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curriculum has to meet the standard ECPD requirements in order to receive accreditation—quality of course offerings, faculty, buildings and equipment, library facilities, teaching methods and materials, laboratories and computing facilities. The major problem facing an engineering management department is the determination of which courses will fall into the various classifications. The point that has to be remembered is that the program is first an engineering program and second an engineering management program. The mathematics, basic sciences and social science and humanities classifications should present no problems. The principal problem will lie in determining and defending the courses that fall into the engineering science and engineering design classifications. A reading and rereading of the ECPD definitions of these classifications must be made. Discussions with the chairman of departments who have been accredited should also be carried out. Finally, consultations with ECPD and the use of ECPD consultants is highly recommended.

Above all, the engineering management department requesting accreditation must "think positive." They have to show by attitude and action that they want to be accredited and that they have put forth the effort to deserve it.

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Institutions with undergraduate programs of the engineering management type often find their introductory courses to be popular electives for students in more traditional engineering disciplines, while in other cases specific courses from business management or industrial engineering departments are elected. Where none of these options are available or suitable, engineering schools are well advised to provide one or two key courses to provide at least an introduction to the management problems their graduates will face. At Brown University, according to Prof. Barrett Hazeltine, a series of two courses in engineering management serve this function; more than half of Brown's undergraduate engineers select at least one of these courses. At Harvey Mudd, this function is served by the innovative course discussed below.—D.L.B.

Teaching engineering management is a little like teaching someone to swim. You can read books about swimming, hear lectures on swimming, and even watch someone swim, but the only way you will ever learn to swim is to get into the water. This swimming analogy has strong implications for methods used to teach engineering management. The best way to gain engineering management experience is to work on *real* engineering projects for *real* clients with *real* budgets and schedules.

The experiential method of applying engineering management concepts to ongoing engineering projects is usually limited to seasoned managers in industry, government or academia. In the spring of 1976, however, we introduced the first engineering management course at Harvey Mudd College (HMC), and in 1977 we decided to experiment with an experiential approach to engineering management education. We had the opportunity to put the course together within the context of an already existing experiential engineering project curriculum that has been successfully used at HMC for about 15 years.

These projects involve actual consulting problems that a student team with a faculty adviser work on for a paying client. The client charge for 1979-80 is $13,500 for a two-semester project—a break-even figure for the college. There are now about 24 engineering projects under way at HMC. The clients are mainly industrial and commercial firms, but also include federal, county, city and state governments, and military and non-profit organizations. The program, referred to as the Engineering Clinic,[1-3] is a teaching clinic analogous to those attached to medical schools.

In our new experiential course, undergraduates and Master of Engineering candidates apply engineering management principles to the ongoing design and development projects they work on for client companies in the Engineering Clinic. Among these have been an oil shale project for the Occidental

Petroleum Company, and a solar energy project for the Southern California Gas Company. The students have a chance to synthesize concepts and provide input into real engineering management problems, such as organization, finance, planning and forecasting, professional and career development, motivation, ethics, labor management relations, problem analysis, interpersonal communication skills, and applied economics. Some recent HMC Engineering Clinic clients are listed at right.

Developing the Course

In developing the new engineering management course, four major questions had to be answered:

1) Which of the four schools of management should be emphasized in this course: scientific, behavioral, functional, or operations research?

2) What educational approach should be used: classical textbook/discussion, case study, or experiential projects?

3) Could the engineering management course be integrated into the existing Engineering Clinic experience?

4) What topics could and should be covered in a one-semester engineering management course?

First, we decided to concentrate on the behavioral or human aspects of management, along with the functional approach. We felt that with the strong technical and mathematical background of our HMC students, a mathematically oriented course in operations research or in the scientific school of management would not be as valuable.

Second, we considered the classical method of presenting a management course by assigning textbook reading or journal articles and having class lectures and discussions on theoretical concepts of engineering management. We also considered the case study approach pioneered by the Harvard Business School in management education. Most engineering management educators have used one or the other of these methods of instruction. Their major weakness is that although the textbook material seemed clear and simple, and case problems could be easily solved, managers were not able to apply the management concepts outside the classroom to the real open-ended problems they faced in industrial, academic or government positions. Overcoming the difficult transition of applying management course concepts to actual problems has been a major obstacle in management training.

As a result, we decided to try the experiential method that I had been exposed to in industry. We also use the classical method to introduce concepts of management and then present a few case studies to practice the concepts before turning the students loose to use these concepts in real, ongoing Engineering Clinic projects. A typical HMC clinic project team organization is shown in figure 1.

