE;
Advertise the products of the Project;
Disseminate the products of the Project;
Socialize the MSE community;
Write proposals for funding;
Write reports of work accomplished;
Develop "state-of-the-art" technologies for module preparation, publication and dissemination;
Develop new operational strategies to recommend to the NAC;
Provide general support to the NAC and its committees.

Innovation Tasks:

Develop curriculum and course analysis tools and data.
Develop digitization of data-base and modular material and cost-effective means for its utilization.

APPENDIX II

Members of the National Advisory Committee

Charles Wert, Chairman
Professor and Chairman
University of Illinois

Turner Alfrey, Jr.
Research Fellow
Dow Chemical Company

James P. Bosscher
Professor
Calvin College

Stephen H. Carr
Professor
Northwestern University

Robert F. Davis
Professor
North Carolina State University

Bruce E. Knox
Associate Professor of Mats. Sci.
The Pennsylvania State University

David E. Laughlin
Professor
Carnegie-Mellon University

George Marra
Deputy Director
Forest Products Lab

Walter S. Owen
Professor and Head
Massachusetts Institute of Technology

Rustum Roy, Secretary
Professor and Director
Penn State University

Roger Porter
Professor
University of Massachusetts

John Ritter, Jr.
Professor
University of Massachusetts

David R. Rossington
Professor
Alfred University

Jerome Saeman
Adjunct Professor
University of Wisconsin

Peter Signell
Professor of Physics
Michigan State University

Paul Turner
Director, Human Performance and Support Center
Bell Telephone Laboratories

L. H. Van Vlack
Professor and Chairman
University of Michigan

Ellis D. Verink, Jr.
Professor and Chairman
University of Florida

APPENDIX III

Prototype Modules Produced and Distributed

Materials for Fiber Optical Communication.
Part One: Optical Properties of Transmission Media
Part Two: Fiber Fabrication
William G. French, Bell Laboratories

Point (Atomic) Defects in Stoichiometric Ceramic Materials
Part One: Solid Solutions
Part Two: Schottky and Frenkle Defects
Robert F. Davis, North Carolina State University

Surface and Bulk Defects in Solids
Craig S. Hartley, SUNY/Stony Brook

Introduction to Dislocation in Crystals
Craig S. Hartley, SUNY/Stony Brook

Viscoelastic Behavior of Polymer Solids
T. W. Huseby, Bell Laboratories

Fibrous and Stressed-skin Composites
D. K. Rider, Bell Laboratories

Principles and Applications of Adhesives
D. K. Rider, Bell Laboratories

Phase Transformations in Condensed Systems
Part One: Nucleation
Part Two: Growth of Phases
Morris E. Fine, Northwestern University

Crystallography: A Nine-unit Minicourse of Programmed Learning
1. Packing: The Crystal as an Assembly of Spheres
2. The Packing of Spheres of Different Sizes - Interstitial Space
3. Unit Cells and Space Lattices
4. Miller Indices: Representation of Planes and Directions
5. The Seven Crystal Systems
6. The Fourteen Bravais Lattices
7. Introduction to X-Ray Diffraction
8. Laue Patterns
9. Powder Patterns: The Debye-Scherrer Method

Bruce Chalmers, Harvard University
James G. Holland, University of Pittsburgh
Kenneth A. Jackson, Bell Laboratories
R. Brady Williamson, University of California, Berkeley

APPENDIX IV

Cumulative Index to Volumes I and II of JEMMSE

Arranged by Topic and Materials Class

4. Wood

Phase Transformations in Condensed Systems
Part Two: Growth of Phases
Morris E. Fine
Northwestern University 2:3:557

9. <u>Other</u>

Introduction to Online Searching of Bibliographic Databases
Lucille M. Wert
University of Illinois 1:2:403

Modularization of the Introductory Course in Materials Science and Engineering
Craig Hartley
University of Florida 1:1:201

APPENDIX V

EMMSE Matrix

THIS MATRIX PROVIDES A GUIDE TO THE INDEX. THE NUMBERS RUNNING VERTICALLY DOWN THE LEFT SIDE CORRESPOND TO THE NUMBERS AT THE TOP OF THE PAGES IN THE INDEX, INDICATING THE LOCATION OF THE RESPECTIVE SUBJECT AREAS. THE LETTERS ACROSS THE TOP WILL BE FOUND IN PARENTHESES AFTER EACH MEDIA ENTRY, IDENTIFYING THE MATERIALS CLASSIFICATION. THE NUMBERS IN THE BLOCKS OFFER A QUICK OVERVIEW OF THE CONCENTRATION OR LACK OF AVAILABLE MEDIA THROUGHOUT THE INDEX.

