

## Engineering Management, an Umbrella Degree

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### The Fifth Year History

Many years ago, a “fifth year” was proposed that would accommodate all of the new developments that were taking place. These topics were then, as now, competing for a place in the undergraduate curricula. Some major engineering schools developed five year programs to accommodate knowledge expansion, but they awarded only the bachelor’s degree. Since a master’s degree could be earned at other schools in the same five years, the five year bachelor’s was economically non-competitive. It is proposed that engineering reconsider adopting a five year format, leading to a master’s degree, not a bachelor’s degree. The ultimate goal is to provide additional technical expertise, but also to add the breadth that could make engineering a more attractive educational experience, leading to expanded career opportunities. with a greater emphasis on leadership of technical activities to support lifetime career development.

### Engineering Enrollments

The number of freshmen entering engineering schools, in the United States, has not substantially increased in over twenty years. This during the greatest explosion of technology the world has ever seen. In 1982, 114,517 freshmen engineers were enrolled. Now we hover around 90,000. With the U. S. Population at 281 million, we should be enrolling 142,000, had we sustained the same population-enrollment ratio of 1982. To cloud our local picture even more, half of the engineering freshmen at Santa Clara are choosing computer engineering, leaving the traditional engineering fields in peril of long term survival. To attract 50,000 additional freshmen to engineering has become a very real goal. But to do this, something has to change.

### New Engineer Perceptions

We asked fifty of our young engineering graduates why they thought freshmen engineering enrollments were flat. Their evaluation:

1. The engineering curricula are viewed as too difficult.
2. There is more money in alternate business careers.
3. Computers are central to today’s careers.
4. Mathematics preparation is inadequate.
5. Lifetime engineering careers are dull--nerdy.
6. Engineers face early career obsolescence.

This is the perception of those who are recent engineering graduates. Each of us probably gives different weights to the items in this list. But the conclusion is the same: something is not right with what we are doing, and experimentation is in order. An Engineering management capstone degree could offer a breadth that would counter some of these student perceptions.

#### The Santa Clara Engineering Management Experience

Santa Clara has a large graduate program for part-time students. We offer classes seven to nine in the morning--when the students and faculty are fresh--for Silicon Valley working engineers. This program was organized in 1959. Engineering Management was added in 1978. We have a specific goal for Engineering Management: "The Preparation of Engineers for Technical Manager Assignments". Until this program was organized, we sent engineers with a management interest to the business school for an MBA. This did not meet their needs, since the mission of the MBA program was to help them develop general management careers. We are focusing on a smaller, unique group: those who wished to utilize their technical preparation and experience, and remain current in their fields, but at the same time, seek to advance in their careers. To meet these dual goals, we chose a fifty-fifty course requirement split. Half of the master's requirement is in courses offered in the traditional engineering programs, and half of the courses are in Engineering Management and Leadership. Our technical stem opportunities include civil, computer, electrical, and mechanical engineering, and applied mathematics.

#### The Changing Work Environment

Our unabashed intention is to encourage engineers and other technical professionals to assume leadership positions. Our interest in leadership stems from the change in the work environment. Empowerment and dispersed processing means that each individual must assume greater self-leadership. The first step is to become a value-added contributor. This is the traditional goal for engineers. But then must come the ability to work more effectively in project teams. The day of the lone ranger has long since passed. Now it is collaboration to reach higher levels of increasingly complex achievement. Next is the need for leadership in the project groups within in which most technical professionals work. This is where facilitation enters our program as described in the paragraphs that follow.

#### Santa Clara's Engineering Management Courses

We begin with a broad survey in three, two-quarter-unit introductory courses.

1. The first course describes the total economic environment for technical managers. Much of this material was once covered in a classical Engineering Economics course, which appears to have disappeared from most engineering degree programs. A mixture from Economics 101 is also included with the goal of increasing the understanding of the front page of the Wall Street Journal. We currently send our undergraduates into the business world without much understanding of how business keeps score.

2. The second course looks closely at the leadership requirements for technical professionals. This is leadership of activities at the project level, not corporate or national political

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strategies. We use the facilitation of group problem solving as our introduction to leadership responsibilities. Groups of seven or eight listen to, and discuss a current problem presented by one of its members. The group then seeks a solution under the guidance of a facilitator. We believe the facilitator role extends naturally into a leadership role because facilitation has become a managing style. The facilitator assignment is rotated among the group members, so that all gain experience in "being in charge of the process." We encourage the group to be responsible for outcomes, helping to reduce their manager dependency.

