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## **Value Estimates of Engineering Leadership Education**

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### ***Abstract***

Leading edge technology firms must continuously invest in innovation through R&D, new products, services, and new business models. For even the best and most efficient firms, the yield on successful products, services, acquisitions, and projects is rarely higher than 50%. Given typical financial models for research and development in technology firms, this means that \$150M to \$210M is lost for every \$1B in revenue.

In this study we find that expensive, yet typical mistakes, such as mis-targeted products, poorly managed projects, indecision on product features, team issues, and disagreement between product management and R&D, could be reduced significantly by equipping engineers and scientists at all levels with the *critical skills* needed to understand and communicate with the strategic, marketing, sales and production functions within those companies. Surveys taken from U.C. Berkeley's Engineering Leadership Professional Program (ELPP) show that program participants project that if the course content taught in the ELPP program was well understood within their organizations that costly mistakes could be reduced by an average of 50%. This could result in real savings of \$75M to \$105M for every \$1B in firm revenue.

Our study also finds that even engineers and engineering managers enrolled in ELPP who claim high competence in areas such as opportunity recognition, strategy, and product management report, after just a few sessions in the program, a significant jump in expertise in course topics. Additionally, almost one-half report having a transformative learning experience.

## ***Introduction***

Engineering leadership is a critical factor in the success of the best technology companies in the world. It is also a requirement for solving the most pressing issues of our day. As a result, the profession is transforming and a new set of skills is required for success (Emison 2011). Today's competitive global market demands that engineers possess leadership, managerial, and entrepreneurial skills in addition to technical skills (Kumar & Hsiao 2007).

This paper reports how the University of California, Berkeley, has addressed this challenge with the creation of its Engineering Leadership Professional Program. We will describe both the program and the development of program metrics and studies to measure its effectiveness, as well as preliminary results from learning experiences after the first half of the program.

ELPP is designed for technical professionals and professionally oriented doctoral candidates, and explores key management and leadership concepts relevant to technology dependent enterprises. The program prepares engineers for careers calling for leadership at the executive level. Participants undertake intensive study of actual business situations through rigorous case study analysis. ELPP also features two parallel projects, done in groups. The first is a strategy project intended to illuminate a future industry change. The second is a new business development project with a focus on technology and innovation processes.

ELPP is comprised of 28 three-hour sessions held weekly for six months. The goals of the program are to:

- teach engineers to expertly manage technical teams,
- influence top-level strategy,
- amplify the inherent value of R&D.

The subjects covered in the course include:

- opportunity recognition,
- technical firm strategy,
- product management,

- customer development,
- operations,
- leadership skills,
- and finance.

The sessions include cases presented by both U.C. Berkeley faculty and co-lecturers from industry, including: Charles Giancarlo, former Chief Development Officer of Cisco; Charles Huang, Co-founder of RedOctane (maker of Guitar Hero); Jerry Fiddler, Founder of Wind River; and Sabeer Bhatia, Founder of Hotmail.

The approximately 50 participating engineering leaders have been recommended and sponsored by their companies. The participants include senior managers, directors, and key technical leaders. Participants in the 2011 program come from leading technology companies, including: Applied Materials, Cisco, Facebook, Lam Research, NetApp, National Semiconductor and Yahoo!. This is the first program of its kind in the U.S.

### ***The Program Metrics and Studies***

We used several data collection methods to measure the program, both quantitative and qualitative and continuously monitored students throughout the program. We began collecting data from the outset of the program to allow adjustments and changes, if needed, to be applied to the program right way.

Program metrics have entailed:

- Surveys
  - initial online survey designed to measure the baseline knowledge before the program began
  - short in-class survey designed to measure learning outcomes and changes in knowledge after topics related to strategy, and to be compared to the baseline survey
  - short in-class survey designed to measure learning outcomes and changes in knowledge after topics related to product management, and to be compared to the baseline survey

- Interviews
- 16 interviewees representing each firm were chosen and qualitative theme-based interviews were conducted during March-April 2011. Those research interviews were recorded and videotaped.