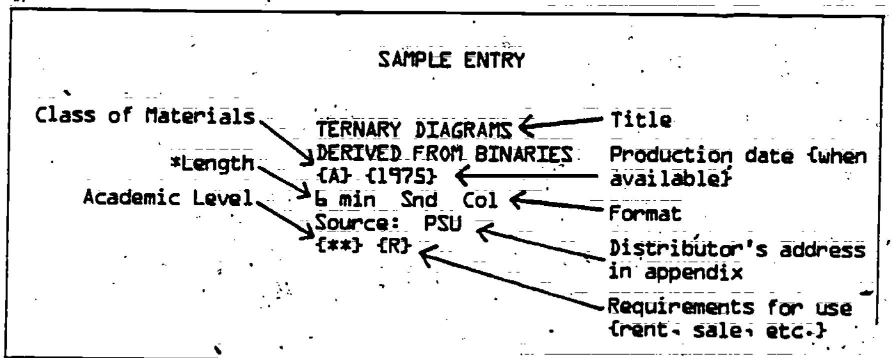
(E)ducational (M)odules for (M)aterials (S)cience and (E)ngineering

SUBJECT AREA			No.	MATERIALS (COMPOSITION): A. ALL SOLIDS IN GENERAL	METALS & ALLOYS: B. FERROUS / C. NON-FERROUS	D. CERAMICS, INCL. CONCRETE	E. POLYMERS	F. ELECTRONIC MATERIALS	G. NON-CRYST. SOLIDS	H. WOOD & PAPER	I. COMPOSITES	J. BIOMATERIALS	K. OTHER
BASIC SCIENCES		SOLID STATE PHYSICS	1	51	8	1	0	13	0	0	0	0	0
BASIC SCIENCES		CRYSTAL CHEMISTRY	2	76	6	3	1	2	1	0	1	0	2
BASIC SCIENCES	THERMO-DYNAMICS	PHASE EQUILIBRIUM	3	22	27	3	2	0	0	0	0	0	0
BASIC SCIENCES	THERMO-DYNAMICS	THERMOCHEMISTRY	4	35	4	2	3	0	0	0	0	0	0
BASIC SCIENCES	KINETICS	DIFFUSION	5	40	4	1	1	0	0	1	0	1	0
BASIC SCIENCES	KINETICS	REACTIONS: MECHANISMS	6	46	4	2	12	0	1	1	0	1	0
CHARACTERIZATION	STRUCTURE	CRYSTAL	7	69	18	2	1	1	0	2	2	2	1
CHARACTERIZATION	STRUCTURE	MICRO	8	29	21	2	16	0	3	8	5	0	0
CHARACTERIZATION	STRUCTURE	DEFECT	9	19	8	2	1	2	0	0	0	0	0
CHARACTERIZATION	STRUCTURE	SURFACES, INTERFACES	10	15	21	4	3	1	0	2	0	1	0
CHARACTERIZATION	CHEMICAL COMPOSITION	BULK	11	42	5	1	33	0	0	1	14	25	0
CHARACTERIZATION	CHEMICAL COMPOSITION	TRACE	12	29	4	1	2	0	0	0	2	4	0
CHARACTERIZATION		NON-DESTRUCTIVE TESTING	13	3	3	0	0	0	0	0	0	0	0
CHARACTERIZATION		INSTRUMENTATION	14	131	11	3	33	1	0	4	17	25	1
PROCESSING		GEN. PROCESSING	15	8	33	4	17	0	3	10	2	1	0
PROCESSING		EXTRACTION: HYDRO, PYRO, ELECTRO	16	6	44	0	2	0	6	11	0	1	0
PROCESSING	PREPARATION	ULTRAPURIFICATION	17	1	0	0	1	0	0	1	0	1	0
PROCESSING	PREPARATION	PARTICULATES	18	2	2	1	3	0	0	0	0	0	0
PROCESSING	PREPARATION	SINGLE CRYSTALS	19	23	3	4	0	1	0	0	0	0	0
PROCESSING	PREPARATION	THIN FILMS	20	2	2	0	0	4	0	1	0	0	0
PROCESSING	FORMING	SOLIDS: FORGING, SINTERING	21	4	63	3	2	0	0	0	0	1	0
PROCESSING	FORMING	FLUIDS: CASTING, EXTRUDING, CVD	22	6	58	1	43	0	3	2	6	1	0
PROCESSING	FORMING	FINISHING: GRINDING, COATING	23	15	63	10	21	0	6	7	2	0	0
PROCESSING	FORMING	JOINING	24	20	46	4	17	0	2	5	6	2	1
PROPERTIES		THERMAL	25	19	15	4	17	0	1	1	0	2	2
PROPERTIES		MECHANICAL: ELASTIC, PLASTIC, FRACTURE	26	43	113	21	71	2	12	8	18	3	3
PROPERTIES		ACOUSTIC	27	2	1	0	0	1	0	0	0	0	0
PROPERTIES		OPTICAL	28	13	0	7	3	7	3	0	0	0	1
PROPERTIES		ELECTRICAL: DIELECTRIC	29	21	20	10	1	59	0	2	1	0	1
PROPERTIES		MAGNETIC	30	2	32	0	0	3	0	0	0	0	0
PROPERTIES		CHEMICAL: CORROSION, ADHESION	31	12	34	1	17	0	0	1	4	1	0
PROPERTIES		NUCLEAR: RADIATION EFFECTS	32	8	1	0	0	0	0	0	0	1	0
PROPERTIES		BIOLOGICAL	33	2	2	2	3	0	0	2	0	8	0
PROPERTIES		RHEOLOGICAL	34	1	1	0	6	0	0	7	0	1	0
APPLICATIONS		MATERIALS SELECTION	35	10	21	5	10	2	4	6	2	2	0
APPLICATIONS		DESIGN WITH MATERIALS	36	23	46	8	32	1	5	7	7	4	0
APPLICATIONS	FUNCTIONS	STRUCTURAL	37	7	16	2	4	0	2	6	5	0	0
APPLICATIONS	FUNCTIONS	ELECTRICAL, MAGNETIC, OPTICAL	38	2	8	6	0	27	3	1	0	0	1
APPLICATIONS	FUNCTIONS	SURFACE: FRICTION,	39	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APPENDIX VI

EMMSE MEDIA INDEX

A guide for locating teaching aids in all media.



