EDUCATING PROFESSIONALS FOR TECHNOLOGICAL LEADERSHIP

William Swart / Jack McGourty and Lemuel Tarshis
Newark College of Engineering - New Jersey Institute of Technology/Assessment Alternatives, Inc.

Introduction

This paper summarizes a series of discussions that have been conducted between several leaders from academia and high technology industries to address the role that Colleges of Engineering might play in preparing technical professionals to take their organizations to a position of technological leadership in the global economy. These discussions were motivated partially by the observation that the focus on meeting the needs of the customer that has been so widely preached and practiced during the last decade tends to create market followers. It centers effort and attention on the here and now and diverts attention from the what could be, Yet, it is the "what could be" that can create new markets; markets that arise as a consequence of combining the creative technological potential of the organization with an anticipation of what customers will want . . . once they know it is there.

The Target Population

Over the past several years, increasing competition in the global business arena and significant changes in available technology have forced US companies to rethink the way they select, create, develop, and implement advanced technologies. To meet their objectives, these organizations have a new and increasing need for technological leaders who can navigate their organizations through accelerating technological change. These leaders must create new business/markets based on an appreciation for the capabilities of existing and evolving technologies.

Companies that create and develop new technologies (e.g. high technology companies) rely on engineers and scientists with advanced degrees to achieve their objectives. With the majority of the US production of Ph.D.s in science and engineering being absorbed by these companies, it is likely that the employees who are hired to create and develop new technologies in high tech industries are an older group than other groups of new hires in the organization. This is the group that most probably understands new technologies and the potential for the organization to create and develop them. But, because they have relatively shorter time to "climb the ladder" to the highest levels of corporate management, they are more likely to be corporate followers than leaders. Consequently, they tend to be "pulled" toward executing corporate strategies that were developed more as a . consequence of business, legal, or marketing oriented considerations than by "pushing" corporate strategies through considerations of technological capability.

It is the thesis of this paper that "market creating" strategies can most effectively be developed through a simultaneous, or concurrent, consideration of what technologies the organization "could" develop and an anticipation of what the customer "would" want, but perhaps has not been able to yet articulate. This "technological leadership" will not come about as a consequence of the traditional linear process of conducting

market research, using the results to develop product/process specifications, conducting a financial analysis and making a go/no go decision. Instead, it will require that those that are at the forefront of creating and developing new technologies also be cognizant of consumer and market behavior and finance so that their R&D efforts and behavior will be oriented toward developing products that anticipate the needs of customers and markets. Ultimately, it will require that these individuals have equal opportunities to become senior managers, in spite of their late appearance in the work force. Colleges of Engineering have a particular responsibility and opportunity to prepare their former and current students to make the transition from technological followership to technological leadership.

Existing Options for Professional Preparation

As business success becomes increasingly dependent on an organization's capacity to create, develop and utilize advanced technology, organizations must hire and develop technologists who have a special perspective - an understanding of the critical linkages between technology creation and development and overall business strategy. Management programs (MBAs and others) in the US annually graduate tens of thousands of people with degrees that do not provide an understanding of technology creation and development in relation to customer and market *potential.* These graduates do not have the strategic management skills required to link the appropriate technology into the *creation* of new global markets. This void creates the need for advanced " education for future technology leaders who require a unique combination of technical, marketing, and managerial capabilities.

In response to a growing awareness that traditional business and management programs do not address many of the critical issues related to maintaining technological superiority in a global economy, a number of institutions have developed special programs often referred to as "Management of Technology" (MOT). The American Management Association describes[1] MOT as: "An industrial activity and an emerging field of education and research that concerns the process of managing technological development, implementation, and diffusion in industrial or governmental organizations. In addition to managing the innovation process through R&D, it includes managing the introduction and use of technology in products, in the manufacturing process, and in other corporate functions. "

While Management of Technology (MOT) educational programs are becoming more common in both engineering and business schools, many existing MOT programs are simply extensions of traditional engineering management programs. A recent survey of 32 MOT-related programs, conducted by Stevens Institute of Technology found that almost all 32 programs are offered by Management or Engineering schools or are joint programs. Forty-four percent of the programs are concentrated in the Northeast, and typical participants are middle-level managers with five or more years of experience. The length of the program varies depending on whether it is full-time or part-time. These programs seem to be quite similar in content and are mostly perceived as line extensions of existing courses of study. Typical classes include the following: Strategic Technology Management; R&D Management; Marketing; Finance; and Organizational Theory.

