Enabling Student Innovation By Leveraging Lessons From Industry

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INTRODUCTION

Now that Engineering Entrepreneurship (E2) programs are emerging in universities all over the world, the E2 Community's focus can be shifted from why teach E2 to what should we teach and how should we teach it? Current programs teem with courses on business models, marketing, accounting, etc. In some ways they resemble mini-MBA's, designed to bootstrap engineers and scientists up the knowledge level necessary to take their product from concept to market. The underlying assumption to building all these skills is that the students have an innovative product to bring to market. Few engineering curriculums teach students to innovate. There is a continuum from science to business. Entrepreneurship programs focus on the business cycles over the technology cycles, assuming students understand the development of technology from their own domain experience.

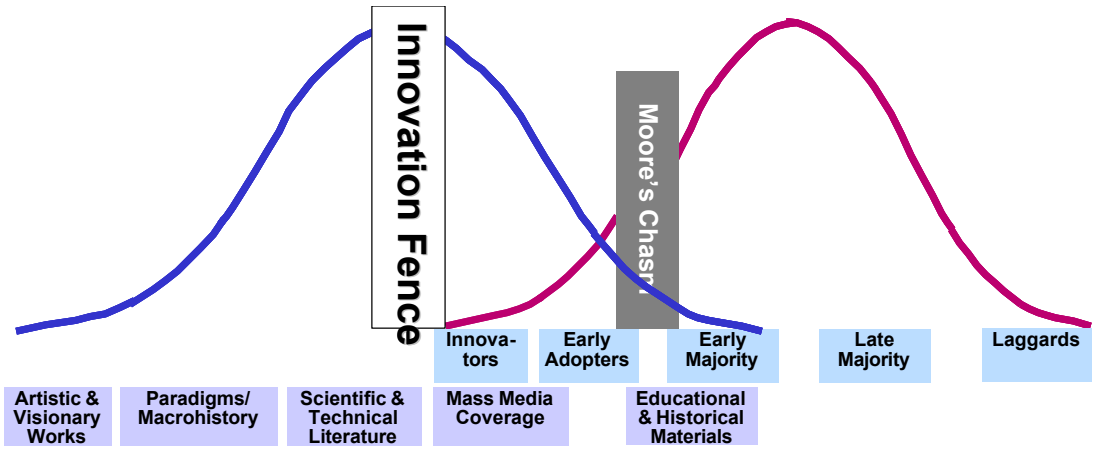

Exhibit 1: Geoffrey Moore's Technology Adoption Life Cycle[1] and the Wildman's bibliographic cycle of technological innovations[2] with the Innovation Fence included. The Innovation Fence is the hurdle a technology must cross before it finds its way into a product. Engineers help technology over this fence and into products.

Geoffrey Moore's Chasm Model has become the dominant framework to discuss the development of the markets for high technology products and services. This model assumes that a product exists at the beginning of the life cycle. The work of the engineer or scientist begins well before Moore's model. They are part of a team that transitions technology from the R&D centers into product architectures. There is a similar life cycle for this transition of technology into an innovative product. There is also an analogous gap to the Chasm referred to here as the Innovation Fence. The Innovation Fence is the hurdle technology must jump before it is ready to be integrated into a product or service. Coming from the School of Engineering, students need to be aware of the technology evolution cycle as much as the business evolution model. Noted British economist Shanks noted "There is a wide gap in every country between the knowledge of new products, processes, and techniques and the successful application of that knowledge in industry… The gap is not just a matter of ignorance, however. The company, and the country, that can best… bridge the gap between knowledge and application will succeed in the economic struggle; those that fail will go under… But neither at the company nor at the national level can the opportunities presented by modern technology without a clear and conscious strategy and without accepting all the implications of a change."[3] We are calling Shanks' gap the Innovation Fence. It is a barrier that all evolving technologies must cross in order to be included into products and services.

An example of the Innovation Fence being crossed is the development of the World Wide Web. Tim Berners-Lee developed the initial server software and browser interface for his community at CERN. This brought the WWW up to the fence. It was only valid for a group of scientists that used the $40K workstations required to run the Web. It was not until Marc Andreassen and some from at the NSCA ported the technology to the Personal Computer did the WWW really cross the Innovation Fence and be in a position to start the Dot.com boom of the late 1990's.
The focus of the engineering curriculum is to prepare students for industry positions, not to go out and create their own jobs and companies. There is a gap in the curriculum in equipping entrepreneurial engineers with the tools to cross the Innovation Fence. The figure below illustrates the position of the **Innovation Fence** as well as the **curricular gap** that exists in current education programs to train and assist graduates in successful breaking through the Innovation Fence.

