

HISTORY OF THE MASTER'S DEGREE PROGRAM IN TECHNICAL MANAGEMENT

The Master of Science in Technical Management Program has several distinctive features arising from the way the program originated and from the special characteristics of the Applied Physics Laboratory where it was developed. This article describes the program's origin and the unusual methods used to develop the curriculum as an integrated entity; the description is intended to provide a context for fuller appreciation of the article by Thompson and Kossiakoff elsewhere in this issue.

INTRODUCTION

From its inception, the history of the Master's Degree Program in Technical Management has been highly unusual. It was conceived by a university president, Steven Muller, who asked a nonacademic division, the Applied Physics Laboratory, to undertake its development, provided that it proved to be distinctive from those offered by other universities and that it depended on the special talents of Johns Hopkins. The problems involved in creating an entirely new curriculum in an unstructured discipline were such that five years passed before potential solutions were identified and the program development was initiated.

The development process itself, which required five years of intensive effort, was also quite unlike normal academic practice in that the program curriculum was treated as a new complex system, and system engineering methods were used to develop it into a fully integrated entity. The curriculum was partitioned into individual courses, each of which was subject to a design phase, a prototype phase, and an operational evaluation phase before offering it to all students. A team approach was used throughout the development, and the experience from each step was used to refine the design for the next. In all, 13 entirely new courses were developed and integrated into a unified curriculum. The resulting program has fully met the objectives originally envisioned, and has received excellent student acceptance.

The belief that the above experience may have lessons of lasting value inspired the preparation of this article.

ORIGIN OF THE PROGRAM

The Technical Management Program was conceived by Steven Muller, President of The Johns Hopkins University, to meet a growing need for scientists and engineers who could direct the application of technology to social problems. As a political scientist, Dr. Muller was acutely aware of the growing stresses placed on societies throughout the world by the population explosion, the maldistribution of economic wealth, the ravages of sickness and natural disasters, and the prevalence of illiteracy. As president of a great research university, he was

also aware of the power of science and technology to solve or alleviate acute economic, medical, and other social problems. He was satisfied with the role of universities in training adequate numbers of scientists and engineering specialists, but he perceived that the successful production of new devices, processes, and services to meet the increasingly complex needs of society also required technically trained people with a broader outlook, capable of managing the collective efforts of the technical specialists to meet specific objectives. Universities had not been effective in providing educational programs to develop such technical managers.

One reason for the lack of university programs in technical management was that few university faculty had firsthand experience in managing large research and development organizations or programs, which effectively limited universities to teaching the theory rather than the practice of management. Dr. Muller saw that JHU had a distinctive asset in the staff of APL, namely, a number of highly experienced technical managers who had succeeded in operating a large research and development organization and had led numerous complex development programs. If this body of experience were used as a foundation, the existence at APL of a branch of the JHU Evening College would provide a unique opportunity for creating a new and different educational program in this field.

CONCEPTUAL PHASE

It was appropriate that the APL Advisory Board served as the initial focus for the conception of the Technical Management Program. Since the Board was concerned with Laboratory affairs of particular interest to the rest of the University, APL's educational program was a regular and prominent agenda item. In response to Dr. Muller's request at the spring 1974 meeting of the Board that the nature of such a program and the need for it in the community be examined, a committee under the leadership of A. G. Schulz was established to study the issue. Other members, in addition to the author, included B. E. Amsler, John Dassoulas, T. R.

Evans, Woodrow Seamone, and R. J. Thompson, most of whom were experienced in both technical management and teaching. After discussions with Dean Roman Verhaalen of the JHU Evening College and his associate deans, the general character of the proposed JHU Technical Management Program was further defined in discussions at the fall 1974 meeting of the APL Advisory Board.