Currently, few if any academic institutions offer a technology management or similar program specifically tailored for the transformation and development of highly accomplished technologists to high-level executives. ' Such individuals will typically need to gain the required expertise without leaving their jobs. They will be required to learn how to combine technical competence with a broad, multi-functional business perspective. They must learn to understand the intricacies of the innovation process from idea generation through diffusion to the marketplace and make this knowledge central to setting the strategic and operational objectives of an organization.

A Vision for a New Option for Professional Preparation

A leadership position in engineering education, especially in the area of technological leadership is required to fulfill the aforementioned need. The goal of such a program is to be a model for technology leadership education for the twenty-first century.

This paper's definition of technological leadership embodies the organization's continuing presence at the leading edge of global competition through the systematic creation and dominance of markets for new or improved services, products, and processes created and developed through technological innovation. Its primary focus is on technology and what technology can do to improve competitiveness in the world wide commercial marketplace. Another way to describe the vision is a technology "push", achieved through a well integrated and concurrently applied knowledge of the organization's core technologies, its potential customers and markets, and its financial and business capabilities.

Achieving this goal requires an entirely different approach to providing an education, something beyond traditional MBA or Engineering Management programs with pre-defined course offerings and a choice between a part-time or full-time degree program. By contrast, this paper's proposed Technological Leadership program is envisaged as "just-in-time" education. It addresses today's company-specific business/technology issues and will include both shorter-term certification programs, a full MS degree, and ultimately a doctoral program.

The proposed Technological Leadership program will occur as a cycle rather than a predetermined one-way street. First, senior executives participate in technological leadership "short courses". These executives will be surveyed about their individual company's particular needs regarding technological leadership. Then employee teams, sponsored by their respective companies and nominated by the senior executives, will participate in a unique educational program where many of the courses are offered in "modules" relating directly to the needs of their respective organizations. These participants can pursue certification in specific areas or advanced degrees in Technological Leadership. The curriculum will be considered "dynamic" as participants in on-going short courses continue to be surveyed for current/future needs and improvements.

Target candidates for participation in Technological Leadership degree programs are engineering or science degreed individuals. They would be people who were hired or were identified by their employers because of an apparent technical ability to innovate and are viewed as having potential for key senior management positions. Their participation will be seen as developmental and as a significant benefit to both the individual and corporation. Since the Technological Leadership program will teach on a "real-time" basis, participants are learning, applying and being developed simultaneously.

With technology changing as quickly as it is today, traditional approaches to business/technology education simply do not work. With the "just-in-time" education provided by the Technological Leadership program, the program will have the potential to lead the way in engineering education in general and technological leadership in particular. In the longer term, the goal is to incorporate some of these concepts in the undergraduate curriculum.

A Comparison of the Traditional and New Options

The information on existing technology oriented management programs shows a potential niche for executive-level and executive driven programs focused on technological leadership. Proximity to a concentration of technology-based firms is desirable in order to offer "just-in-time" education to senior-level technology leaders. It is important for Colleges of Engineering to differentiate programs in Technological Leadership from

traditional management oriented programs (MBA, Engineering Management, Management of Technology).
There appear to be five key differences in the Technological Leadership program:

1. Coordinated multi-level participation.
   Senior executives participate in "short courses" that help define the curriculum to be offered to follow-on employee teams.
2. Broad Technology Focus.
   The proposed Technological Leadership program covers a much broader range of technological issues than traditional approaches. For example, several existing programs are skewed toward the perspective of an R&D manager and provide limited content in product development, manufacturing, and product marketing. By contrast, the proposed Technological Leadership program focuses on the broader technology spectrum - idea generation and creativity, product development, concurrent engineering, manufacturing, marketing, consumer behavior, and appropriate advanced technologies.
3. Flexible, Needs-Based, Just-in-Time Curriculum.
   As the "Vision" outlined above describes, the Technological Leadership program will be something truly unique and different in engineering education. This form of education offers many benefits to industry, especially in producing managers whose education helps provide answers to actual, company-specific business problems/challenges. In addition, the modular curriculum will be offered to suit the needs of the students and company, rather than the convenience of the academic institution.
4. Team building.
   Since the just in time education will be provided to company teams, and team dynamics will be an integral part of the curriculum, team building will be a fundamental of participants' total experience. It, therefore, is expected that participating companies will experience a direct benefit from the teamwork.
5. Technology-Based.
   All participants will be involved in creating and/or developing new technologies for their company. Consequently, each will possess at least a B.S. in either engineering or science. This will allow the program to focus on building the relationship between technology creation and development and corporate strategy.