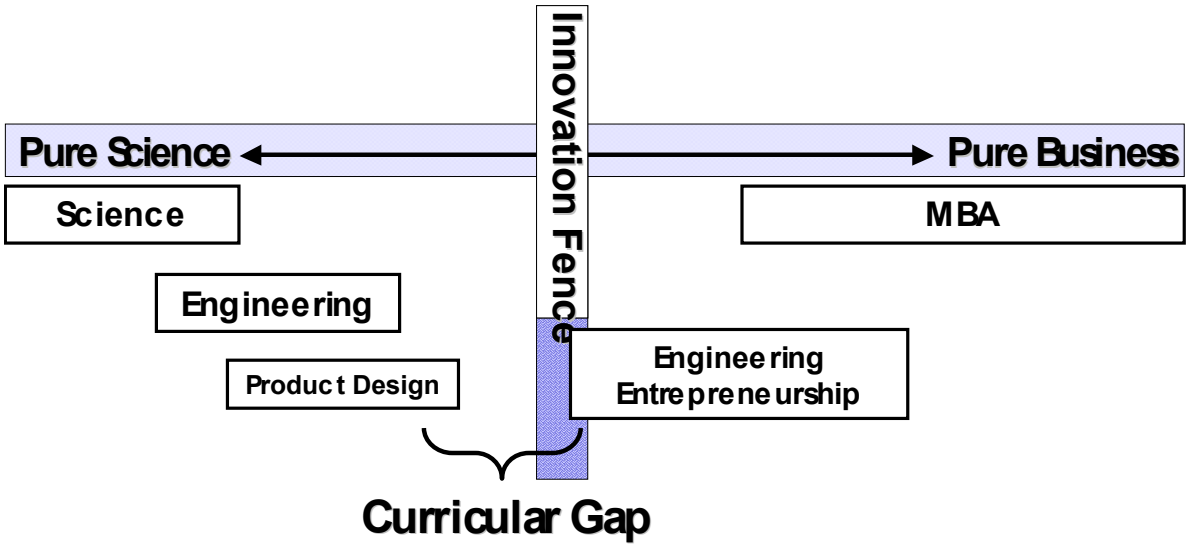

Exhibit 2: Diagram of the Innovation Fence showing how various academic programs cover the transition of technology into the marketplace. Crossing the Innovation Fence is critical skill for students to attain. Currently no academic programs assist students in developing this skill or even awareness of the transition across the fence.

Historically, the programs that have been closest to bridging this curricular gap have been the design curriculums within Mechanical Engineering. Notable examples are the Illinois Institute of Technology's Institute of Design, which offered the first PhD in the United States in Industrial Design, and Stanford University's Product Design program. The Stanford offering is a joint program between the Mechanical Engineering and Art Departments that has produced students capable of generating world-class user centered products that are closer to crossing the Innovation Fence than other programs. This program is currently undergoing a renaissance under the leadership of Prof David Kelley based on his years of experience with his company IDEO Product Development. Prof Kelley is using a programmatic framework that harkens back to Asimow's guidance that effective design "requires a synthesis of technical, human, and economic factors."[4] IDEO integrates these concepts into what it calls the Innovation Engine concerned with Technical (feasibility), Human (usability), and Business (viability) Factors. A working group of Stanford Design Division students and faculty have extended the Innovation Engine to create a new academic discipline, Comprehensive Design Engineering. The following figure illustrates how existing disciplines can be represented within this framework.