*In most cases {films, tapes, etc.} the time given is running t.
In some instances {print} it is study time.

KEY TO INDEX

AC	Audio Cassette	R	Rental
AT	Audio Tape	RP	Rental or Purchase
B/W	Black and White	r/r	Reel to Reel
Col	Color	SA	Special Arrangement
F	Free	Sil	Silent
FC	Film Cassette	Snd	Sound
FL	Free Loan	VC	Video Cassette
FS	Filmstrip	VT	Video Tape
OT	Overhead transparency	*	Introductory
P	Purchase	**	Advanced

APPENDIX VI

Sample Page from Media Index

PROPERTIES: CHEMICAL {CORROSION, ADHESION} **31**

16 mm film {cont.}

RESTORATION OF EQUESTRIAN STATUES AT THE MEMORIAL BRIDGE {C} {1972}
16 min Snd Col
Source: Assoc F
{*} {FL}

RUBBER BY DESIGN {E}
27 min Snd Col
Source: Shell
{*} {FL}

SHAPES AND POLARITIES OF MOLECULES {A} {1963} {Cat. No. 20168}
18 min Snd Col
Source: PSU
{**} {R}

SPECIFIC PROPERTIES OF STAINLESS STEEL {B}
"discusses physical and chemical properties"
40 min Snd Col
Source: Rep Steel
{*} {FL}

STRESS CORROSION IN MAGNESIUM BASE ALLOYS {C}
18 min Sil B/W
Source: OSU
{**} {R}

STRESS CORROSION IN STAINLESS STEEL {B}
13 min Snd Col
Source: OSU
{**} {R}

THINK ABOUT IT {C}
"film about zinc coating - the most effective way of controlling rust without spending a lot of money on a continual maintenance program"
20 min Snd Col
Source: Assoc F
{*} {FL}

SUPER 8 FILM

CORROSION {B,C} {A set of 3 films}
1. Corrosion I - Filiform Corrosion
2. Corrosion II - Hydrogen Embrittlement
3. Corrosion III - Aluminum
FCs 4 min each Sil Col
Source: Wiley
{*} {P}

FILIFORM CORROSION OF ALUMINUM {C}
FC 4 min. Sil Col
Source: LBF
{*} {P}

SLIDE TAPE

BIOMATERIALS — TISSUE INTERACTION {J} {S&S Series}
Approx. 2.5 hrs ACs
Prints of slds
Source: ACS
{**} {P}

A BREAKDOWN IN PLASTICS {I & II} {E} {M&M Series}
15 min AC each side, 30 min total
Source: ACS
{**} {P}

CORROSION SERIES {A}
17 Slds No tape
Source: ASM
{**} {P}

DURABLE CONCRETE {I} {1963}
18 Slds AC Col
Source: PCA
{*} {R}

ELECTRO CHEMICAL PROPERTIES {A}
Half Cell Potentials
Polarization and Overvoltage
22 Slds 46 min tape
Source: Ruoff & PC
{*} {P}

NEW DIMENSIONS FOR POLYMERS {E}
AC No time given
Source: ACS
{*} {P}

Educational Modules for Materials Science and Engineering

PRIORITY TOPIC LIST 1979

All accepted modules will be published in the JOURNAL OF EDUCATIONAL MODULES FOR MATERIALS SCIENCE AND ENGINEERING

EMMSE is a self-help venture of the worldwide Materials Science and Engineering community to develop, publish and disseminate a variety of quality-controlled modular materials for educational use. This priority topic list has been developed to encourage members of the constituency to become authors of such modules.

The EMMSE Project is supported by the Science Education Directorate of the National Science Foundation.

AN INVITATION TO ALL MEMBERS OF THE MATERIALS COMMUNITY AND CLOSELY RELATED DISCIPLINES

We invite you to become an author of an EMMSE module. In doing so you will be participating in a venture that will ultimately contribute substantially to materials science and engineering education. You can do this by selecting a topic from the accompanying list and writing a module on that subject. In many cases you may already have a big start in performing this service; lecture notes or an unpublished manuscript could provide the basic outline and formulation of ideas to be communicated.

When you have decided on the topic or topics that are of interest to you, please use the form provided to send this information to the appropriate Topic Area Team (TAT) Chairman. He will assist you through all stages of development and review. (All EMMSE modules are peer and student reviewed to ensure a high degree of quality for education.) An early contact is important, since some topics are being commissioned by the TATs, and duplication of effort can thus be avoided.

Accepted modules will be published in the Journal of Educational Modules for Materials Science and Education (JEMMSE), thus providing an author with a citable reference to a refereed publication. Subscriptions to JEMMSE confer unlimited reproduction rights; offprints are available in bulk as well.

GUIDELINES FOR AUTHORS

WHAT IS A MODULE?

A module is a relatively small unit of printed material designed as a teaching vehicle. (In length it is essentially the equivalent of a short chapter in a textbook.) One distinctive feature of modular units is the way in which they can be linked together by careful selection to form larger groups which fit individual or specialized needs. (A particular textbook represents one such *fixed* set.) The other basic advantages of modules are that they are written by "experts" in the relatively narrow field of their specialization, and that they are peer-reviewed much like research papers. They are also tested in the classroom to provide additional input to the author for a second stage revision.

