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EVALUATION OF INSTRUCTIONAL MONOGRAPHS IN UNIVERSITY AND INDUSTRIAL USE

by

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Summary

The difficulty of keeping abreast of new technology with the rate at which it is being created is proving to be physically impossible as well as an inefficient use of engineer's time. The NASA Pilot Program in Instructional Monographs has been conducted at Oklahoma State University since June, 1966, with an objective of providing up-to-date instructional material derived from current research as rapidly and as efficiently as possible for use in engineering education.

An Instructional Monograph is designed to be used by a teacher or engineer without undue reference to additional material. The amount of material is normally adjusted to require one to three hours for formal presentation. Where possible, homework problems demonstrate any principle developed in the new technology being presented.

Considerable effort has been made to test the use of Instructional Monographs both in the classroom by professors and in self-study use by engineers in industry. This has resulted in requests for Instructional Monographs from 262 different professors at 111 universities in 39 states and 5 foreign countries. In addition, there have been requests from 56 different industries. The analysis of those evaluation forms returned has shown a very positive response in acceptance of the Instructional Monograph concept. Further development of the concept appears to be needed to refine this method of speeding new technology into use. In addition, the development of the program into a test of its ability to sustain itself financially is required.

The personnel of the NASA Pilot Program at Oklahoma State University have been convinced by this experience that this is an excellent technique to insure that scientific and technological developments from current research be retrieved and made available to the maximum extent for industrial and educational benefit.

Introduction

Engineering educators and practicing engineers have difficulty in keeping abreast of new technological advances being created in research and development laboratories throughout the world. An individual in either phase of the engineering profession today finds it a near-impossible task to keep up with the state-of-the-art if he is required to search the literature documenting new technology and to glean useful information for himself. It is physically impossible to individually review all the new documents at the rate they are being produced. To attempt such a task can result only in an inefficient expenditure of the valuable time of many practicing engineers and teachers.

In general, engineering societies do not have the manpower, time, or inclination to edit and publish an adequate amount of material in a form suitable for educational purposes that can be used by educators and practicing engineers. They prefer to publish original research results that have not been published elsewhere and which are more appropriately fitted for the limited space available in these journals. However, engineering societies have recently expressed interest in developing new methods of augmenting textbook material with current literature in a form similar to the Instructional Monographs.

Representatives of book publishers have reported that the format of the Instructional Monograph does not fit into their present mode of operation. The book publishers believe that the marketing of Monographs would only partially support a continuing program of creating Instructional Monographs. Greater selection of Monographs is needed in each subject area to assure frequent use by engineering educators. Although the book publishers are not optimistic on the paper back concept, they have not completely turned it down; one major company's representative continues to check with Oklahoma State University on the program's progress.

A Center for Creating Instructional Monographs in Engineering, established at Oklahoma State University in June, 1966, has the objective of providing up-to-date instructional material derived from current research to educators and practicing engineers. Recognized authorities in their fields have provided the guidance for a systematic search of the literature, the selection of appropriate educational material in their subject areas, and the preparation of the written Monographs for use as supplementary material in the classroom, in the industrial seminar, and for individual study. Monographs prepared from documentation of NASA research efforts have been written in the subject areas of heat transfer, thermodynamics, and control systems.

The Monographs resulting from the Center's program are primarily based on one or more research reports and are commonly supplemented by other material. They are designed to augment textbook and class-note material in a course of instruction. The material is sufficiently complete to be used in one to three hours of instruction. Where possible, the Monographs contain and develop only one central idea. A homework problem and its solution are included when applicable. These Instructional Monographs produced have been circulated widely for use both in university classrooms and by practicing engineers. A listing of the titles of the Instructional Monographs produced as of the program to date is given in the Appendix.