During the ensuing year the committee developed an initial curriculum organized around three subject areas: (1) system engineering and system analysis, (2) organization, direction, and motivation of technical people, and (3) management of research and development projects and programs. A memorandum of 3 September 1975 from A. G. Schulz listed the proposed courses and assigned the development of each to one committee member. The courses, in order of their proposed introduction, were as follows:

- System Engineering in Technical Management I and II
- Introduction to Analysis for Technical Management
- Organization Dynamics I and II
- Decisions in the Management Environment
- Technical Planning and Reporting
- Program Management I
- Organizational Management
- Original Problem
- Program Management II (Problems in Program Management)

CONCEPT DEFINITION

Despite a consensus on the general content and structure of an appropriate curriculum for a degree program in Technical Management, the next steps proved much more difficult. The committee found, not surprisingly, that there were virtually no applicable textbooks to serve as teaching aids. The task of formulating each projected new course entirely from scratch was seen to be clearly beyond the capacity of a single individual, particularly since all potential instructors were already overcommitted in their regular duties. And perhaps most important, it was not at all clear how management skills, which are more art than science, could be taught effectively, rather than acquired through actual experience.

The committee realized, then, that before the envisioned program could be developed, it would be necessary to find solutions to those serious inherent difficulties, and that finding them would require, at best, considerable time and effort. In effect, we had conceived a worthy objective but did not have at hand a practical plan or the available resources to achieve it. Accordingly, the effort remained in the study phase during 1976 and 1977 while these issues were being addressed.

In defining the specific subject matter to be covered in the technical management curriculum, the course content of existing university programs in the general field of engineering management or technical management was examined. These included programs of the University of Southern California, the University of Pittsburgh, the University of Missouri, Drexel University, and the UCLA Engineering Executive Program. Additionally,

several other programs in engineering administration were directed largely to giving engineers some training in business practices and operations analysis. Examination of those programs provided valuable examples of certain management theories, tools, and techniques that should be covered in the JHU Technical Management Program.

Considering the basic problem of teaching practical aspects of technical management, principal emphasis had to be placed on getting the students deeply involved in thinking about how they would handle management situations. To accomplish this goal, three approaches were formulated: a highly interactive classroom format instead of formal lectures, homework assignments featuring simulated management situations, and extensive use of team assignments where students could learn from one another. A special type of problem assignment called a scenario problem was conceived, which was a variant of a case study that allowed the student to become a direct participant with a specific role to play, rather than a spectator and analyst. Such problems offered students experience with situations typical of those they would face as managers. Collectively, these approaches were designed to help the student learn by doing.

Having realized the magnitude of developing an entirely new program of instruction, it was decided that formulating each course required an organized team effort over an extended period, rather than the efforts of a single person. Further, to ensure that the courses would form parts of an integrated whole, a coordinating team was needed to obtain the collective wisdom of a number of experienced managers, each bringing to bear his particular viewpoint on the management process.

The problem of enabling practicing managers to serve as instructors was addressed by having each course taught by two instructors, supported by several guest lecturers. This approach had the further benefit of providing the students a broader perspective on each subject than they would obtain from a single instructor—an important ingredient in teaching experience-based rather than knowledge-based subject matter.

PROGRAM INITIATION

An occasion that contributed significantly to a decision to undertake active development of a program in technical management was a "retreat" of JHU's top administrative officers and academic deans, hosted by APL, in August 1978, at which time Steven Muller asked for a description of the program as we then envisaged it. The response to the presentation by A. G. Schulz and the author was very favorable and echoed the president's belief in the general need for such a program.

The decision to commit the Laboratory to the program was made early in 1979. By then we had identified the means by which a program could be developed that promised to be effective and distinctive and fill a manifest need. I had personally become intensely interested in the problem of developing a pioneering program in technical management; in view of my forthcoming retirement as Director, which was in the stage of active dis-

cussion with Dr. Muller, I perceived it as an opportunity to make a contribution in a new and important field. The decision was embodied in a report to the Trustees Committee for APL at the fall 1979 meeting.