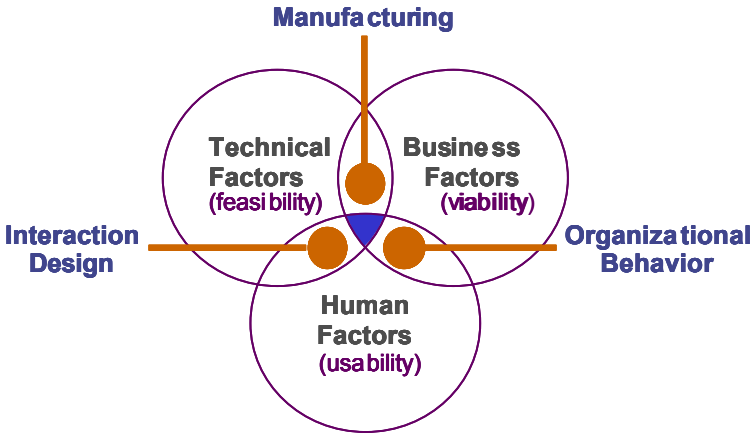

Exhibit 3: Comprehensive Design Engineering is an extension of IDEO's Innovation Engine, first documented by Weiss.[5] This extension brings together Technology Issues, Business Issues, and Human Issues within a particular context to create a comprehensive model that enables consistent brilliant innovation. Comprehensive Design Engineering is positioned at the intersection of these three domains.

IDEO Product Development is one of several companies that cross the Innovation Fence as part of their daily operations. Another such company is Doblin, Inc. Headquartered in Chicago, Doblin specializes in assisting companies in crossing the Innovation Fence. Doblin utilizes a unique mix of product design, cultural anthropology, and business acumen to assist companies in improving their innovation 'hit rate' and profitability by developing new innovations grounded in customer needs.

The practices of successful consultancies such as Doblin and IDEO are cloaked in mystery to casual observers and even their clients. Despite efforts to reveal the designer behind the curtain, client companies and competitors have been unable to replicate their success. This paper will seek to clarify the processes of one of these companies by applying a proven innovation framework. This framework is based on observation of practices and methods of the top Innovation and Design consultancies such as IDEO Product Development and Doblin. At its core is the insight that any innovation can be modeled as a compelling pairing of needs and solutions. Successful innovators simultaneously evolve needs and solutions until a compelling combination is achieved. This framework is examined through the lens of Doblin's Ten Types of Innovation to create a powerful suite of framework and assessment tools to equip student innovators. This paper details the nuances of this framework, makes recommendations as to its placement in the curriculum, and provides the reader with resources to begin building these skills within their own students.

Current Views Of Innovation

Esther Dyson encourages "creative solutions to real problems" while discouraging innovation for innovation's sake.[6] Mary Lou Maher uses genetic algorithms to create innovative architecture designs by coevolving design requirements and design solutions.[7] Peter F. Drucker outlines his seven sources of Innovation in his seminal work on the topic, Innovation and Entrepreneurship.[8]

1) Unexpected Occurrences
2) Incongruities

3) Process Needs
4) Industry and Market Changes
5) Demographic Changes
6) Changes in Perception
7) New Knowledge

Exhibit 4: Drucker's list of the seven sources of Innovation. The one most commonly affiliated with High Tech Entrepreneurship is that of New Knowledge. This source has the longest lead time of all Innovations.

Doblin developed a framework called, the Ten Types of Innovation which helps clients analyze current innovation efforts and develop new ones. Doblin's research suggests that innovations that cross more than one category are harder to for competitors to replicate and have a higher success rate.

Finance	Processes	Offerings	Delivery
1. Business model How you make money **2. Networks and alliances** How you join forces with other companies for mutual benefit	**3. Enabling process** How you support the company's core processes and workers **4. Core process** How you create and add value to your offerings	**5. Product performance** How you design your core offerings **6. Product system** How you create product systems and platforms **7. Service** How you provide value to customers and consumers beyond and around your products	**8. Channel** How you get your offerings to market **9. Brand** How you communicate your offerings **10. Customer experience** How your customers feel when they interact with your company and offerings

Exhibit 5: The Ten Types of Innovations identified by Doblin, Inc. These are grouped into four different categories of Finance, Processes, Offerings, and Deliveries.

Each of these perspectives is correct in their own context. Each approach sheds new light on understanding this complex notion of innovation that is used as a noun, verb, adverb, and adjective. These perspectives can be divided into two groups: a process perspective and a product perspective. Dyson and Maher speak in terms of the Innovation process, providing hints to guide the would-be innovator in crossing the fence from technology to market. The Drucker and the Doblin perspectives tend to be applied once an innovation approaches or crosses the fence. Used in concert, the process and product view create an Innovation feedback loop that is useful for both the novice and expert Innovator in their quest for the new. The process understanding can assist the novice in planning their path to and over the fence. The product view can assist the novice in assessing if they have set the proper course. For example, Doblin employs the Ten Types of Innovation to create the Innovation Landscape™, an industry assessment tool that applies bibliographic data to analyze where an industry's innovation focus has concentrated over the past 10 years. [9] The figure below is an example of the Innovation Landscape™ from the Personal Computer and Peripherals industry.

