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A one day course was developed to train and inform working scientists and engineers in the most direct and efficient means of seeking and acquiring scientific and technical information related to their day-to-day professional activities. The course was given three times to groups of forty Federally-employed scientists and engineers in the middle professional categories. Responses from the first two groups, both observed and from questionnaires filled out by the students, were used to modify the course to cover topics of greatest interst. The course, as finally presented covered these topics: (1) information about information, (2) information on ongoing research and development, (3) information on current or recent research and development results, (4) information on past research and development results, (5) major American libraries and resource collections, (6) organization of personal files, and (7) the relationship of the scientist and engineer to his information tools and mechanisms. Two physical products of utility resulted from the course: (1) a portfolio of demonstration materials, and (2) a text which was essentially a recapitulation of the lectures (ED 022 068). The course may later be "repackaged" along broad subject lines or for special interdisciplinary interest groups. With few changes it could also be used in schools of library and information science. (CM)

FINAL REPORT

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Introduction

In the Fall of 1967, at the request of the Panel on Education and Training of the Committee on Scientific and Technical Information (COSATI), with the financial support of the U. S. Office of Education, Herner and Company developed and tested what started as a two-day and emerged as a one-day course to train and inform working scientists and engineers in the most direct and efficient means of seeking and acquiring scientific and technical information related to their day-to-day professional activities.

The first and most obvious impetus for the course was the realization that the rate of development of new information tools and resources far exceeds the ability of the average scientist and engineer to understand and use them. Indeed, one need not cogitate exclusively upon new tools and resources in establishing the fact that there is a problem; for the most part, the older and more traditional tools and resources have remained within the realm of the librarian and information specialist, and have been rarely or sparsely used by the working scientist and engineer. This leads to a secondary rationale for the course, which was the understanding, or feeling, on the part of the Panel on Education and Training and other participants in the development and testing of the course, that many of the available information tools and services are

1/ Paper presented at 156th National Meeting of the American Chemical Society, Sept. 8-13, 1968.
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best used directly, by scientists or engineers themselves, rather than through surrogates such as librarians and information specialists. The problem was to develop means of ensuring that the scientists and engineers were made aware of the information aids available to them.

The third rationale was a very important one. It has been shown in various studies, at the Massachusetts Institute of Technology, the University of Wisconsin, and elsewhere, that the better performers in science and technology, in terms of their comparative contributions to their fields and work environments, are also the most efficient seekers and users of technical information (1,2). However, the information gathering techniques of these "best performers" are, on analysis, quite different from those of the run-of-the-mill scientists and engineers. In terms of how we think information <u>should</u> be sought and obtained, the superior types have to be viewed as nonconformists and, in a sense, "cheats," in that they always seem to seek out and use the easy rather than the classical paths to work-related information.

Typically, in his day-to-day work, the superior scientist or engineer apparently treats information and information gathering on a problem-solving rather than a "duty" basis. He tries to find the simplest and least time-consuming route to what he wants or needs, or thinks he needs, just as he does in all his other professional activities. In developing our course, we tried to emulate this approach: to point out the shortest and, at the same time, the safest routes to work-related information.

While seemingly contradictory, the shortest and safest routes to information are, in practice, quite reconcilable; too often, perhaps as a result of early training and exposure to pseudo-scholarship, scientists and engineers become so concerned with knowing everything about a subject that they fail to find out about the sub-part in which they are actually interested. Also too often, information tools -- the library, the information center, the abstracting and indexing publication, advanced searching and dissemination systems, etc. -- used out of context, for purposes for which they were not designed, have proved quite unsafe and illusory. The job of our course was to put the available tools and resources into context, and to guide their effective use and disuse, and to promote their fullest and most effective exploitation in the performance of the jobs they were created to do.

In summation, our course was designed to tell people where to go or where to look, or where not to go or look, to obtain required information as expeditiously as possible. We treated the acquisition of each general type of information we dealt with as an exercise in problem-solving, rather than as strictly a scholarly undertaking.