To offer a new degree program, it was necessary to obtain the approval of the Academic Council of the Johns Hopkins Evening College, which then oversaw the graduate programs taught at APL, and to submit the plan for review to the Maryland Board of Education. Both of these efforts were led by Paul Edwards, then Director of Education and Training for APL. He was able to cite the results of his doctoral study, completed in 1971 and confirmed by subsequent investigations, which found a high degree of interest in technical management among the staffs of engineering and research organizations in the Baltimore-Washington area.

In November 1980, the University submitted to the Board of Education a formal request in which the objectives and rationale of the program were stated as follows:

The overall objective of the program leading to the degree of Master of Science (with a major in Technical Management) is to prepare persons trained and experienced in science or engineering in the elements of managing technical projects and organizing and supervising technical personnel. The program is organized along two parallel tracks: Program Management—the organization and direction of specific technical work; and Organization Management—the organization and supervision of people to accomplish technical objectives. The methodology employs a mixture of lectures on theory and practice by experienced technical managers in their areas of expertise, and realistic problem situations in which students will be asked to play a management role, dealing with problems and making decisions which are typically required of technical managers. Management theory and tools are presented in the context of the problem situations in which the student may immediately apply them in order to develop his own skills. The dynamics of continual technical change is emphasized throughout. Appropriate emphasis is given to the blend of technical, administrative, business and interpersonal skills required for the successful management of high technology organizations and projects.

After a visit of two members of the board for an in-depth presentation, the program was approved in the spring of 1981.

During that same spring, we visited the Defense System Management College at Fort Belvoir, Virginia. The college enjoys an outstanding reputation for offering education and training in subjects related to systems acquisition for middle- and high-level military officers and civilians and a few students from the defense industry. In the course of the visit we were given a four-hour briefing of the work of the college and had the opportunity to discuss the program with members of the faculty. The college publishes excellent pamphlets and manuals, several of which were subsequently used as reference books in our courses. We received the syllabi of the courses of particular interest and used the information as a checklist for determining the course content of relevant

subjects. We found that their approach to teaching the subject was much the same as our own and, as regards course continuity and integration, quite different from that practiced by academic institutions. We have maintained contact with the college through follow-up visits by R. J. Thompson, M. W. Woods, and C. J. Rorie.

Two particularly striking features we noted about the college's faculty were the team approach and *esprit de corps*, which encouraged us to promote a team spirit among the instructors participating in our own program and to create an environment of community enterprise. One means to that end has been the institution of a monthly luncheon for all active faculty, during which time is devoted to reports from the various instructors on their experience with the classes, as well as discussions of various issues and ideas concerning teaching this difficult subject. The lunches have been attended by well over half the faculty, even though most have extremely busy schedules.

The development of the Technical Management Program would not have been practicable without the support of the Navy. Before the development began, a letter of justification was prepared for a budget item under the portion of Laboratory overhead devoted to staff education and training. Recognizing the direct contribution that this program would make to the effective management of the Laboratory's technical programs, the Navy approved the budget item and continued to support it during the development of the initial curriculum.

PROGRAM DEVELOPMENT PLAN

The plan adopted for developing the technical management curriculum was different from that normally used in developing new academic programs. Instead, the general approach was very similar to one used in developing a new complex system, namely, a highly organized and structured effort, carried out by integrated development teams, bringing each course through several successive phases of design and evaluation. We believed this approach to be necessary to ensure not only that the appropriate subject matter was selected, but also that effective means for involving the students in the learning process were successfully worked out.

Each course was designed, validated, and tested before being offered to the public. The validation or pilot phase consisted of presenting a prototype version of the course to a specially selected group of student critics. Five to six APL junior managers were chosen to participate in the process, in which they listened to the lectures, did the homework, and then periodically changed roles to give their opinions regarding the effectiveness of the course material. This produced excellent feedback for the instructors and course developers and also resulted in a superb learning experience for the pilot students, several of whom later became members of the technical management faculty.