3. The third course focuses on the basics of project management. Most of our students work in a project environment. We carefully consider the various project manager styles that will lead to a "spirit of hearty collaboration", among group members. While many of the students are captivated by the many software packages available to help manage projects, we resist the temptation to become package analysts, and point out that most failures in project management are in the human domain, not in the selection of the right software package.

The balance of the 25 quarter-unit Engineering Management stem is in elective courses, including accounting, budgeting, finance, marketing, human interaction, risk management, quality management, new product definition, strategic technical management, and various courses to improve personal skills. Many of our students have earned their bachelor's degrees in another country, and wish to enhance their communication skills. While it is possible to question the acceptability of skill courses in a graduate program, we chose not to evade the problem and leave it to someone else to solve.

#### A Business School Partnership

Why haven't we teamed up with our business school and let them teach the traditional business courses. Two problems. First, our courses are significantly abridged. Accounting, budgets, finance, are presented in four quarter-units. Close to twenty units would be required to present the same material in the business school. The second, practical constraint, caused by the large part-time enrollment in our business school, is that engineers are admitted to their courses only after their own students are enrolled. A customized program in the school of engineering best meets student needs. We encourage students to take some of their electives in the MBA program. Marketing is popular with some.

#### The Leadership Goal

To help us learn more about our leadership focus, we recently surveyed our entering class of 70 Silicon Valley technical professionals. What were their perceptions about assuming leadership positions. Their response:

1. They are reluctant to deal with people.
2. They lack the skills which would give them greater confidence.
3. They resist the potential failure as managers, when they are already successful, as technical contributors.
4. Fear of assuming responsibility for the work of others.

5. Cultural insecurities.
6. Difficult colleagues with ego problems.
7. Inadequate rewards for first-line managers.
8. They don't wish to give up their technical edge.
9. Shyness
10. They are not sure just how to go about leading.
11. Too much public speaking is required.
12. Too much paper work.
13. They are afraid that no one will listen to them.
14. Lack articulation skills.
15. They are not certain how you get promoted, gain visibility, and deal with company politics.

Some of their concerns are with fundamental skills, including those now omitted from our undergraduate programs. Others, like public speaking, can be addressed in formal courses. We hope to provide enough live experience in facilitated group problem solving to improve the confidence levels which leadership requires.

#### The Future

What is the direction in which this twenty year old program is evolving:

1. We are seeking to incorporate more of the topics related to knowledge creation and transfer. This is leading us further into the management of information technology. While information technology is addressed in the computer engineering program, the management of the function is not an emphasis. It is of growing interest among those whose technical stem is in computer engineering.
2. The number of students educated in foreign universities is increasing, even as the enrollments in engineering across the United States remains flat. We are sensitive to the cultural adjustment problems. The accommodation level is very high in the Silicon Valley.
3. The enrollment in computer engineering has reached 50% of the entering engineering freshmen at Santa Clara, and the unique needs of this area are not the same as in traditional engineering. Is the era of civil, electrical and mechanical engineering really over as indicated by the Silicon Valley interest, or are we a unique slice of tomorrow.
4. As a consequence of the rapid increase in computer engineering enrollment, our offerings in information technology related courses will increase. This includes the Management of Information Technology Centers.
5. Our research is focusing on leadership. Despite the hundreds of books on leadership published yearly, we haven't yet found the combination that best meets the needs of our technical managers and leaders, who must deal with "knowledge creators." The latest concern is the

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Leadership of Intellectual Asset Creation. This is the result of intellectual assets replacing physical assets as the primarily contributor to the income of many firms.

6. It's not clear what it would take to move engineering into the five year--master's degree goal. It might be possible to project a less focused, image, and show greater concern for lifetime career preparation.

7. Finally, we wish to create a program which will lessen the view of engineering as developing dead-end jobs with great appeal to "nerds." In other nations, at other times, engineers were historically viewed as managers. This wouldn't be a bad perception for attracting future engineers.

#### ROBERT J. PARDEN

Robert J. Parden has been The Chair, and Professor of Engineering Management and Leadership in the School of Engineering, Santa Clara University since 1982. His degrees in Mechanical and Industrial Engineering are from the University of Iowa. Dr. Parden was an army lieutenant, an industrial engineer with the La Crosse Rubber Mills, and an associate professor at the Illinois Institute of Technology. He then served as Dean of Engineering at Santa Clara for 27 years. He is a registered engineer in Iowa and California, and holds a General Contractor's license in California. This is his fiftieth year teaching in an engineering school.