The Engineering Talent Issue

The push towards developing engineer-leaders comes at a time of a decline in talent entering engineering studies around the world – a fact acknowledged with dismay at the highest levels and which has prompted many countries and institutions to rapid action. In the UNESCO’s 2010 report “Engineering: Issues, challenges and opportunities for development”, there was clear urgency and a call to (among other points):

- develop public and policy awareness and understanding of engineering, affirming the role of engineering as the driver of innovation, social and economic development;
- transform engineering education, curricula and teaching methods to emphasize relevance and a problem-solving approach to engineering;
- more effectively innovate and apply engineering and technology to global issues and challenges such as poverty reduction, sustainable development and climate change – and urgently develop greener engineering and lower carbon technology.

Engineering faculties, institutions and associations worldwide have expended efforts in reviewing curricula for students, and strengthened & broadened continuing education and development opportunities for engineering graduates to address the concerns above.

This paper describes the initiatives championed by the Institute for Engineering Leadership of the National University of Singapore in prototyping innovative programs to address these concerns in Singapore’s context.

Addressing the Talent Issue: Innovation and Enterprise Experiences as Mechanisms of Change

The Faculty of Engineering, National University of Singapore, established the Institute for Engineering Leadership (IEL) to give focus and added impetus to the Faculty’s drive towards
nurturing engineer-leaders, to create and catalyze compelling programmes that will draw in talented students into engineering.

The IEL’s mission was defined as such:

“Enhance the leadership potential of individuals and enterprises in engineering, through innovation research, education and development programs.”

Where engineer-leaders have been defined as being:

“Individuals who are strategic systems thinkers and value creators. They can identify market and technology opportunities and engage people around them to deliver profitable growth with social impact.”

Innovation and enterprise development are key elements of the IEL mission in the belief that both can be mechanisms of change in the development of engineer-leaders. They are value-creation activities with the potential for tremendous impact not only in terms of assets produced and value created (from inventions, IP, start-ups etc.) but the experience of being involved in such activities can be in itself a learning and change process for the individual.

Since start of operations in early 2012, IEL has, through its Enterprise Development Lab, prototyped a number of experiential modules at the graduate level to validate principles and methodologies for engineering leadership development.

These modules were aligned either along a technology to market (T2M) pipeline where potential opportunities for identified NUS technologies are validated and acted on, or along the market to technology (M2T) pipeline where market opportunities are explored and technology solutions developed. A description of some of these modules is provided below in Table A.
Table A: Experiential Entrepreneurial Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Description</th>
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<tr>
<td>MarketZoom:</td>
<td>This course assesses whether a technology has commercial potential and identifies potential market areas where the technology can bring the highest value. The methodology is used for identifying technologies with commercial potential that can be further developed in TechLaunch.</td>
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<tr>
<td>Technology Venture Lab:</td>
<td>A mindset changing programme where researchers learn what it really takes to translate technology into a successful product. Designed for researchers who never thought about commercialization and do not understand their place in converting a technology into a viable product.</td>
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<tr>
<td>TechLaunch:</td>
<td>Mixed business and technology teams identify market applications for a pre-selected patented engineering technology and validate customer value, business model and other assumptions in the market with customers and other stakeholders.</td>
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<tr>
<td>MarketTraction:</td>
<td>TechLaunch graduates work with industry experts, customers and business development experts to complete the first product using rapid prototyping techniques and working with early adopters, to strengthen the composition of the team and to raise money for a start-up.</td>
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Experiential Programs in Innovation & Enterprise: How They Work at IEL

The basis of all experiential learning is that experience matters. Learning through experience takes place in discrete components; a "concrete experience" where the learner is involved in an exploration, undertaking an activity of some kind; reflection whereby the learner shares reactions and observations publicly and processes the experience by discussing and analyzing; and the “application” or "conceptualization" phase that helps the learner deepen and broaden their understanding of the concept or situation by cementing experiences through applications in real world and then generalization. This process is cyclical. New concepts, hypotheses, or impressions based on the experience or situation will constantly be modified as learners experiment and undergo new experiences.

In the IEL modules, students work on real problems and real technologies, dealing directly with potential customers and other stakeholders. Students develop leadership skills through commercializing technology & solving open market problems leveraging technology. An environment as close to the real-world as possible is created so that students can practice the taught value-creation skills without the risk of failing in the real world.