The initial pilot courses also had three or four "monitors," experienced managers serving as observers and advisors. The practice was later discontinued because the monitors did not do enough work to become immersed

CURRICULUM DEVELOPMENT

in the course and hence could not offer effective criticism.

The test phase for the program was designed as a full operational evaluation by a class limited to APL students. To that end, an announcement of the new program was circulated to the APL senior technical staff, and 40 students were selected from 90 applicants to constitute the entering class (20 students in each of two introductory courses).

This group of students was the first to try out each new course as it became available, and the resulting experience was used to refine the material presented to the first open enrollment students. The first offerings of each course were videotaped. Transcriptions of the tapes were used to further refine the presentations, to indoctrinate new instructors, and as the basis for written handouts in subsequent classes. A few of the tapes are invaluable and irreplaceable (e.g., the superb lectures in system engineering by the late Richard B. Kershner).

With a program concept and development plan in hand, the development of individual courses began in the winter of 1979-80, starting two new courses each semester. Figure 1 shows the development and introduction schedule for each of the 13 courses in the curriculum, indicating how they passed through the design, pilot, test, and open enrollment phases. The courses in the figure are shown in groups according to their application, rather than in strict chronological order.

Throughout the program development, R. J. Thompson and I participated in the planning and pilot sessions of every course, acting as curriculum integrators and passing along the lessons learned as the development progressed. Also, M. L. Moon served as the integrator for courses in the project management option and E. J. Hinman served the same function for courses in the organization management option.