Evolution of the Course

As noted, the course started out as a two-day and ended up as a one-day affair. The main elements that were eliminated had to do with the fundamentals of information communication and dissemination processes and future developments in information tools and resources. These deletions were made at the request of the first and second of three groups of students to whom the course was given. Each of the three groups consisted of approximately forty Federally-employed scientists and engineers ranging from the GS-9 to 15 levels. This would be in the middle professional categories.

Aside from our own analyses of student response, and those of the Panel on Education and Training, the instrument that elicited the request for the deletions (and also additions and changes) was a questionnaire that was distributed to the students at the end of each of the three times that the course was given. The questions that were asked were these:

1. What do you believe to be the most significant weaknesses of the course?
2. What do you believe to be the most significant strengths of the course?
3. What changes or improvements would make the course more useful from your viewpoint?
4. What portions of the course, if any, would you recommend be eliminated or de-emphasized?
5. What additional topics do you think should be included in the course?
6. Which of the topics that were included should be given greater emphasis?
7. Additional comments or suggestions.

The responses to the questionnaire were many and varied, extending from the physical appearance and speech mannerisms of the lecturers, to detailed comments on the substantive content of the course. However, two areas were especially emphasized. These had to do with the aforementioned deletion of material on information and communication processes and anticipated information developments, and also with the addition of a discussion of methods of creating and maintaining personal document and index files. The apparent rationale for this requested addition was that we took great pains to tell the students how to track down and acquire useful sources of information, but we told them little about how to organize it for future use once they had gotten hold of it.

Final Course Syllabus

The course syllabus that was finally evolved from the three test sessions, consisted of the following lecture topics:

Information About Information. In this lecture we were concerned with one of the most time-consuming aspects of information-gathering: determining the most responsive and efficient sources or methods for acquiring useful information. We dealt with such institutional aids as the National Referral Center for Science and Technology, and such published aids as Winchell's Guide to Reference Books, as well as some thirty-five other directional or "switching" tools and services.

Information On Ongoing Research and Development. Here we dealt with information about current research and development activities, in advance of publication or announcement of results. Our prime examples are the Science Information Exchange of the Smithsonian Institution, the Research Grants Index of the National Institutes of Health, the various abstracting and indexing publications that announce unpublished progress reports emanating from R&D projects, and some twenty other major tools and resources.

Current or Recent Research and Development Results. In this lecture we dealt with keys to published results of research and development of relatively recent origin. Typical examples were the aforementioned abstracting and indexing publications dealing with unpublished research and development reports, announcement publications such as Physical Review Letters, the letters to the editor sections of journals such as Nature and Science, Clearinghouse Announcements in Science and Technology (CAST) of the Clearinghouse for Federal Scientific and Technical Information, Current Chemical Papers, Chemical Titles, Current Contents, and Selective Dissemination of Information services (SDI) such as ASCA III of the Institute for Scientific Information.

Past Research and Development Results. In this lecture, the primary emphasis was on conventional abstracting and indexing publications such as Chemical Abstracts, Biological Abstracts, Engineering Index, and Physics Abstracts, and other, more avant-garde,retrospective searching tools such as the Science Citation Index and the Uniterm Index to Chemical Patents.

Major American Library and Resource Collections. Here we departed from our essentially temporal treatment of types and sources of information, turning instead to major or exemplary libraries and information resources in two categories: national libraries and facilities, such as the Clearinghouse for Federal Scientific and Technical Information, the Science and Technology Division of the Library of Congress, the National Agricultural Library, and the Defense Documentation Center, maintained by the Federal government, and other important libraries and information centers inside and outside the Federal government.

Organization of Personal Index Files. Here we dealt with methods of organizing the documents themselves, as well as methods for organizing surrogate files based on unit records such as library catalog cards and edge-notched punch cards, inverted indexes such as those based on Uniterm cards and peek-a-boo or optical coincidence, and personal files produced and maintained via computers.