WHAT ARE THE MOST IMPORTANT FEATURES OF A MODULE?

(1) The author should have in mind the background in science he is counting on in his intended audience. A few sentences about these prerequisites helps the learner know if he can utilize the module effectively.
(2) A series of statements setting forth the learning objectives of the module is desirable.
(3) The author should attempt whenever possible to make her/his unit as free-standing as possible; i.e., avoid extensive reliance on immediate antecedent material, except the general background referred to in (1), or where a group of modules are written by the same author and such references are unavoidable.
(4) A high proportion of good illustrations is often the most important addition to a more traditional text. Reference to supplementary visual aids, such as films, video tapes, etc., may also be desirable.
(5) SI units preferred with English equivalents in parentheses.
(6) The author should add some questions which a student should be able to answer if he has grasped the substance of the module. Some of these can be interspersed with the text, and wherever appropriate, it is recommended that example problems of mathematics (with answers) be used. Other problems and questions can be grouped at the end as a post test to determine mastery.
(7) The module will naturally contain some references and bibliography. In a teaching module it is rather important that those which the author believes to be essential or especially relevant be separated from a more complete bibliographical list.

AT WHAT "LEVEL" AND FOR WHAT AUDIENCES ARE MODULES BEING PREPARED?

Four levels and audiences have been conceived:

Levels	Audiences
1. Introductory materials science and engineering (MSE)	College students in MSE and related disciplines
2. Materials Technology for non-MSE majors	Non-science majors, community colleges, industry technicians, etc.
3. New areas suitable for graduates in industry and seniors and grad students in college	Industry, MSE majors, other disciplines
4. Advanced topics — pedagogical reviews	University and industry materials research workers

HOW LONG WILL IT TAKE ME TO GET A MODULE PUBLISHED?

As mentioned before, one of the valuable aspects of the EMMSE module is that it will be peer and student reviewed. This procedure will take some time, but should prove its worth in the long run. The various stages of preparation and review in a typical case might take the form of that shown below.

STAGES OF PREPARATION AND REVIEW

Stage	Author's Activity	Review Activity	Cumulative Turn Around Time
1	First draft. May be an outline consisting of table of contents, objectives, abstract of text, figures and post tests	Review by Topic Area Team	2 weeks
2	Second draft. Complete module with full text	Review by peers	6 weeks
3	Third draft with revisions from 2	Review by selected students	10 weeks
4	Fourth draft with revisions from 3	Field testing by students	14 weeks
5	Final version ready for publication	Formatting and preparation of module for printing by EMMSE	16 weeks

WHAT HAPPENS WHEN MY MODULE IS ACCEPTED FOR PUBLICATION?

As indicated in Stage 5 above, an approved manuscript is forwarded through the appropriate TAT to the EMMSE Staff Headquarters at The Pennsylvania State University where it will be formatted as camera-ready copy for the printer. The EMMSE staff will also help the author by enhancing or redrawing figures on request and will provide other services, including securing copyright permissions and distributing the published module to users through the Journal of Educational Modules for Materials Science and Engineering.

WHAT ARE THE "COMPENSATIONS" FOR AUTHORS?

During the current funded stage of EMMSE, a small honorarium will be paid to authors. In addition, EMMSE will work diligently to provide professional recognition and other compensations for authors along the following lines:

1. The author's module will be used by hundreds and possibly thousands of students and their teachers, as opposed to the dozen or so people who read the average research paper.
2. Modules will be published in JEMMSE, the Journal of Educational Modules for Materials Science and Engineering, a citable, peer-reviewed publication.
3. Department Chairmen and Deans, or the two appropriate levels in industry, will receive letters from EMMSE advising them of the valuable contribution made by the author.
4. Requests will go out to professional societies to accord module writers some recognition through their educational sections.
5. Consideration will be given by each TAT to establish a prize to be awarded by some major professional society for a "best module".

WHAT ABOUT ROYALTIES AND COPYRIGHTS?

The potentional market for EMMSE products is relatively small and the intention is to keep the cost to students as low as possible. Therefore, it is anticipated that the opportunity for royalties will not be very great.

During the current funded stage, copyright will be held by The Pennsylvania State University for EMMSE. Future arrangements for both royalties and copyright must be negotiated with and approved by NSF.

PRIORITY TOPIC LIST

The following list of topics is a preliminary subdivision of the field which is intended to suggest areas in which authors might want to write modules. The major subdivisions (Metals, Ceramics, Polymers, Wood and Characterization) correspond with their respective Topic Area Teams. Topics under GAPS do not fall into any of these major subdivisions. Modules in the GAPS category should be forwarded to the EMMSE Coordinator. Other modules should be sent to the appropriate TAT Chairman.

METALS

BASIC SCIENCES
- Metallic Elements
  - Atomic Structure
  - Atomic Bonding
  - Crystal Structure
  - Structure of Amorphous Metals
  - Crystalline Defects
    - Vacancies
    - Dislocations
    - Stacking Faults
  - Microstructure
    - Grain Boundaries
    - Twins
  - Phase Equilibria
    - Allotropy
    - P-T Diagrams
  - Thermodynamics of Multi-Component Systems.
    - Two-Component Systems
      - Solid Solutions
      - Ideal Solutions
      - Regular Solution
      - Sub-Regular Solutions
      - Interaction Coefficients
      - Intermediate Phases
      - Free Energy Diagrams
      - Liquid-Solid Transformation
    - Phase Diagrams
      - Development of
      - Use of
        - Composition
        - Lever Rule
        - Phase Rule
    - Three-Component Systems.
      - The Mode of Depicting Phase Diagrams
      - Phase Rule
      - Solid Solutions
    - More Than Three-Component Systems.
      - Methods of Depicting Phase Diagrams
  - Phase Transformations in Metallic Systems.
    - Thermodynamics

Metals (cont'd.)