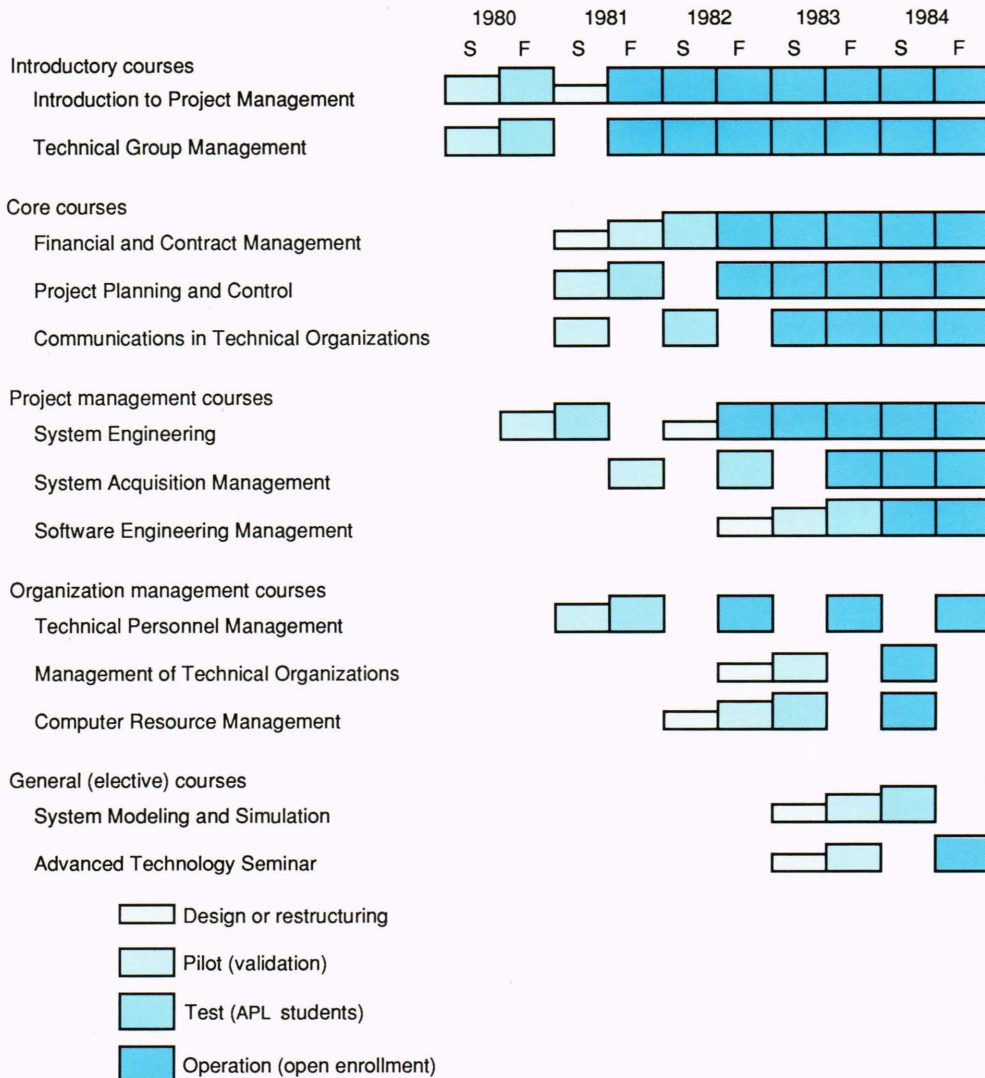


Figure 1—The development and introduction schedule of the 13 courses making up the Technical Management Program. Gaps between spring (S) and fall (F) terms indicate that courses were not offered at that time.

Considering the newness and magnitude of the task, the final course organization was remarkably close to that defined in 1979, a tribute to the extensive planning that preceded the development. The development methodology also proved generally valid, as was shown by the successful development of the two introductory courses. Several deviations from the original plans did occur that are worthy of mention.

A significant new core course devoted entirely to the subject of communications in a technical organization was introduced. Its purpose was to help students learn skills in interpersonal communications (effective listening, reading, speaking, and writing) that are vital to their success as managers. The course was designed to provide students with extensive practice in communicating, using examples set in realistic management scenarios.

The two courses immediately following the introductory courses experienced difficulties for different reasons. Management of Technical Organizations, which was originally planned as a follow-on to Technical Group Management, was taken halfway through the pilot stage when we realized that its content was too advanced for such an early position in the curriculum. Accordingly, the effort was reoriented to a course called Technical Personnel Management, which was piloted the following semester. Management of Technical Organizations was later developed as the senior course in the organization management option.

The problem encountered in the System Engineering course did not surface until early in the test phase, when it became clear that the initial technical content, especially in the assigned homework, was too difficult for many of the students. On noting this difficulty, we took immediate corrective action at midterm, putting special emphasis on tailoring the homework assignments to the class objectives and student abilities. For this task the resources of the development team, led by Ben Amsler and including two curriculum developers, were instrumental in quickly bringing the problem under control. Under the usual limitations of resources for development of academic courses, where a single instructor must cope with unexpected difficulties, such a quick response to a problem could not have been achieved.

The foregoing difficulties pointed to the need for more thorough planning of the individual courses before the start of the pilot phase. For all advanced courses, a formal design phase was introduced in which the development team met once a week throughout the semester preceding the pilot phase to define in detail the course content, organization, and a session-by-session syllabus. Particular attention was devoted to the identification of appropriate homework assignments so that they would receive full evaluation during the pilot phase. This added stage more than paid for itself by facilitating the subsequent phases.

ACADEMIC OVERSIGHT

A significant change in the auspices of the Technical Management Program, as well as in other graduate education programs at the Laboratory, occurred in 1983,

when the University transferred the academic oversight over the APL programs from the Evening College to the G. W. C. Whiting School of Engineering. The change was part of a general restructuring of the Evening College into what is now called the School of Continuing Studies. A direct result of this move was the creation of Program Coordinating Committees headed by a program chairman for each of the master's programs. The Whiting School still retains the general responsibility for the academic oversight of the programs, but the program chairmen serve the same function as department chairmen in selecting curricular content and faculty, and otherwise ensuring the quality of the programs. The program chairmen originally reported to an associate dean for Continuing Professional Programs, but now report directly to the dean of engineering.