Some Recent HMC Engineering Clinic Clients

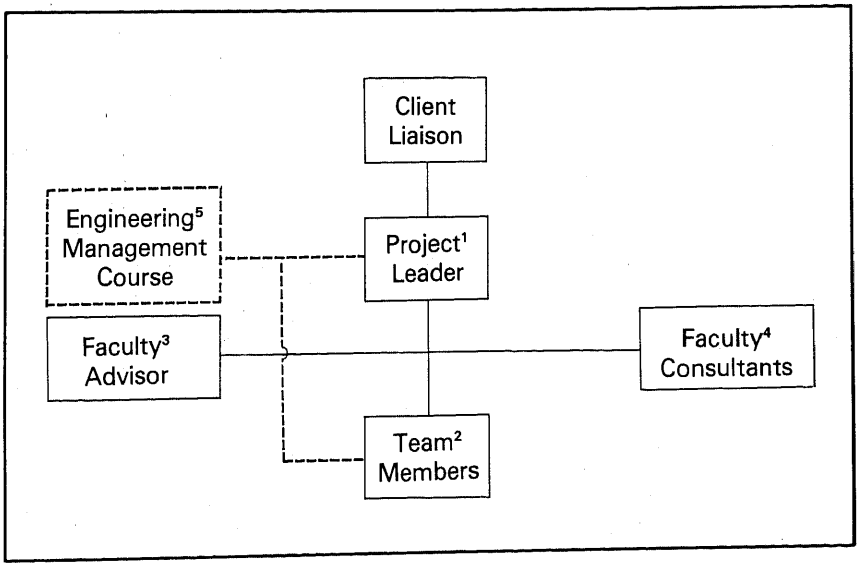
Aerojet Electro Systems
Beckman Instruments
City of Anaheim
General Dynamics
IBM Corporation
Jet Propulsion Laboratory (Caltech)
Kaiser Steel
Lockheed Aircraft Company
NASA—Ames Research Center
Pomona Valley Community Hospital
Rockwell International
Sandia Laboratories
Union Oil

Results

The results of our approach have been gratifying. Students have tackled all kinds of problems in their clinic projects, including motivational, communication and scheduling problems. The project leader and team members bring their management problems to our seminar course setting, where they present their potential solutions. The class then serves as a sounding board. Project leaders and team members report back on their successes and failures.

Students who have been exposed to this experiential engineering management course have been tremendously enthusiastic. They seem to especially enjoy trying to apply management concepts to their own engineering team project. One measure of this enthusiasm is that during the first three years, the number of seniors taking this elective course rose by about 67 percent each year.

We ask the students to anony-



1. Project leader is usually a senior or master's candidate.
2. Team members are usually juniors and seniors, but we have been experimenting with freshmen. Typically have 1 to 4 members per team.
3. Faculty adviser meets with team weekly. He usually advises projects within his area of specialty, such as mechanical, electrical or chemical engineering.
4. Faculty consultants are usually outside the engineering department—for example, chemists, physicists, mathematicians, economists and psychologists.
5. This course is shown in dashed lines to denote that not all clinic projects include members of this elective management course.

Figure 1. HMC engineering clinic team structure.

Example of a Typical Problem

During the first year of a project now in the middle of its second year, the current project leader was a member of the team but not the project leader. As the new leader, he was faced with several management problems: 1) He was supervising former co-workers; 2) His team's evaluations of his performance last semester indicated that he was not a sufficiently decisive leader (for example, he did not hold the team to their scheduled deadlines); and 3) the team felt that he had lost interest in the project, because he was not communicating enough with them. He, however, felt that he was giving them freedom to increase their motivation. This is a good example of how a leader and his team can have very different opinions on the proper leadership style.

After learning how his team members felt, the project leader modified his style and started to give a lot more structure to the team by rigid scheduling and explicit task delegation. He also began doing a lot more individual and team communication. His switch from a supportive, "consulting" type of leader to a strong, decisive one worked very well during the final stages of the project and led to excellent and timely results for the client. This project leader concluded that the supportive, "consulting" leadership style had worked very well for the first project leader during the project's first year, because that was the problem definition and creative stage of the project. During the later stages, however, time pressures became critical, and a more forceful management style was necessary to meet the deadline.

mously evaluate the course (at mid-term and at the end of each semester). Here are a few typical written replies.

The best course in the whole college.

Most realistic and useful course in the engineering curriculum.

Great course—wish it were two semesters instead of one.

I never realized how difficult management problems were.

Felt uncomfortable with open-ended problems that don't have a numerical answer.

We often hear this last comment from engineering students who seem to think that all problems have a single numerical answer. An experiential approach to education gives students a more realistic understanding of what they will encounter in the real world after graduation. After this experiential exposure, several students have told me they never realized that engineering projects required as much or more communication and personal interaction skills than technical calculations.[4]

References

1. Harrisberger, Lee, *et al., Experiential Learning in Engineering Education,* ASEE, Wash. D.C., 1976.
2. Woodson, T.T., "Accelerating the Practice of Engineering", *IEEE Spectrum,* Sept 1979, p. 50.
3. Woodson, T.T., "The Harvey Mudd Experience", *Engineering Education,* vol. 63, no. 5, Feb. 1973, p. 345.
4. Remer, D.S., "A New Experiential Engineering Management Course", paper presented at ASEE Annual Conference, University of N. Dakota, 1977. (Offers more detailed information about the course discussed in the article.)

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Nominees for ASEE Offices 1980-81

Presented on the following pages are the candidates nominated for ASEE offices for 1980-81. These candidates, who have been accepted by the Board of Directors, have been selected for your consideration by the Nominating Committee. The membership is reminded that additional nominations of eligible candidates for President-Elect may be made by petitions of not fewer than 200 individual members. Petitions of 50 or more signatures may be made for other candidates. Such petitions and agreements must be presented to the Executive Director no later than February 1, 1980.

Write-in votes shall be accepted for all offices. In all cases, a simple plurality vote constitutes election. The official ballot will be furnished to each individual member by March 1, and must be returned by March 31, 1980.

This year, more offices have multiple candidacies. Candidates for President-Elect were offered the opportunity to make short statements to accompany their biographies. The Nominating Committee feels that the candidates offered here are emininently qualified and deserve the close consideration of the membership.