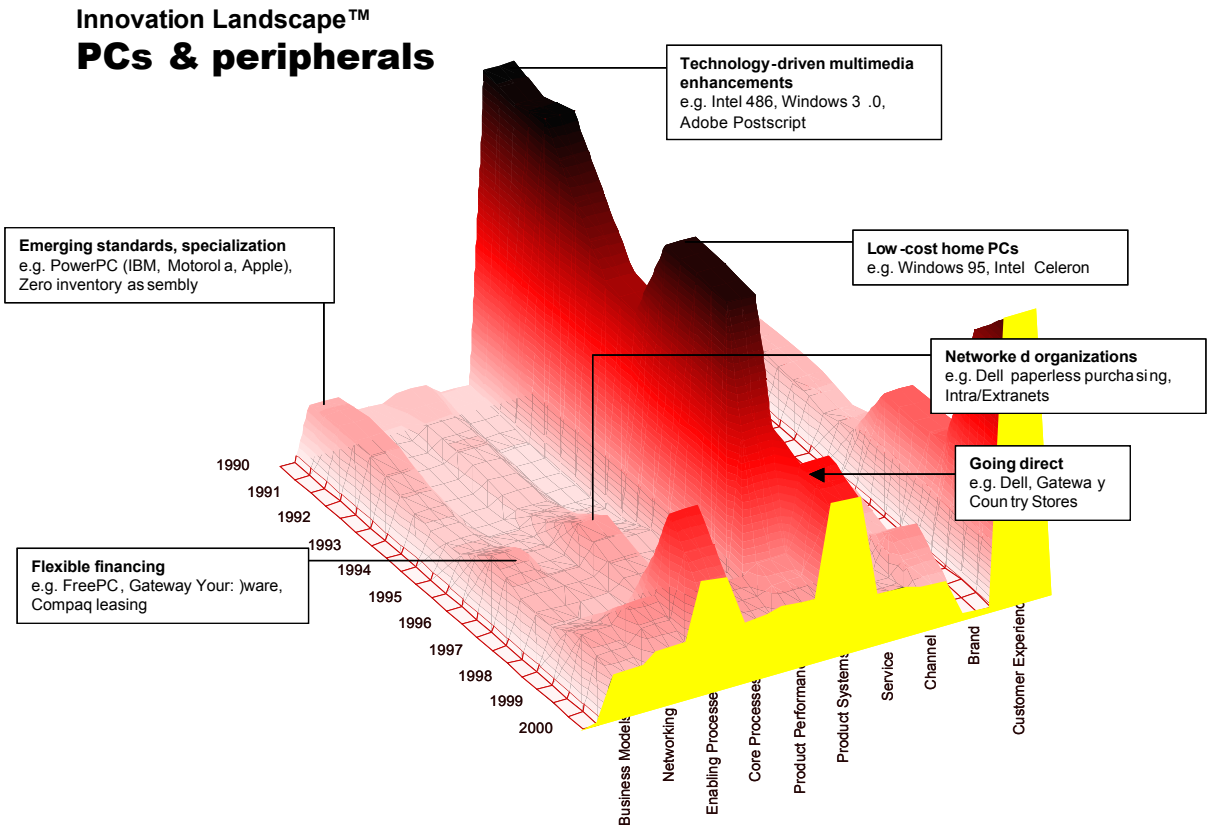

Exhibit 6: Doblin's Innovation Landscape for the Personal Computer and Peripherals industry. The height of the peaks is determined using a proprietary bibliographic technique. Using this Innovation Landscape, Doblin can assist clients in identifying new areas of opportunity.

Evolving View Of Innovation

Feland proposes a new view of Innovation from the perspective of a designer. This new view couples a new process understanding with a unique opportunity assessment tool that sits at the core of the Innovation Engine. This new perspective has its roots in understanding the practices of the enterprises hired to assist other companies cross the Innovation Fence. Core to this view is the notion that an Innovation is a compelling coupling of a Need and a Solution. For the purposes of this model a need is defined as a perceived gap between a person or organizations present state and their desired state. The stakeholder of these needs many not explicitly state them as such. Methods such as surveys and customer interviews have proven to not be as effective as ethnographic methods of discovery to uncover latent user needs. Many times the user is not aware of their most compelling Needs. Solutions are creations that enable a transition from the present state to the desired state, bridging the perceived gap as illustrated below.