In addition, future program metrics (during the remaining program period) will include the following:

- Short in-class surveys after completing operations/leadership, and finance topics
- Second round of qualitative video interviews in June 2011
- Interviews of guest speakers and industry partners

The most important outcome of the study is to understand what percentage of mistakes can potentially be reduced by the targeted approach used in this curriculum. Examples of “mistakes” commonly made by companies include, poorly defined projects, ineffectively run development efforts, mistaken or missed opportunities, strategically ineffective projects, and delays based on poor communication between marketing and business functions. According to the first survey administered, the mean response from program participants was that 50% of such incidents could be reduced if the material covered in the program was widely understood within their companies. An additional one-third of participants reported that mistakes could be reduced by as much as 60-100% through education.

The underlying thesis is that better engineering leadership – mastery of nontechnical “soft skills” in addition to technical mastery – will lead to a reduction of mistakes typical in the engineering field and could potentially result in significant cost savings.

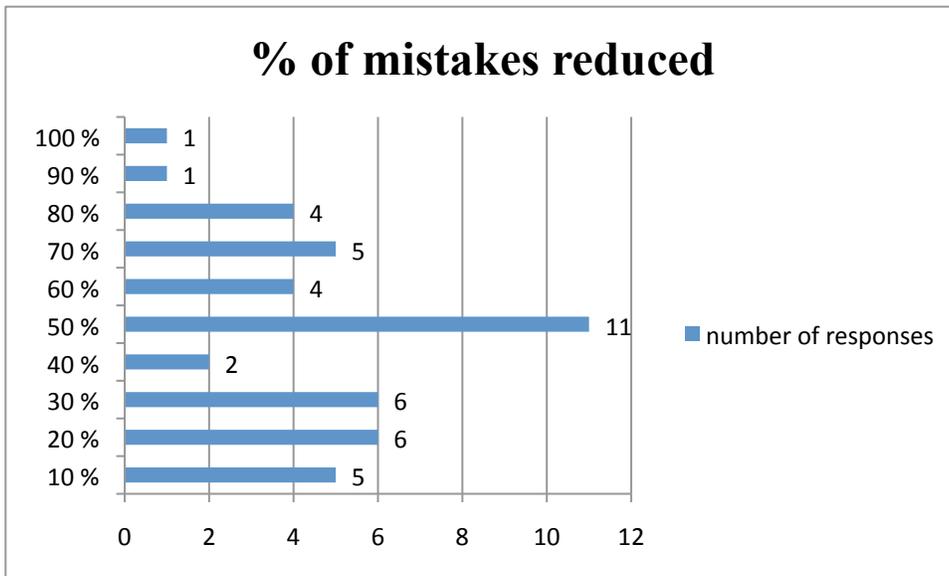


Table 1. Percentage of mistakes reduced by engineering leadership education

The remaining surveys in the first half of the program specifically focused on the program’s effectiveness on the topics of opportunity recognition, strategic planning and product development.

### ***Motivating Factors for Firms***

Mistakes for technology firms or any firm that leverages technology in their business can be substantial and expensive. While innovation is essential to the survival and success of new and large firms, the process of innovation is inherently risky and inefficient. For firms that take very few risks, the likelihood of innovations with new products and services is correspondingly low.

However, the state of the art today for most leading edge firms results in a financial model where approximately 10% of a firm’s expenses are in R&D, and of that, 30% to 50% of projects yield successful results in the market. For example, for a leading edge \$1B revenue firm we expect that \$50M to \$70M is lost to mistakes in the innovation process. Given a multiplier of only 3 to 1 for related marketing expenses, a typical firm can lose \$150M to \$210M for every \$1B in revenues. Our results show that there is a potential to reduce this number significantly through targeted education for

engineering leaders. To extrapolate out from the survey results, better engineer education and training could result in savings of \$75M to \$105M for every \$1B in revenues.

### ***Surveys in Sub Areas Show ELPP Can Cut Expensive Mistakes***

The initial survey was designed to measure the baseline of knowledge prior to the start of the program. Participants filled in an online questionnaire in January 2011 just before the first class. The questionnaire had mainly closed-ended questions with a 5-point Likert response scale, regarding their current level of knowledge, experience and confidence level on the topics to be covered in the course of the program. Results from the baseline survey (N=47) reveal that participants were generally most confident with areas of product management, innovation processes and team leading, and least knowledgeable in the areas of marketing, pricing, selling, distribution channel development and some financial aspects of the business, such as forecasting or mergers and acquisitions.

A few open-ended questions in the survey gave us further direction on how to focus the comprehensive course material and insight into participants expected learning outcomes. To generalize, we can state that these results were as expected and proved out that the program had reached its target group – top technologists in need of tools and skills for better leadership.