The outcomes from the proposed program in Technological Leadership will be a core group of high potential technically advanced employees. Each of these employees will have a vision of the market and the business that will allow them to think about new technology creation and development from the perspective of creating new and profitable services, products and processes not yet anticipated by the customer . . . but based in the technological possibilities of the organization.

Implementation

The proposed first step in implementing the plan is to initiate a series of novel, multi-day (1-3) short courses. These short courses will serve as the model for future courses to possibly be offered in an advanced degree Technology Leadership program. The short courses are targeted at the senior executive level (CEO) of industrial corporations. Sessions are intended to be highly interactive and, ideally, personally beneficial to participants. Presenters will be prominent individuals in their respective fields. As part of these short courses, participants will be surveyed for interest in further short courses but also for their requirements/desires for an advanced degree in Technological Leadership. Their inputs will serve as the foundation for a customer-driven and pragmatic curriculum.

The initial short course offering is in the area of innovation The focus of this first short course is the full spectrum of technological innovation, from concept generation through product development and manufacturing, including concurrent engineering. Exposing participants to the full breadth of the domain in this

first offering will give them the opportunity to express ideas regarding the full extent of future educational requirements, Such a short course could be built, for example, upon the research of McGourty and Tarshis[3] (1996). This multi-phase research has resulted in the development of a model of innovation that provides a framework for facilitating innovation-related productivity within organizations. Other potential course offerings include more focused courses on such areas as: Managing Product Development Processes; Multi-functional Teaming; Empowerment; and Concurrent Engineering.

Conclusion

This paper is a summary of discussions that have been held between several leaders from academia and industry. As such, it represents a conceptual framework that both parties agree has desirable features not found in other programs. At the same time, the concepts have not yet been incorporated into a specific curriculum proposal and submitted to the academic processes that are required for new program approval. Similarly, industry has not yet had to respond to the availability of such a program. Although the inputs and responses have been favorable, whether actual students and support really materializes remains to be seen. Nevertheless, the issue dealt with in this paper does, in part, address some of the many questions that have been raised about the need to produce additional Ph.D. degrees in science and engineering. Perhaps a shift in Ph.D. education from creating assembly line (laboratory?) workers for the R&D establishment to producing a new breed of " technologist that can "push" their companies to technological leadership will be a desirable step in contributing to our continued but precarious leadership in the global economy.

References

[1] *Management of Technology: An American Management Associate Report* (1 988). AMA: New York, NY.

[2] *Survey of MOT Educational Report* (1 994). Technical Report: Stevens Institute of Technology: Hoboken, NJ

[3] McGourty, J., Tarshis, L. and Dominick, P. (1996). *Managing Innovation: Lessons from World Class Organizations.* International Journal of Technology Management, vo13/4

Biographical Information

WILLIAM SWART: William Swart is the Dean of New Jersey Institute of Technology's Newark College of Engineering. He holds a Ph.D and M.S. in Industrial& Systems Engineering from the Georgia Institute of Technology and a B.S. in Industrial Engineering from Clemson University. Prior to NJIT, he held positions in industry and academia.

JACK MCGOURTY: Jack McGourty is a Principal of AAI, a management consulting firm located in Florham Park, NJ. He received his Ph.D from Stevens Institute of Technology in Hoboken, NJ where he is a senior . research associate of Stevens Alliance for Technology Management, conducting research on idea generation, innovation and teamwork.

LEMUEL TARSHIS: Lemuel Tarshis besides being a Principal of AAI, is the Dir. of Research& Technology Transfer for the Alliance for Technology Management and a Research Professor at Stevens Institute of Technology. He received his Ph.D from Stanford University and spent several years as a research and R&D - manager in industry.