They are not shielded from contact with externals. Teams are actively guided throughout the modules as they deal with external customers and other stakeholders. Most have insufficient exposure to non-academic situations and lack the necessary connections in order to validate market interest for technology or determine, source and act on solutions for identified real
market problems. Hence, the modules require the extensive involvement of experts with industry and/or entrepreneurship experience to help teams connect to relevant external parties, provide them with business and industry guidance and act as a sounding board throughout the process, as they test & re-test their hypotheses and models.

As teams progress through the module, they develop a complete business proposal that they have the option to take up and implement into a company after the module concludes. Thus, students are invested in the projects from the start, not merely for the grades or knowledge gained but potentially for their future. That is a form of investment in learning that no classroom lesson can hope to generate.

As the students are invested to succeed they realize that to progress, working with others as a team is critical. Students learn to value and develop skills in relating to people, understanding and valuing other perspectives.

Feedback from the students in the first prototype modules reflect the observations made:

“Individual freedom: in the sense of trying new things, explore new industries, managing your team your own way.”

“The best thing was the uniqueness of it - being thrown into the real world, talking to real customers and finding real solutions to problems.”

“This is the course that every student should take since it is a course of self-discovery and equips you with the skills to create a successful product or a company.”

In summary what we observed is that:

1. Leadership development can best be fostered through real value creation activities.
2. The learning is best when students are truly invested in the results.
3. Engineering leadership development requires a combination of the exercise of hard (technical) skills and soft skills (EQ) through real value creation.
**The Next Steps**

The prototype programs described above and the observations made are still very much in development stage. Students are excited and enthused with the opportunities now provided in the Faculty to be involved in making something “real”. However, there is much that needs to be done to validate these programs as a means of generating engineer-leaders as well as to extend the reach and value beyond students to graduates and engineers in industry.

**Measuring & Tracking Development**

Currently feedback post-module is obtained from the students. We have not tracked students’ development throughout the program and post-course. A preliminary base of metrics has been developed based on national metrics of leadership set up by Singapore’s Workforce Development Agency.

Draft first-level metrics have been defined as such:

1. Lead with Vision: Direction & Strategy
2. Drive Change: Innovation, identification of change opportunities, risk taking
3. Build Relationships: Building teams, business networking
4. Develop People
5. Achieve Results: Performance management, crisis & risk management, resource management
6. Lead by Example: Personal Effectiveness

A series of questions under each is being created and tested. These questions would take into consideration the innovation & enterprise context the students are being put through, and test accordingly. A baseline response will be obtained pre-course. Post-course response will be obtained from all students and those teams taking proposals through to realization in the real world will also be tracked.

**Integrating Modules into Curriculum**

The IEL modules are currently elective modules targeted mainly at postgraduates. In the new academic year, these modules will be integrated into a Master’s of Science in Management of Technology (MSc. MOT) with a specialization in Innovation & Entrepreneurship.
The experiential and fluid nature of the modules makes integration of the modules as is into a structured undergraduate curricula difficult to achieve. IEL is currently experimenting with providing an alternative program for undergraduates.

**Extending Value: Application for Industry**

The modules have attracted the interest of R&D-centric organizations in Singapore. It is envisaged that the pipeline of modules could also be open to industry teams keen on solving a particular technological problem or wanting to promote innovation and enterprise development. After all, a significant side benefit of these programs has been the development of a pipeline of unique, global by design start-ups based on patented engineering technologies. To date 4 start-ups have been created, $1.8M money raised and 14 teams are in the pipeline. Such success can serve as a real draw to talented engineers and students.

Another way of involving engineers in industry is to provide an opportunity for mid-career engineers who may be itching to expand their horizons to contribute their time into teams as they take their business models into reality. Exposure to a start-up environment can help unlock their innovative & entrepreneurial capabilities and thus result in stronger & more open-minded leaders. Among the issues that have to be addressed could be the reluctance of organizations to release their talent to other opportunities, and issues of potential conflict of interest if there is IP involved.

IEL is keen to work with other like-minded organizations interested in applying innovation & entrepreneurial modules in developing engineer-leaders – the global leaders for tomorrow!