Diffusion
Phenomenology
Atomistic
Nucleation
Homogeneous
Heterogeneous
Effect of Coherency
Growth
Interface Controlled
Diffusion Controlled
Kinetics
TTT Diagrams
Specific Transformations
Precipitation
Allotropic
Martensitic
Bainite
Order-Disorder
Spinodal Decomposition
Massive
Recrystallization
Solidification
Eutectic
Eutectoid
Peritectic
Non-Equilibrium Conditions
Solidification
Coring
Metastable (transition) phases.

PROCESSING
Melting
Casting
Ingots
Mechanical Forming
Joining
Adhesive Bonding
Diffusion Bonding
Welding
Heat Affected Zones
Microstructure
Heat Transfer
Metal Removing Processes
Machining
Powder Metallurgy
Thermal Treatment
Annealing
Tempering
Aging
Finishing
Mechanical
Chemical
Electrochemical
Organic
Ceramic
Polymer
Processing of Metals for the Electronics Industry

PROPERTIES
Mechanical
Principles of Deformation
Thermally Activated Deformation
Plastic Flow
Work Hardening
Fracture
Ductile
Brittle
Hot Work
Texture
K Concept
Machinability
Wear
Fatigue
Fracture in Hostile Environments
Chemical
Thermal
Acoustic
Optical
Electrical
Magnetic
Nuclear
Biological
Rheological
Structure — property relationships
Testing for Properties

APPLICATIONS
Materials Selection
Structural
Electrical and Magnetic
Optical
Surface: Friction, Wear, Corrosion
Thermal
Nuclear
Biological
Failure Modes in Sercice
Process Selection
Composites
Fracture Analysis

CERAMICS

BASIC SCIENCES
Theory of Elasticity
Continuum elasticity
Thermodynamic concepts
Stress — Strain
Linear and non-linear elasticity
Atomic theory of elasticity
Lattice statics
Linear lattice dynamics
Non-linear lattice dynamics
Solid solution effects
Phase changes and elastic constants
Internals friction
Frequency effects

PROCESSING
Conventional Powder
Raw material extraction
Raw material processing
Powder characteristic
Binders
Powder consolidation
Sintering
Hot pressing
Multi-phase systems
Deposition
Vapor
Particle
Electrolytic
Scaling
Fusion
Techniques
Applications
Microstructures
Single Crystal Growth
Methods
Solutions
Melt
Vapor
Applications
Other Bulk Methods
Pyrolysis
Hydrothermal
Fibers, Fabrics, Coatings, Films, Tapes
Forming, Hot Working, Alloying, Heat Treating
Joining
Adhesive, Elastomeric, Sealant Joining
Mechanical
Cementing
Brazing
Welding

Machining
- Bonded abrasic — sawing, grinding
- Free abrasive — lapping and polishing
- Free abrasive — fluid driven

Glass/Glass-Ceramic
- Melting
  - Tanks and furnaces
  - Combustion and fuels
  - Dissolution
  - Refining
- Forming Operations
  - Pressing
  - Blowing
  - Casting
  - Rolling
  - Float process
  - Drawing
  - Fiberizing
  - Dry gaging
  - Lamination
- Finishing
  - Annealing
  - Cut — off, scoring, firepolishing
  - Grinding, polishing, drilling
  - Decoration
  - Sealing
- Secondary Forming
  - Repressing, redrawing
  - Fiber optics
  - Lamination (safety glass)
  - Foaming
  - Multiform
- Controlled Crystallization (Glass-Ceramics)
  - Phase separation
  - Nucleation
  - Crystal growth
  - Phase transformation
  - Thermal history effects
  - Photosensitive effects
  - Automatic viscosity control
- Strengthening of Glass and Glass-Ceramics
  - Tempering
  - Ion exchange
  - Surface crystallization
  - Differential densification
  - Alkali extraction
  - Glazing
  - Lamination

PROPERTIES
- Thermal and Thermal Shock
- Mechanical
  - Elastic
  - Strength
  - Hardness
  - Impact and Erosion
  - Friction and Wear
  - Electrically Induced Fracture
  - NDT — Proof Testing
- Electric Conductivity
- Dielectric
- Magnetic
- Chemical
- Optical

APPLICATIONS
- Extruded honeycomb catalytic substrates
- Lucalox for high pressure sodium vapor lamps
- Single crystal sapphire tubes, filaments, etc. by Tyco process
- Steel plant refractory
- Glass tank refractory
- Spark plug
- Auto water pump seal
- Glass-ceramic radomes

POLYMERS

BASIC SCIENCES
- Solid State Physics
  - Chain-folded crystallization in polymers
  - Control of fold-period in polymer crystals
  - Ultimate moduli and strengths in polymer solids
  - Polymer glassy state
- Phase Equilibria
  - Thermodynamics of rubber elasticity
  - Phase separation in block copolymers
  - Rubber-filled impact plastics: Synthesis and microstructure
- Thermochemistry
  - Sorption processes in polymeric solids
- Diffusion
  - Barrier properties of polymeric films
- Reactions:
  - Addition polymerization
  - Condensation polymerization
  - Solid state polymerization