Instructional Monographs

Definition

An Instructional Monograph is defined as a

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technical paper that develops a single topic based on one or more technical reports and possibly supplemented by other published material or original work of the author. An Instructional Monograph is designed for use by engineering faculty members for use in advanced undergraduate or graduate engineering classes or practicing engineers and scientists for self-study programs. They are developed for one to three hours of instruction. The subject material may include: (1) a new application of some principle regularly taught, (2) a new method of solving a typical problem, (3) the demonstration of some new application of a known principle, or (4) the presentation of new technical data for engineering use. These Monographs are segmented supplementary units of textbook material. Instructional Monographs are presently limited to the Engineering Sciences, in particular, the subject areas of heat transfer, thermodynamics and control systems.

Modes of Writing

The mode of operation used to produce Instructional Monographs must be attractive to the senior author to gain his participation. He is the key person in the production of Monographs and is expected to be qualified as a recent textbook author or as a recognized authority in his field, as an experienced teacher, and as an experienced engineer. In the process of producing Monographs, he must be able to recognize new and significant material in his field; he must be able to develop a complete and accurate presentation of the new contribution to engineering; and he must be able to write or edit the Monograph in such a way as to make it valuable as supplementary teaching and learning material in his field. An individual with these qualifications has many places where he can fruitfully apply his labors, so a satisfactory mode of operation of the Monograph program is important.

Three primary methods of operation have been used for writing Monographs. With the first method, the senior author does all of his own development of material and writing with minor assistance from a graduate associate when desired. This procedure uses a considerable amount of the senior author's time. With the second method, an experienced engineering professor in the field takes the material selected by the senior author and prepares it as supplementary textbook material under the guidance of the senior author. With this method, both the senior author and the supporting experienced engineering professor are regular, salaried participants in the program. The third method modified this procedure slightly by hiring the experienced engineering professor as a consultant at an appropriate hourly stipend to prepare the Monograph from the material selected by the senior author. The senior author then edits and prepares the material for final typing.

The senior author—consultant author mode of operation provided the most economical method of writing Monographs. An average cost of four Monographs prepared under this mode of writing averaged $1,700 per document compared to $9,200 for the average cost of 29 documents. However, the senior author-graduate student mode of writing has its place in the program as it apparently works well when the topic requires a great amount of technical development of the source material.

Dissemination of Monographs

An active publicity program over the past two years seeking the use and evaluation of Instructional Monographs for the purposes intended has resulted in good response from engineers both in universities and in industries. Papers have been presented at national conferences, letters have been sent to engineering colleges and to industries, and a full page advertisement has been placed in the Journal for Engineering Education. The chronological increase in requests for Monographs is plotted by quarters in Figure 1. As can be seen, a total of 1924 had been sent to engineers requesting them, was an evaluation form which they were urged to complete. There have been 254 evaluation forms returned by 61 professors at 41 universities located in 30 states and 66 practicing engineers in 15 industrial organizations. Of particular interest is a concentrated effort of evaluation by the Rocketdyne Corporation in Canoga Park, California. This effort was particularly well done and contributes significantly to the study in determining the value of Monographs to practicing engineers in industry for self study use.
Perhaps of interest is the distribution of the evaluations according to specific Monographs as listed in the Appendix. This is shown in Figure 2. An attempt has been made to obtain at least 10 evaluations for each Monograph with the feeling that this would provide significance in the evaluation of each one. Those Monographs showing no evaluations were either not completed in time for distribution or are not yet through the publication mechanism.

Figure 2. Monograph Evaluation Statistics

Analysis of the Evaluations

The concept of preparing Instructional Monographs with the general guidelines established in this program has been favorably received by the individuals requesting the material. For every 11 positive responses to the concept, only one negative response has been received. Some of the general trends which can effect development of the Monographs have been noted by separating the written comments into three categories, positive responses, negative responses, and suggestions for improvements. This has been done with a representative group of the written comments in the following tables.