### ***Opportunity recognition***

The objective of the first two in-class surveys was to find out how and whether participants' understanding of several key concepts had changed during the program as well as gather comments, observations and questions. The first short in-class survey (N=42) was conducted after covering opportunity recognition, innovation, strategy processes and value chains. The response scale used in the surveys was as follows: 1=no change, 2=an incremental step in knowledge, 3=increased understanding in a new dimension of thinking; transformative, 4=a step increase in knowledge and also a new transformative perspective, 5=increased understanding to a sophisticated level.

Even though participants had rated high their existing ability to recognize opportunities which would lead to a greater value for their firms (in baseline surveys 46.9 % said that they are almost always able to recognize opportunities), after classes and going through the materials 45.2 % of participants indicated a

step increase in knowledge and having experienced a new and transformative perspective. Only 9.5 % reported just an incremental increase in knowledge.

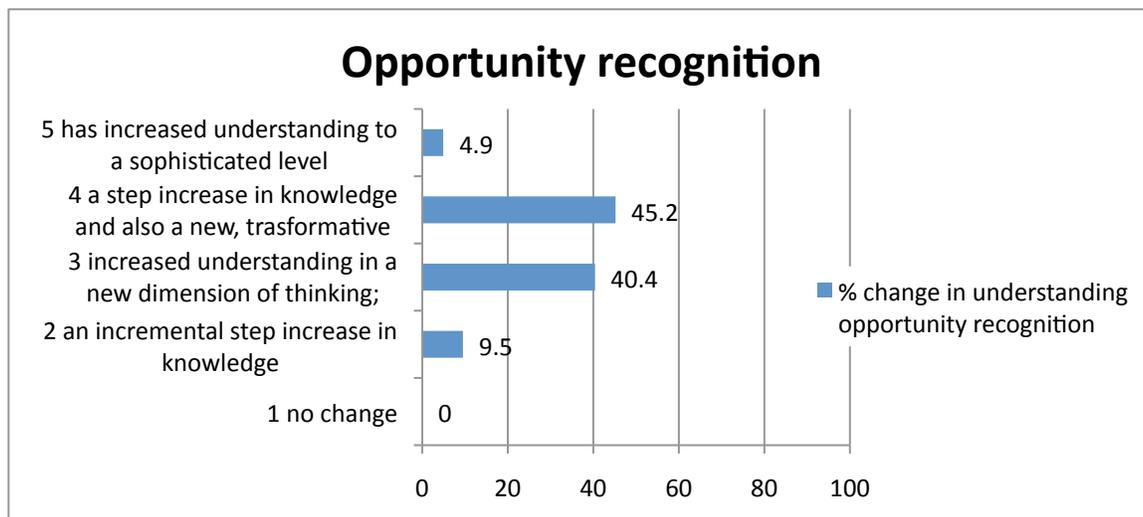


Table 2. Change in knowledge to understand opportunity recognition better

### *Strategic planning*

In the baseline survey we also asked about participants' level of understanding of their firm's strategic planning and how easy it is to connect that strategy with decisions in their work. Here they also showed confidence and 46.8% stated that they are almost always able to recognize the connection between the company's strategy and their work, 17 % replied they always recognize the connection. Even so, in-class surveys evidenced that 80.5% of participants felt increased understanding in this area and a new transformative perspective on the topic.