The first Technical Management Program Committee was composed of A. Kossiakoff, Chairman; R. J. Thompson, Vice-Chairman; E. J. Hinman, and M. L. Moon, with Dr. John Boland representing the Whiting School. Shortly thereafter, J. R. Austin became a member, as did G. L. Smith in 1986. Last year Moon retired, although he has continued teaching. Each committee member also serves as a student advisor. As Vice-Chairman, Thompson has participated in all of the course development activities and has taken primary responsibility for coordinating the student admission and registration process.

EXTENSION TO MONTGOMERY COUNTY

In 1985 JHU accepted the invitation of the Montgomery County Council, working in conjunction with the Montgomery County High Technology Council, to establish a graduate education program in the Rockville-Gaithersburg area. In response to the stated needs of the county community, the programs that JHU first undertook to present in Montgomery County were in computer science, electrical engineering, and technical management.

Because the courses in the Technical Management Program had no counterparts in established disciplines, securing additional instructional staff for the new location posed a potentially difficult problem. This made it necessary to recruit APL staff members with prior experience in teaching the courses at the APL Center to fill most of the positions at the new site. Fortunately, an adequate number of the technical management faculty were willing to devote the extra travel time because of their belief in the value of the program and the importance of JHU's commitment to the new endeavor. This reflected the pride that the faculty have taken in their product, and their desire to maintain its quality and reputation.

Adding to the vicissitudes of creating a new program was the decision to offer courses in the fall of 1986, two years before completion of the new Johns Hopkins Montgomery County Center. Thus, the first courses for all three programs were taught in temporary quarters provided by the Montgomery Community College. In the second year, those quarters became unavailable, and most classes had to be transferred to one of the Mont-

gomery County middle schools, where their presence was disturbing to the resident teachers. Fortunately for the Technical Management Program, the University made arrangements to use a small conference room at the Ramada Inn in Rockville, which was quite comfortable and attractive, although hardly the normal educational environment. Finally, the fall 1988 classes opened in the newly completed Johns Hopkins Montgomery County Center, which is extremely well appointed and equipped.

THE SYSTEM ENGINEERING OPTION

In September 1985, representatives of Westinghouse Electric Corporation asked JHU to consider establishing a part-time curriculum in system engineering for the benefit of Westinghouse and other firms in the area. They offered to support part of the development of such a curriculum.

After discussions with the School of Engineering and with APL, it was determined that the most advantageous way to meet this objective was to establish system engineering as an additional track within the Technical Management Program. This conclusion was based on considerations of (1) the intimate relationship between system engineering and project management and (2) the most expeditious way of developing a curriculum that would offer Westinghouse students as well as those from other companies the best educational base practicable within the limitations of a master's program.

System engineering education had long been recognized to be an essential need for the staff of APL, and a two-semester course in that subject was taught in the Evening College program from 1974 to 1977 by A. R. Eaton and B. E. Amsler. Later, a one-semester course was taught for three years by Ben Amsler in the Biomedical Engineering Program. As noted previously, an

introductory course in system engineering had been incorporated as an integral part of the technical management curriculum, forming a solid basis for the extension of system engineering methodology in a formal program.

The development of the system engineering component of the Technical Management Program has been a special collaborative effort between key Westinghouse and JHU/APL staff, and is an interesting story in its own right. The Westinghouse part of the curriculum formulation team has been headed by S. J. Hardesty, Manager, Resource Planning and Analysis; C. G. Green, Program Manager, Human Resource Development; and J. W. White, Chief Engineer of SYSCOM. The APL members included R. J. Thompson, J. R. Austin, W. N. Sweet, B. E. Amsler, and myself. Roger Westgate represented the G. W. C. Whiting School of Engineering in the formative discussions. In April 1986 a preliminary curriculum was created that proposed the development of four new courses, together with six existing courses from the project management option. This was accepted as a starting point for the development of the system engineering component.