Table 1
Positive Responses Excerpted from Evaluation Forms for Instructional Monographs

1. Excellent aids to understanding new technology.
2. Permits inclusion of timely material in courses.
3. Providing systematic searches in subject areas for new material.
4. Useful method for presenting new technical material.
5. Useful in industry to keep engineers up on new developments.
6. Useful in industry to update engineers' skills through self study.
7. Written information is brief and does not distract reader from the technical information.
8. Preparation of classroom or self study form is different from journal articles.
9. Useful for students to use in directed reading and problem solving not now commonly done in universities.
11. Useful to add to textbook materials for up-to-date technology.
12. Useful as an experiment in material preparation.
13. Students acquainted with real analysis of problems confronting engineers who are now active.
14. Can discuss specific problems and specific methods which a textbook cannot cover completely.
15. Useful to introduce current topics to students.
16. Subject is treated in depth.
17. Better approach than professor giving classroom lecture on material only.
18. New materials of this form should be helpful in stimulating research ideas.
19. These Monographs are excellent.
20. Useful method of presenting new technical information to the engineer.
21. Of use to get this information out to most engineers.
22. Monographs provide brief, condensed summary of technical information.
23. Monographs may be circulated more quickly and reach more people.
24. Practical application of theory is demonstrated.
25. New methods can be made widely useful soon after their innovation.
26. Good idea, since a complete text is often too formidable for self-study.
27. Excellent means of introducing new techniques to industry.
28. Presents subject in "bite size" pieces easy to go thru.
29. Information is in small enough "package" to permit easy reading.
30. New methods can be made widely useful as soon as possible.
31. Useful method of presenting new technical information before material can be included in textbook.
32. Of value in keeping engineers up-to-date on technical advances.
33. Useful particularly to a person who is not an expert in the field.
34. Presentation tends to be clear and more explanatory than typical technical paper.
35. Very useful in presenting new technical information to engineers.
36. Useful for giving quick introduction to a new concept.
37. Monograph is much easier to understand than principles contained in its basic reference, although reference is a good report.
38. Good points include briefness, straightforwardness and productive value.
39. Gets new material to engineer quickly in easily assimilated manner.
40. Furnishes a collection of referenced material not yet summarized in a textbook.
41. Are current and brief, providing stimulation without smothering.
42. Material is clear, specific and developed in a well organized manner.

Table 2
Negative Responses Excerpted from Evaluation Forms for Instructional Monographs

1. Too confined to one area.
2. Too specific to be useful.
3. Only useful to a professor with no industrial experience and no interest (or possibility) of attending technical materials.
4. Too much detail in one specific item to be included in a course. Too much time required in classroom.
5. Nomenclature was not the same as used in the courses—hence students became confused.
6. There were several technical errors in the Monograph.
7. Problem could be reworded for more clarity.
8. Offers no advantage over article in technical journal.
9. Original paper (for this Monograph) was more orderly in its explanations.
10. As educational exercises they are convenient but have a narrow audience for practical use.
11. (This Monograph has) too little content for anyone needing it for work.
12. This particular Monograph sacrificed clarity for brevity.
13. Needs more complete exposition to be suitable for a broader audience and for self study.
14. As it stands, this monograph can be replaced by the reference paper from which it was drawn.

Table 3
Suggestions for Improvements Excerpted from Evaluation Forms for Instructional Monographs

1. Should be directed specifically at either graduate or undergraduate.
2. Should be coupled with use of a textbook.
3. Should be quite detailed in development for ease of use.
4. Should be written specifically for classroom use.
5. More relation of subjects to practical problems would fit a design course.
6. More than one relatively simple problem based on the material.
7. Problems should be written which deal with current hardware.
8. Provide a statement of difficulties and history which led to the problem (such as encountered in practice) would stimulate the teaching and learning process.
9. Provide more Monographs so that the instructor can be more selective.
10. Provide more background material in Monograph.
11. Provide several Monographs covering the same subject in different technical depths.
12. Should have some definition of symbols listed.
13. More careful proofreading is needed.
14. Care should be exercised to maintain clarity at all times.
15. Example problems are extremely necessary.
17. Should have hinted at limitations and suggested methods to extend.
18. More problem examples would facilitate understanding.
19. Monographs should be expanded to cover a wide variety of subject areas.