CHARACTERIZATION
- Crystal Structure
  - X-ray diffraction from polymers
- Microstructure
  - Pole-figure analysis of textured polymeric solids
  - Small angle x-ray scattering from polymers
  - Spherulitic crystallization
  - Polymer morphologies
- Defect
  - Defects in polymer crystals
- Surfaces, Interfaces
  - Surface physical chemisty of polymers
  - ESCA of polymer solids
- Bulk
  - Vibrational analysis of polymers
  - Raman spectroscopy of polymers
  - Determination of M of polymers
  - Determination of M of polymers
  - Dilute solution viscometry of polymers
  - Gel permeation chromatography of polymers
  - Nuclear magnetic resonance of polymers
  - Infrared absorption spectroscopy
- Trace
  - Analysis of additives in polymeric systems
- Non-Destructive Testing
  - Acoustic emission from polymers
- Instrumentation
  - Optical microscopy of polymers
  - Scanning electron microscopy of polymers
  - Transmission electron microscopy of polymers
  - Thermal analysis of polymers

PROCESSING
- Ultrapurification
  - Preparative purification of polymers
- Particulates
  - Fillers: Reinforcing and non-reinforcing
  - Rubber-filled impact plastics
- Thin films
  - Glow-discharge polymerization
  - Photolithographic polymers
- Solid: Sintering, etc.
  - Plastic deformation mechanisms
  - Vacuum forming materials
  - Sintering of polymer powders
  - Solid state extrusion
- Fluid: Extruding, etc.
  - Mechano-chemical effects in polymer processing
  - Compatibility of polymer blends
  - Extrusion of polymers
  - Molding of polymers (thermosets, thermoplastics, foams)

Aramide fiber production
Flow-induced crystallization in polymers
Preparation of polymer blends
Other
Rubber compounding
Recycling of plastics
Effect of processing on structure and properties
Joining
Welding plastics
Adhesives

PROPERTIES
Thermal
Thermal conductivity of polymeric systems
Mechanical: Elastic, plastic, fracture, etc.
Rubber-filled impact plastics, properties
Tensile testing of polymers
Compressive and shear strengths of polymer solids
Creep properties of polymers
Time-temperature superposition in polymers
Dynamic-mechanical properties of polymers
Crazing and fracture in polymers
Mechanical failure of plastics; Fatigue failure
Fractography of polymeric solids
Impact resistance in polymers
Acoustic
Sonic velocity measurement in polymers
Acoustical insulations
Optical
Light scattering from polymer solids
Electrical: Dielectric
High voltage breakdown
Dielectric properties of polymers
Ionic conduction in polymeric systems
Polymer electrets
Magnetic
Reaction of macromolecules to magnetic fields
Chemical: Corrosion, Adhesion
Polymer adhesion and wettability
Photooxidative degradation of polymeric solids
Hydrolytic degradation of polymeric resins
Nuclear: Radiation Effects
Radiation chemistry of polymers
Biological
Microbiological attack of polymeric solids
Rheological
Normal stress effect in flowing polymer melts
Viscosity-shear rate dependence of polymer melts
Tensor description of flow in polymer fulids and solids

APPLICATIONS
Materials Selection
Role of plastics in energy conservation and management
Materials selection with plastics
Design with Materials
Designing with plastics
Fabrication of tires
Structural
Fiber-reinforced plastics
Polymer laminates; sheet moulding compounds
Polymer concrete
Thermal insulation of structures with polymers
Urethane foam structures
Load-bearing materials based on polymers
Electrical, Magnetic, Optical
Electrical insulation applications of polymers
Plastic lenses
Capacitor films
Surface: Friction, Wear, Corrosion
Polymeric coatings
Tribology of plastics
Friction materials based on polymers
Corrosion control of metals with polymeric coatings
High-temperature stability
Blood-compatible polymeric materials
Implantable polymers
Flammability of polymeric systems

CHARACTERIZATION

NON-DESTRUCTIVE EVALUATION
Overview (Comparison of Techniques)
Principles and Applications of:
Radiographic Examination
X-ray
Neutron
Ultrasonic Methods
Acoustic Emission Methods
Dye Penetrant Methods
Magnetic Particle Methods
Eddy Current Methods
X-ray diffraction (Residual Stress Measurement)
Other

SURFACE ANALYSIS
Overview of Thin Film Analysis Methods (Comparison)
Principles and Applications of:
High Resolution Electron Microscopy
Scanning Transmission Electron Microscopy
Scanning Electron Microscopy (SEM)
Selected Area Diffraction
Low Energy Electron Diffraction
Electron Microprobe Analysis
Replica Electron Microscopy
Specimen Preparation for Electron Microscopy
Thin Foil Specimens
Replication Methods
Dynamic Theory of Contrast in Electron Microscopy
Kinematic Theory of Contrast in Electron Microscopy
Auger Electron Spectroscopy (AES)
Electron Spectroscopy for Chemical Analysis (ESCA)
Secondary Ion Mass Spectrometry (SIMS)
Ion Scattering Spectrometry (ISS)
Scanning Auger Microanalysis (SAM)
Rutherford Scattering for Thin Film Analysis
Ion Sputtering (Principles and Applications)