Two of the new courses have been developed in the same phased manner as the original technical management courses. The program thus far has been limited to students from Westinghouse (and a few from APL), who are "testing" the newly developed courses just as an APL class tested the others. Westinghouse system engineering managers are serving as instructors, together with their APL counterparts. Development is expected to be completed within the coming year.

STUDENT ENROLLMENT HISTORY

The first class to be awarded master of science degrees in Technical Management were eight APL students who

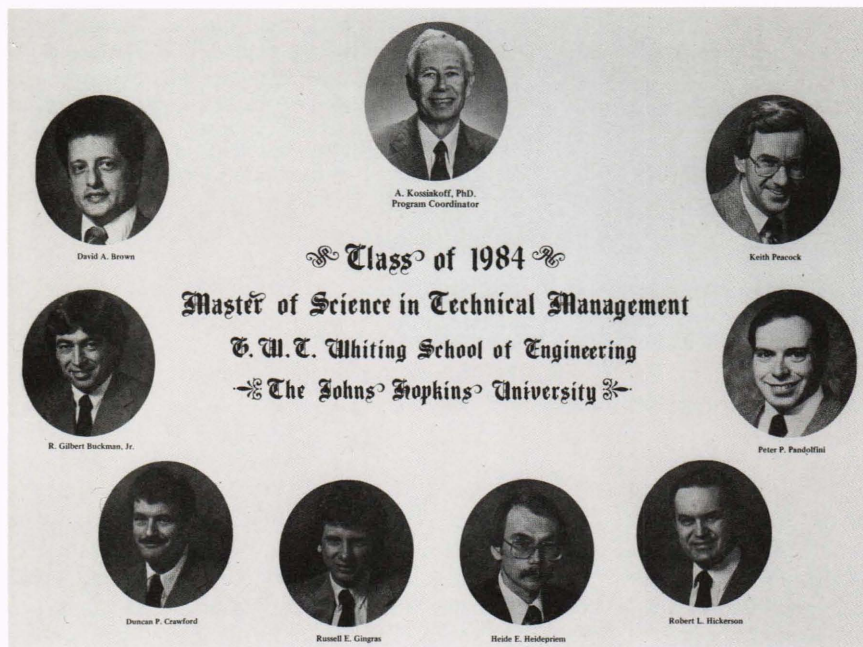


Figure 2—The spring 1984 graduating class of the Technical Management Program. Clockwise, from top: A. Kossiakoff, Keith Peacock, Peter P. Pandolfini, Robert E. Hickerson, Heide E. Heidepriem, Russell E. Gingras, Duncan P. Crawford, R. Gilbert Buckman, Jr., and David A. Brown.



Figure 3—The first full (five-year) Technical Management graduating class. Front, left to right: Douglas R. Ousbourn, David K. Larson, William C. Trimble, Ark L. Lew, Henry E. Reichenberg, Stuart A. Fogel, Carl L. Imler, William E. Engelkemier, and David J. Buscher. Rear, left to right: Donald J. O'Brien, Barry E. Tossman, G. Richard Thompson, Reginald M. Rhue, Dean R. Coleman, Louis R. Gieszl, Stephen P. Yanek, and Roger O. Weiss.