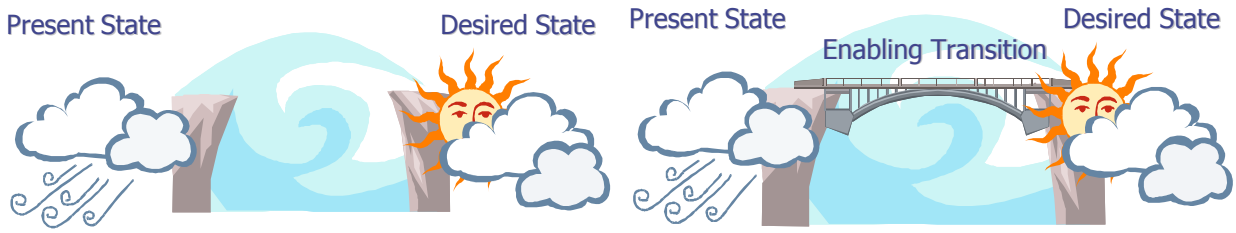

Exhibit 7: Illustration of Need, demonstrating the perceived gap between the present state and desired state of an entity. This perceived gap is valid for a particular context that must be explicitly stated. Solutions are creations that bridge the gap between the present state and the desired state. Solutions can be Products, Process, Services, or some combination of all three depending on the nature of the gap to be bridged.

Building on this notion of Innovative products are compelling Need-Solution pairs, we can quickly apply this model in the understanding of recent product releases. The most poignant example is that of Dean Kamen's Segway Personal Transporter. The Segway is a marvel of modern engineering. Without a doubt it is a compelling technical Solution. Unfortunately, the Need is not as compelling. The gap between the present state and the desired state perceived by Kamen is much wider than the rest of society perceives. For another example, we can look to the Listerine Pocket Paks. Pfizer created a way for people to get fresh Listerine breath outside the bathroom. They designed the Pocket Paks as a portable Solution – one small enough to fit in a jeans change pocket. By coupling a compelling Need and a creative Solution, Listerine Pocket Paks have become a run away hit – evoking multiple copycats and opening the door to a whole new category of portable healthcare products.

Apply Need-Solution Thinking to New Product Development.

This new model is used to create a new version of Wheelwright and Clark's Product Development Funnel. This version of the Funnel represents the decreasing uncertainty as the enterprise moves through the various stages of product development as well as the increasing confidence in the success of the product in the market place. As uncertainty decreases and confidence grows, the realm of potential Need-Solution pairs is narrowed to one compelling coupling that eventually transitions through the remainder of the product development process into the customer's hands.