Relationship of the Scientist and Engineer to His Information Tools and Mechanisms. Here we dealt with such topics as how the user of permutation indexes is affected by how authors title their publications; how users of other indexes produced through the manipulation of whole texts are affected by the style and content of scientific and technical writings; how the users of citation indexes are affected by ways in which authors refer to prior published works; how direct access to computer-based retrieval systems, via remote terminals and consoles, is affected by the way that scientists and engineers couch their search questions;and, leaving the subject of computer-based systems and products, how cooperation or lack of cooperation with major centers such as the National Referral Center for Science and Technology, the Science Information Exchange, the Defense Documentation Center, the Clearinghouse for Federal Scientific and Technical Information, and other major information resources affect the completeness and utility of their responses to queries and their dissemination services.

Supporting Materials

In addition to the final syllabus, two physical products of potential subsequent utility resulted from the course. One was a bound portfolio of illustrations of the major information aids that were discussed. At the onset of the planning of the course, careful consideration was given to the use of visual aids such as slides. However, because of the amount of material to be covered, it was decided that slides would be unwieldy, time-consuming, and generally distracting, since they would require the lecture room to be darkened. Instead, a portfolio of demonstration materials, containing all of the items that would have been illustrated via slides, was distributed to each student. This approach was received very positively by the students, a number of whom expressed enthusiastic appreciation of it and considered it a highlight of the course. It had the multiple advantage of placing each illustration immediately in front of the student on his desk, of permitting notes to be taken at all times during the lectures, and, perhaps most important, it permitted the illustrative materials to be taken away by the student for subsequent perusal and study.

The second supporting product that came out of the course was a text entitled A Guide to Information Tools, Methods, and Resources in Science and Technology. This text was essentially a recapitulation of the lectures constituting the course. While the book was not ready for distribution at the time of the three demonstration sessions, it will, as in the case of the portfolio of the demonstration materials, be useful for subsequent reference and study by students who take the course, or variations of it, in the future.

Applications and Modifications

It is evident that any course that essays to cover the major information tools, techniques, and resources of all of science and technology is bound to involve areas which have no interest, or only peripheral interest, for significant portions of any given group of students. We are considering remedying this problem, first, through the development of course "packages" based on broad subject lines such as chemistry, biology, medicine, engineering, etc. This would mean, in essence, that we would be extracting and putting together only those portions of the course lectures which pertain to specific subject areas, insofar as is feasible. There are limitations to this specialized "repackaging," arising from the fact that a number of the lectures, such as Information About Information, Major American Library and Resource Collections, Organization of Personal Index Files, and Relationship of the Scientist and Engineer to his Information Tools and Mechanisms, which are pertinent to all fields of science and technology, and which cannot be refined or slanted without a significant loss of effectiveness. However, to a degree, the lectures on Ongoing Research and Development, Current or Recent Research and Development Results, and Past Research and Development Results, do lend themselves to slanting and refinements on a subject basis.

We have also been approached by a number of our students, and by various organizations, to consider the development of interdisciplinary (guided missiles, pharmaceuticals, environmental control) to serve the needs of mission-oriented groups and activities. This would mean cutting the pie in a slightly different way, but is certainly feasible.

On the other hand, there are many organizations and groups that do, in fact, cover all or most of science and technology and would benefit from the course as constructed in the final version of the original syllabus. Examples are the U. S. Civil Service Commission Office of Career Development, which emphasizes general principles in the courses it develops and gives for Federal employees; the Naval Research Laboratory, which covers all or most of the basic sciences; and private research and development institutions, such as the Battelle Memorial Institute and the Midwest Research Institute, both of which run the gamut of science and technology in their interests and activities. Thus, it is conceivable that future versions of the course would take three forms: broad subject, mission-oriented, and general.