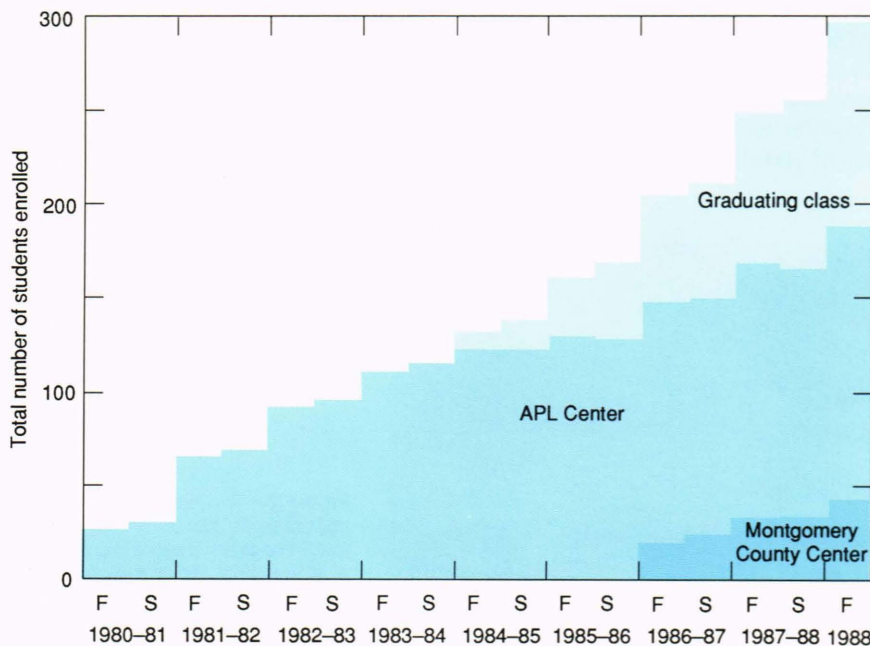


Figure 4—Student enrollment history of the Technical Management Program. All graduates to date have attended the APL Center (F = fall semester, S = spring semester). (Students in the system engineering option are not represented.)

pursued an accelerated schedule and graduated in the spring of 1984. Figure 2 is a photograph made by the class to commemorate the occasion. A group photograph of the first full graduating class, awarded degrees in 1985 (Fig. 3), was similarly presented to the program's prin-

cipal architects, the author and Dr. Thompson. By the spring of 1988, 109 students had been awarded degrees.

Figure 4 shows the record of enrollments and graduations of degree students throughout the life of the program. The sharp increase in the number of students en-

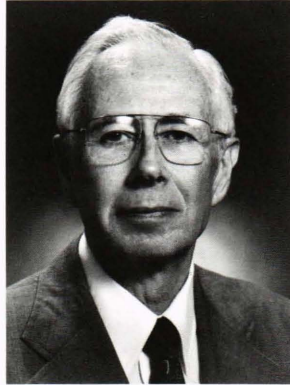
rolled in the fall of 1986 and growth thereafter correspond to the opening of the Montgomery County Center, which is expected eventually to bring the total enrollment to about 300.

CONCLUSION

The Technical Management Program is a new and original product of the Applied Physics Laboratory, in the tradition of its many innovative contributions to sig-

nificant national needs. The story of its development illustrates how experience acquired in the engineering of complex systems can be effectively applied to the development of a new educational curriculum. The enthusiastic acceptance of the resulting program by the students and the stability of the curriculum attest to the validity of the development approach. The lessons learned in the process may well have application to the development of other new educational programs.

THE AUTHOR



ALEXANDER KOSSIAKOFF received a B.S. degree in chemistry from California Institute of Technology in 1936 and a Ph.D. from The Johns Hopkins University in 1938. He taught at The Catholic University of America (1939-42), served with the wartime Office of Scientific Research and Development, and was Deputy Director of Research at the Allegany Ballistics Laboratory, Cumberland, Md., from 1944 to 1946.

Dr. Kossiakoff joined APL in 1946 and served as head of the Bumblebee Launching Group until 1948, when he was appointed Assistant Director. He became Associate Director in 1961 and was appointed Director on 1 July 1969. In 1980 he stepped down as Director and was appointed Chief Scientist, a position he currently occupies. He is also Program Chairman of the Master of Science Program in Technical Management, G.W.C. Whiting School of Engineering.

In recognition of his work on national defense during World War II and at APL, Dr. Kossiakoff was awarded the Presidential Certificate of Merit, the Navy's Distinguished Public Service Award, and the Department of Defense Medal of Distinguished Public Service. He is a Fellow of the American Institute of Chemists, and a member of the American Association for the Advancement of Science, the Cosmos Club, and the Governor's Scientific Advisory Council.