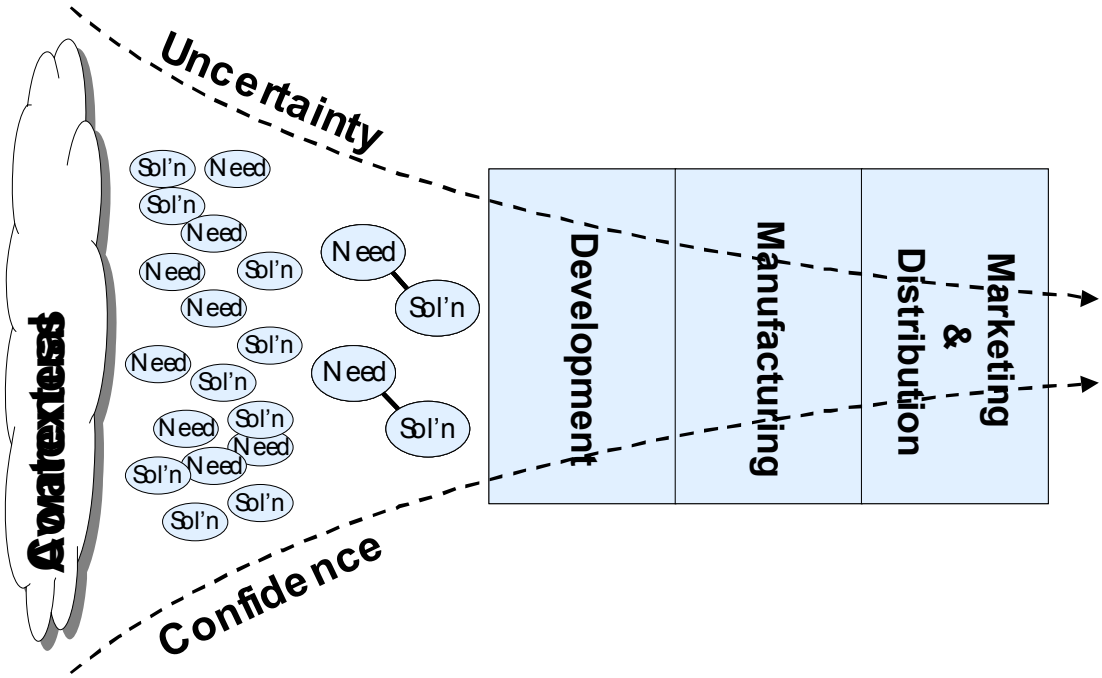

Exhibit 8: Need-Solution Pair Evolution represented as a Product Development Funnel. Notice that the process begins with superior awareness of a given context. This enables the greatest potential creation of compelling Need-Solution Pair.

Understanding Professional Innovation Consultants

Using this process of generating and assessing Need-Solution pairs, we can better understand the processes used by professional Innovation consultants. Doblin assists client companies in understanding the depth and breadth of needs to be addressed within a certain context grounded in client capabilities. Doblin works with clients to understand what's desirable, viable, and possible. This iterative process often begins with an internal capability assessment to better understand the client's core competencies. Doblin utilizes the Innovation Landscape™ to identify areas of opportunity that have been overlooked and underaddressed by a particular industry. . With the target Innovation Types identified, Doblin then immerses themselves into an ethnographic study of the various users. This method of uncovering latent Needs is more effective than traditional surveys, focus groups, or user interviews. In parallel, Doblin undertakes contextual research to understand and forecast developing technology and business trends both inside and outside the client's industry. Each of these steps improves Doblin's and the client's contextual awareness. As their awareness increases, Doblin consultants identify and develop potential Need-Solution Pairs. These candidate N-S Pairs are evaluated against the Innovation Landscape to investigate which Innovation Types they map to. Should promising Pairs require expertise and capabilities outside the client's core competencies, Doblin will suggest that the client build, buy, or lend these required skills. In other words, Doblin will propose they develop in-house capabilities, acquire the necessary capabilities from outside, or partner with outside enterprises to bring this N-S Pair to the market.

Implications for the E^2 curriculum

Armed with these insights and this new model, students will be able to begin to mimic the processes of world-class innovators. Additionally, the use of Doblin's Ten Types of Innovation provides students with a powerful tool to assess their infant Need-Solution pairs as to the breadth of their planned innovation. These tools have already made their way into the curriculums at Stanford and the Institute of Design at IIT. The model of Need-Solution pairs provides a powerful common language of innovation within the classroom setting. This model has been used in two Stanford classes to provide students with a pedagogical scaffold to assist students in developing their innovation process. In ME297x, Innovation with Emerging Technologies[12], this model was used to study historical innovations across disparate domains. Students also used this model to analyze the diffusion of emerging technologies as a Solution biased innovation process. That is to say, viewing the transition of Emerging Technologies into the greater market is a practice of potentially compelling Solutions in search of compelling Needs to be paired with. In ME116A, the first in the capstone design sequence for the undergraduate Product Design curriculum, the framework was used to develop and evaluate product concepts as compelling Need-Solution Pairs. In this context the framework was valuable in ensuring student teams did not just design a widget but a widget with a purpose. Traditionally the products designed in this course reflect the perspectives of the designer more than meet the Needs of any customer group.

By integrating the Need-Solution framework with a new understanding of the Doblin process, courses in innovative product development can equip students with the tools to cross the Innovation Fence. By using the Need-Solution framework to provide a language to support product team interactions and Doblin's Innovation Landscape™ to assist teams in targeting and evaluating their innovation efforts. This tool set begins to fill the curricular gap in the academic offerings design to develop the skills within students to achieve consistent brilliant innovation.

Conclusion

Engineering Entrepreneurship can improve their chances of crossing the Innovation Fence by utilizing the process of coevolving Need-Solution pairs to understand the successful Innovation processes of professional innovators such as Doblin, Inc. Bringing the proven business practices of Doblin into the classes combined with the scaffolding provided by the Need-Solution framework allows the secret "magic" of Innovation to be explained and adopted by novice innovators.

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