MICROSTRUCTURE
Light Optical Microscopy (LOM)
Principles of Light Optics and Lenses
Polarized Light Microscopy (Principles and Applications)
Specimen Preparation for Light Optical Microscopy
Metals
Ceramics
Polymers
Wood
Quantitative Metallography (Principles and Appliactions)
Other
Electron Optics
Principles and Applications of:

X-RAY DIFFRACTION
Small Angle Scattering
Principles
Applications
Inorganic Glasses
Organic Polymers
X-ray Line-Slape Analysis
Particle Size Analysis
Crystal Strain Analysis

CHEMICAL ANALYSIS-BULK
Principles and Applications of:
X-ray Fluorescence Spectrometry
Thermal Analysis
Differential Thermal Analysis
Thermogravimetric Analysis
Differential Scanning Calorimetry
Chromatography
Gas Chromatography

Liquid Chromatography
Gel Permeation Chromatography
Raman Spectroscopy
Infra Red Spectroscopy
Atomic Absorption
Nuclear Magnetic Resonance
Solid State EMF measurement
Mossbauer Spectroscopy
INSTRUMENTATION
Principles and Applications of:
Radiation and Particle Detectors
Electron Spectrometers
Mass Spectrometers
Solid-State Detectors
X-ray Spectrometers
Techniques of Sampling
Physical Methods (e.g., sample selection, sample preparation)
Statistical Methods.

WOOD

Wood as a Material
Fine Structure of Wood
Cellular and Supercellular Structure of Wood
Wood and Moisture
Physical Properties of Wood
Mechanical Behavior and Properties of Wood
Modification of Wood for End Use
Paper
Wood-based Composite Materials

GAPS

Crystal growth
Catalytic materials
Phase equilibrium
Laser processing
Non-crystalline materials
Metals
Semi-conductors
Ceramics
General
Directional composites
Radioactive waste
Sialons
Adhesivers
Concrete — cement
Polymer additives
Specialty materials
Electronic materials
Magnetic Materials
Biomaterials
Teeth
Bone
Ceramic, metallic, polymeric
Coal
Metallic impurities
Sulfides
Use of computer for:
Graphics
Thermodynamic properties
Tensor properties
Phase diagrams
Data acquisition

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AUTHOR REPLY FORM

(Please send to the appropriate TAT Chairman)

I would like to contribute EMMSE modules on the following topics:

TOPIC: ______ Instructional Level: ______

TOPIC: ______ Instructional Level: ______

TOPIC: ______ Instructional Level: ______

Appropriate Topic Area: (circle one)
Metals
Polymers
Characterization
Ceramics
Wood
Gaps (none of the others)

Name ______ Title: ______

Address: ______

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APPENDIX VIII

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APPENDIX IX

REPORT OF THE FIRST EMMSE-WECC/NATO WORKSHOP

The main meeting of the First EMMSE-WECC/NATO Workshop for the production of teaching modules in the field of Materials Science and Engineering took place in the Conference Center of the CNEN Laboratories (Comitato Nazionale della Energia Nucleare) by kind invitation of the Director, through the good offices of Professor Guiseppe Lanzavecchia, during the week 21-26 September, 1980. The Workshop was conceived and organised by the West European Coordinating Committee for the Educational Modules for Materials Science and Engineering System, with finance provided by a grant from the Special Programme Panel for Materials Science of the Scientific Affairs Division of NATO. It was attended by 34 teachers and industrial scientists representing 9 European countries and America, who functioned as members of 5 main subject groups, together with 11 family members. Appendix A lists the Participants.

The charge laid upon EMMSE by its principal funding agency, the National Science Foundation, is

> "To experiment with a means for developing, indexing and disseminating instructional materials in Materials Science and Engineering."

One of the experiments in developing instructional materials is the use of Workshops. The idea behind these is that a group of experts are invited to write modules, short instructional articles, on subjects 'clustered' around a common topic. They then interchange their modules, read them, and come together to review the set critically and prepare them for publication in the Journal of Educational Modules for Materials Science and Engineering (JEMMSE), the publication medium for the EMMSE System. Moreover, this review session normally includes people interested in the subject under discussion but not expert in it, who can comment on the intelligibility of the modules to a non-expert reader. The process does appear to work well and some good modules have been produced by this method, as the first experiment carried out by the Wood Products group showed.

The 'Wood' Workshop was devoted entirely to wood and wood products. The Workshop devised by EMMSE-WECC, however, has taken a different form and has, in many ways, been more a set of interlocking Workshops than a single unit. From the start it was decided that the Workshop should cover a range of topics rather than a single one so that there would be two types of person automatically at the meeting, with the experts for one topic acting as the 'lay persons' for the others. This was a sensible format for Europe, since one aim of the Workshop activity was to make EMMSE better known within Europe and 'socialise' teachers, etc, on this side of the Atlantic, an activity that had already happened in America. The multi-topic format allowed us to contact a broader spectrum of people than a single topic meeting could have done.