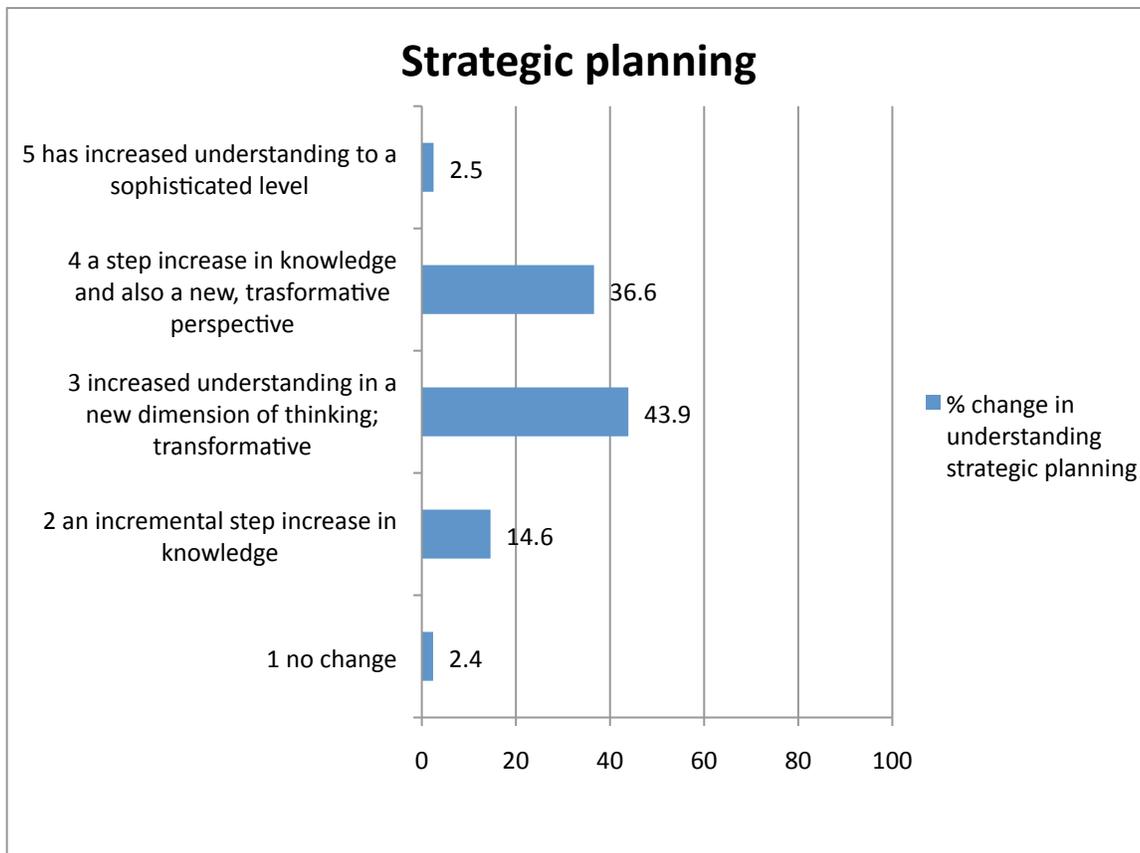


Table 3. Change in knowledge to understand strategic planning better

#### *Product management*

The second in-class survey (N=46) was conducted after covering product management best practices. Product management was a topic that created a very lively and sometimes heated discussion in the classroom. Even though this expertise area was definitely the strongest among the program participants based on the responses in the baseline survey, nevertheless, 41.3% stated increased understanding in this area and some transformative new thinking.