20. Subject areas of practical interest should be chosen.

General Evaluation and Conclusion

As a general review of the evaluation forms was made, some general conclusions have been reached with respect to some possible truths in the preparation of Instructional Monographs and in the type of material that should be included.

The following general requirements should be met in providing the Instructional Monographs:

1. Author should be a respected authority in the subject area.
2. Topic of the Instructional Monograph should be new and significant to the subject area; one not covered in recent textbooks.
3. Contents of the Monograph should be sufficiently detailed to cover the topic but concise enough to be covered in preferably one hour lectures—not more than three hours.
4. Contents should cover sufficient amount of background material applicable to the topic to eliminate undue research on the part of the using professor and students.
5. Monographs should be reviewed for content, clarity, and accuracy by the author and editor.
6. Monographs should be based on a specific topic but not necessarily limited to one source document.

The overall evaluation of the program does indicate a need for further development to prepare a realistic analysis of the concept and to determine its future direction.

1. Arrange and conduct colloquia of "valued" consultants and Monograph authors to evaluate and analyze the Instructional Monograph program and its results.
2. Create additional Instructional Monographs, incorporating those changes in format and technique based on our experience and evaluations.
3. Continue to apply effort to obtain additional evaluations of Instructional Monographs.
4. Apply additional effort in surveying the industrial prospects for the Instructional Monograph.
5. Develop positive future plans for expanded implementation of the program from results of colloquia, Monograph evaluations, and general analysis of the entire NASA Pilot Program.
6. Continue to solicit additional support for the developmental phase of the Instructional Monograph program from other agencies, institutes, foundations, and private organizations.

The staff personnel of the NASA Pilot Program for Instructional Monographs at Oklahoma State University have been convinced by the experience and results obtained in the program that this is an excellent technique to insure that scientific and technological developments from current research be retrieved and made available to the maximum extent for this nation's industrial and educational benefit. It is yet to be determined whether such a program can be self-sustaining from a financial standpoint.
Acknowledgements

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Appendix I

Monograph Titles

Heat Transfer

HT-1 Calculation of Radiant Heat Exchange by the Monte Carlo Method
HT-2 A Generalized Correlation of Vaporization Times of Drops in Film Boiling on a Flat Plate
HT-3 Method for Estimating Ratio of Absorptance to Emittance
HT-4 Formulas for Radiant Heat Transfer Between Nongray Parallel Plates of Polished Refractory Metals
HT-5 Pool Boiling Heat Transfer at Reduced Gravity
HT-7 The Method of Zones for the Calculation of Temperature Distribution
HT-8 Heat Pipes and Vapor Chambers for Thermal Control of Spacecraft
HT-9 Thermal Modeling

Thermodynamics

TD-1 Calculation of Complex Chemical Equilibria
TD-2 Thermodynamic Equations, Data and Techniques for Preparing Properties Compilations
TD-3 Critical Flow of Real Gases Through Nozzles
TD-4 Thermodynamic Consistency of Vapor-Liquid Solubility Data
TD-5 Computer Program for Thermodynamic Performance of Brayton Cycle Space Power Systems
TD-6 Enthalpies of Co-existing Equilibrium Vapor and Liquid Mixtures from Solubility Data and Equation of State Calculations
TD-8 Thermodynamics of Space Flight

Control Systems

CS-1 An Example of Compensation Network Design
CS-2 An Application of Root Locus Techniques to Lunar Vehicle Control
CS-3 An Example of Nuclear Rocket Control Design
CS-4 An Example of Bang-Bang Control System Design
CS-5 Controller Design for Nonlinear and Time-Varying Plants
CS-6 An Example of Optimal Control Design