The Workshop was experimental, and it was decided that it should be held in two parts, with a Preliminary Meeting in the spring of the year, at which to identify subject clusters with the chosen topic areas and to assign modules to authors, and the main Meeting later in the summer at which the modules would be reviewed and prepared for publication. The Preliminary Meeting was held at Brimingham University at the end of March, and its report is included as Appendix B. Some 30 modules were identified and assigned tentatively to authors, in five main topic areas, and from these some 25 modules were offered

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assessed.
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›r Frascati, as listed in Appendix C. In the event, four
›e completed for the main Workshop, the second titles from
those from Williams and Idorn, leaving 21 modules to be
ılly it had been hoped that these could be available before
›rkshop so that people could have read them before arriving
›e time between the two meetings was too short to allow this,
ants had their first sight of the modules at the start of

in the Hotel Flora on Sunday, 21 September, after the main
at Leonardo da Vinci airport by Mrs Petruzzi and her helpers
ht to Frascati in a special bus. This helpfulness and
need was typical of all the CNEN personnel throughout the
hank them enough for making my task as organiser so easy.
inner on the Tuesday evening was provided by CNEN, as part
ing us feel really welcome.

e Conference were days of hard work. The topic groups met
der the technical contents of each module, and each one was
ne tooth comb! Although we had to leave CNEN at 5pm each
top then, but was simply transferred to the Hotel and groups
les until midnight or after, with lively and stimulating
eral pattern that developed was that each group considered
separately, then presented one or more to the meeting in
ereby opening up the discussion to other interested parties
, and some very valuable discussions arose from these
result has been that all the modules will be rewritten to
er extent and it has been decided that separate authors
-ready copy for direct transmission to JEMMSE, through the
Organiser. The groups plan to have final copy ready by
n 1981.

also charged with the task of planning for future work,
task very seriously. All wish to continue the exercise
d, the Cement and Concrete group planning a set of modules
the American Ceramic Society Congress in May, 1981, for
the whole party came together on the Friday morning to
on, and to hear of separate group plans, and it was very
he enthusiasm with which everyone looked to the future.
commented on how unique the meeting was, with so many
it European countries together to discuss education, and
he idea that such activity could form the basis of some
of educationalists. It is probable that a Newsletter to
erials Departments throughout Europe will be the first
rkshop. In addition, there was a lot of interest in the
rkshop as a forum for the interchange of ideas on teaching
Björklund led a very interesting discussion on this
sday, as well as demonstrating the computer-based PLATO
ter truly herculean efforts to obtain the required terminal
ry connections to the main computer in Brussels. A
considering methods of teachings and comparing and contrasting
countries and Universities was proposed and may occur in
nly appeared much support for it.

took the opportunity to meet, on the WEdnesday, and it was
ple want this type of --tivity to continue and to spread.
formats for Workshops, and the ideas that have been proposed
re welcomed wholeheartedly. Particular note was taken of
rkshops should be organised in association with other
t NATO-sponsored Meetings might be a good source of modules.
tures should prove very cost-effective, since the major
iferences is that of travel, and it would cost little more

to have people stay to assess modules based on the topics covered in the main Meeting, and the resulting co-publication in JEMMSE could prove beneficial to the main publication, by providing additional publicity for the work. Every effort will be made to organise such cooperative events. The meeting was also delighted to learn that Professor Karl Tostmann, of the Fachhochschule, Aalen, is willing to join the Committee as representative from Germany, a major omission that has been a source of concern for some time. Lastly, Professor Viana invited the Committee to hold its next meeting in Lisbon in April, and his kind offer was gratefully received, subject to availability of travel funds.

How, then, can one summarise the Workshop. Firstly, it was an experiment and as such it very largely succeeded. The aims were twofold, in the main, to make people aware of EMMSE and to provide a forum in which persons could discuss the teaching of materials science and engineering and produce modules for inclusion in the EMMSE System. It did make people aware, and many more than were able to attend the meeting. It did provide a forum in which interested people could discuss didacticism and pedagogy and compare and constrast teaching methods, and define what needs to be provided for the effective teaching of a group of disciplines within the overall field, and participants were willing and eager to take advantage of this. There were, of course, some things wrong, mainly that the modules should have been available for reading well in advance of the meeting, that the time given for writing the modules and the time of year were not ideal, and parallel sessions always generate conflicts. This last was inevitable, given the five groups and the limited time available for assessment, reading, and discussion, but it was also generally felt that something important would have been lost if the Workshop had been devoted to only one subject. The cross-topic interactions gave an important input to the overall assessment and review procedures. We hope that we have learned some of the lessons of the week and that we shall be in a better position to organise the next event. As far as output is concerned, the tangible product is a pile of 21 modules which will soon be ready for JEMMSE. The intangible, but equally important, product is the spirit that was engendered by the participants in the Workshops, the friendships made, and the possibilities for cooperation that have been provided.

I think that, for me, the Workshop was summed up by the groups sitting round the tables in the garden of the Hotel Flora, the tables covered with beer galsses and papers, animatedly discussing modules well into the evening, and even until midnight, as I mentioned earlier. There was a huge amount of work done and everyone seemed to enjoy doing the work. It was one of the happiest and friendliest Workshops I have attended, and EMMSE-WECC is most grateful to NATO, and particularly to the Special Programme Panel, for the financial aid that made it all possible.

Alastair W Nicol
2 October, 1980

EMMSE-WECC WORKSHOP

Frascati, Italy 21 - 26 September 1980

PARTICIPANTS

Professor G. Ball	Imperial College, London	U.K.
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Professor P. Pratt	Imperial College, London	U.K.
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Professor H. F. W. Taylor	Aberdeen University	U.K.
Dr. A. W. Nicol	Birmingham University	U.K.
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Dr. A. Demaid	Open University, Milton Keynes	U.K.
Dr. P. Lewis	Open University, Milton Keynes	U.K.
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Professor Della Roy	Pennsylvania State University	U.S.A.
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