One further consideration in regard to future applications and variations relates to schools of library and information science. Surprisingly (although perhaps not so surprisingly in retrospect), the course, and particularly the Guide and demonstration materials, manifested considerable interest among members of faculties of schools of library and information science, which are concerned, among other things, with the teaching of scientific and technical bibliography. In developing the course, we focused on working scientists and engineers. However, it is obvious (belatedly) that persons who serve the bibliographic and information needs of working scientists and engineers must be equally, or more, cognizant of the available tools, techniques, and resources. It would appear that, with minor deletions, additions, and refinements, the course and its supporting materials could be made to serve the library and information community.

Two final modifications relate to means of disseminating and presenting the course, in whatever form or forms it takes in the future. In regard to dissemination, consideration is being given to putting the course on video tape, so that it can be reproduced and broadly distributed to interested groups and organizations. The obvious advantage of this approach is that a video tape version, designed and executed by professionals in the field of audio-visual communication, is a very cheap and efficient means of bringing the course and its contents to the largest possible audience. However, there are disadvantages. One of these is the limited number of organizations that have the required display equipment. Another is the loss of interchange between the teacher and student. We found such interchange crucial and extremely beneficial in our trial executions of the course. This diminution in teacher-student communication can, perhaps, be remedied through the use of quiz or discussion sessions at intervals during the lectures, or the use of "interrupt" procedures, in which students ask questions during lectures, and the video display is stopped in order to answer them. This "interrupt" procedure was used extensively and beneficially in our trial sessions.

Lecturer Characteristics in Future Courses

In regard to future presentations of the course on a conventional face-to-face basis in the classroom, certain changes are clearly indicated. One such change is to increase the number of lecturers from one to two or more. In order to control as many variables as possible, we elected, in the first trial rendition of the course, to use only one lecturer. This served the avowed purpose at the time, but it also presented problems. The first and most obvious problem was lecturer exhaustion, partial voice failure, and other marks of debilitation. The second was student ennui, resulting from hearing and watching the same voice and lecture style over a relatively long period of time. In order to get around this problem, we plan, in future renditions of the course, to use a minimum of two lecturers who would alternate from lecture to lecture, to minimize monotony and establish clear demarcations among lecture topics.

Equally important, we plan, as we did in the experimental sessions, to use lecturers who are not only experienced speakers and teachers but also totally conversant with all of the subjects and materials covered in the course. Preferably, the lecturers should be trained in science or engineering. These background requirements are extremely important, since one of the most significant characteristics and features of the course was a continuing interchange between the lecturer and the students. This necessitated an ability to "field" questions -- frequently unexpected or tangential questions -- as they arose. This obviously connotes seasoned lecturers with catholic knowledge and experience in the course topics.

By-Product Gains of the Course

As stated earlier, one of the factors that turned what was originally a two-day course into a one-day course was the deletion of lectures on the fundamentals of information communication and dissemination processes, and future developments in information tools and resources. Actually, these topics were not entirely eliminated from the course, but, in the second and third sessions, were injected into lectures to illustrate some of the newer information tools and techniques available to scientists and engineers. Thus, the students were made acquainted, painlessly, with such developments as permutation indexes, Selective Dissemination of Information (SDI), citation indexes, inverted as opposed to unit record indexes, optical coincidence (peek-a-boo) systems, and computer-based retrieval systems. And so, through the advice and reaction of our students, we were able to attain our original goal -- more efficiently and more responsively than we thought we could when we originally planned our experimental course.

Need for Updating

One final factor has to be considered in connection with the evolution and implementation of courses such as that presently described. We are in a period of increasing dynamicism in the development of concepts and products in the field of information science and technology. Illustrative of this dynamicism is the fact that several useful and important information tools and products became commercially available during the very period in which the course was being developed and tested. It is, therefore, obvious that the course syllabus -- regardless of its structure or the audiences to which it is addressed -- and the supporting materials will have to be updated relatively frequently, in order to be meaningful, viable, and truly responsive to the needs and opportunities of the student groups to which it is addressed. In short, what we have done thus far is a mere beginning of what can and should be done to help working scientists and engineers, and other users and seekers of scientific and technical information, to make the most effective use of the available information tools, methods, and resources.

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