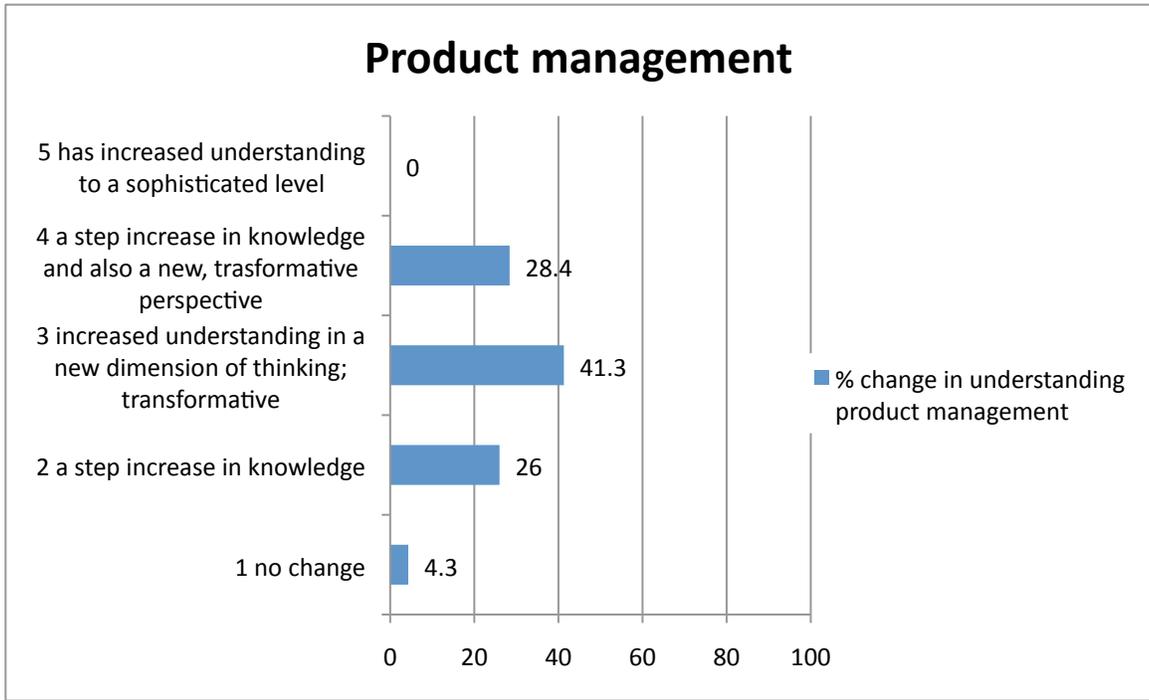


Table 4. Change in knowledge to understand product management better

Participants were asked what areas of the workforce would benefit the most from the program.

Participants responded that top-level managers such as director-level technical managers or *all* technical managers would benefit most from the knowledge presented. This gives support that the efforts taken to carefully fine-tune the curriculum to meet the needs of this specific target segment and to build in ways to best serve the learning of today’s top engineers and tomorrow’s rising stars have been successful.

***Results from the Video Interviews***

In the research interviews we were able to stimulate in-depth discussions, and encouraged interviewees to think back and reflect on what they have learned, while providing suggestions for the last half of the program. We included two participants from each partner firm and one Ph.D. student, thus our sample size is 16. Each interview lasted 30-45 minutes and was videotaped. Most interviews were conducted individually, but with three firms we had participants interview together to test whether that would increase flight of thought and provide us even more rich data.

### *Motivation*

We enquired about participants' motivation in deciding whether to participate in the program. Interviewees mentioned the following motivating factors: their positive attitude towards lifelong learning, the program's compact format to accommodate busy professionals, content – especially the emphasis on technological leadership and problem solving, and the U.C. Berkeley brand. For many this program was a perfect match for their educational needs. Most engineers interviewed had a clear roadmap for how they could develop themselves.

*“Lot of the course descriptions seemed applicable to what I'm working on thus that seemed very appealing to me” (Interviewee #3)*

*“Everyone in the program is very ambitious...I am too. I really wanted to see my career progress. And I'm looking for more challenge progressions – not just hierarchical” (Interviewee #6)*

*“Getting out of my comfort zone and applying some of these principles to a new area outside my domain expertise is very useful” (Interviewee #13)*

### *New realizations*

Even though this first round of interviews was conducted in an early stage of the program, interviewees reported several ways in which their thinking regarding technology leadership and conduct of business, as well as their own role has already changed. Strategic importance of well-timed decision making, understanding customer or end user perspective, lessons learned from success and failure cases, and avoiding the symptoms of “engineering without leadership” were among the issues mentioned most often.

*“It has been so eye opening for me. Kind of like...opening a door to a bigger world... not just technical thinking” (Interviewee #2)*

*“And most importantly you also get exposed to a lot of other firms, corporations, and different perspectives... I did not expect that I would be interacting with so many other professionals from other companies.” (Interviewee #3)*

*“A-Ha moments? Tons of them. Every class there are at least two or three of them. Some of them from course materials, from cases, some from the comments from discussions.” (Interviewee #5)*

### *Takeaways*

Most interviewees stated that they already had applied the gained knowledge to their everyday job. For a few of them, more time is needed to set the new concepts better into context. One interviewee explained how he has enjoyed the role of transmitting his learning to team members and superiors, therefore affecting a wider audience within his firm. And we heard how discussions among colleagues participating in the program had continued at their work place and led to changes in project scheduling and communication practices between the departments.

Many of the interviewees mentioned also that their expectations for the remaining part of the program have risen significantly due to the high quality of content; the lectures, cases and guest speakers.

*“The most significant takeaway now is just the change in my perspective which has now more of a customer focus...understanding the end user perspective.” (Interviewee #7)*

*“I feel more in control of my job rather than my job controlling me” (Interviewee #10)*

*“For me, the strategy portion is probably the most important. You got very valid frameworks... this is the way to look at your markets, competition, value chain... Because (knowledge of) that strategy helps to shape my judgment, increase my confidence in my decisions.” (Interviewee #11)*

*“Guest speakers are amazing! These guys have been there, done that, they have gone around, pitched their ideas successfully, sold their companies. I think this is a real life lesson; this is not coming from a book.” (Interviewee #3)*

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