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INNOVATION IMPACT MAP: AN OPPORTUNITY EVALUATION TOOL

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Abstract

There is a need for advanced tools and methods to support the entrepreneurial engineer as they move their ideas through development and out to the market. These tools and methods are being developed under the new discipline of Comprehensive Engineering. These tools seek to bring together Technical, Human, and Business Issues in a compelling and useful fashion to support the development and deployment of innovative products and services. One of the first tools developed in this framework is the Innovation Impact Map. Currently in the early stages of development, the Innovation Impact Map creates a framework in which to explain past successes as well as assess current and future products under development for their innovation potential and market impact. The Innovation Impact Map brings together an understanding of customer needs, the economics of the market, technical feasibility, and the changing state of information in the competitive marketplace. This paper will develop the theory behind this model as well as exhibit its usefulness applied to real world design issues from industry.

1. Innovation Context

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 designer begins well before Moore's model. The engineer is 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 is the hurdle technology must jump before it is ready to be integrated into a product or service. Figure 1 below illustrates both cycles and the critical transition points for an innovation to make it into the greater market.

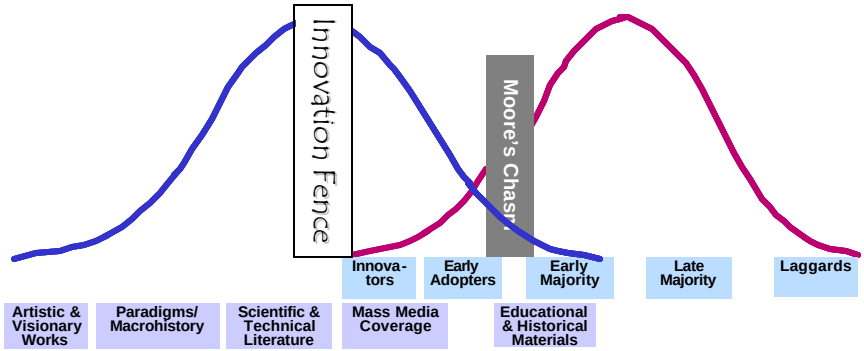

Figure 1: Geoffrey Moore's Technology Adoption Life Cycle [1] and the bibliographic cycle of technological innovations [2] with the Innovation Fence included. The Innovation Fence is the hurdle a technology must cross before it finds its way into a product. Engineers work to help technology over this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

These professional innovation-consulting firms assist enterprises in crossing the Innovation Fence and many times work with the client enterprises in the development and deployment of products into the market. By exploring the processes used by these firms to cross the Innovation Fence we hope to gain insights that allow others to achieve this practice of consistent innovation. It is understandable the rarity of these enterprises. Current academic programs ignore the skills necessary to cross the Innovation Fence. There has been a shift to include more entrepreneurship content in the traditional engineering curriculum. These 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. The focus of the Engineering Curriculum is to prepare students for industry positions, not to go out and design their own jobs. This gap in the curriculum is illustrated in Figure 2 below.

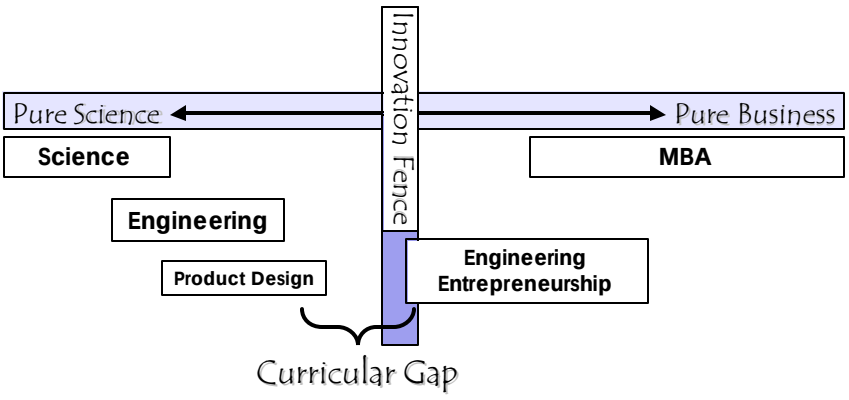

Figure 2: Feland's diagram of the Innovation Fence showing how various academic programs cover the transition of technology into the marketplace. [3] Crossing the Innovation Fence is critical skill for students to attain. Currently no academic programs assist students in developing this skill or even 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 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 [5] 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. Figure 3 below illustrates how existing disciplines can be represented within this framework.

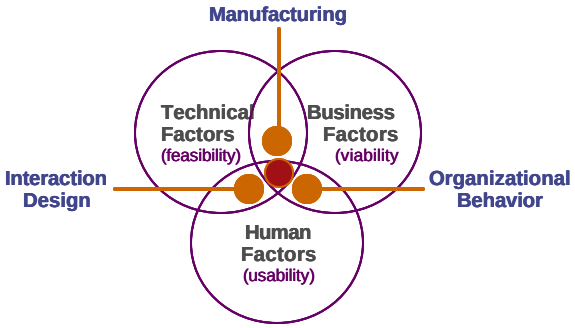

Figure 3: Comprehensive Design Engineering is an extension of IDEO's Innovation Engine, based on Weiss [5] and Asimow. [4] This extension brings together Technology Issues, Business Issues, and Human Issues within a particular context to create a comprehensive that enables consistent brilliant Innovation.

A notable example of a consultancy assisting clients to consistently innovate is IDEO Product Development (www.ideo.com), the winner of more Business Week Design Awards than any other firm in the world. [6] IDEO assists clients in two powerful methods: providing top design and product development as well as Innovation process training through their IDEO-University offering. IDEO provided the innovative product development horsepower behind Apple's first mouse, and more lately, the Palm V PDA for Palm Computing and the original Handspring Visor Handheld for Handspring, Inc. Seemingly similar in functionality, the Palm V and Handspring Visor had vastly different target markets, development times, and engineering challenges. Without the efforts and services provided by IDEO, the product and business success experienced by both Palm and Handspring would not have been realized. IDEO Product Development is one of several companies that cross the Innovation Fence as part of their daily operations. IDEO works with clients during all phases of New Product Development, providing expertise in mechanical design, electrical engineer, industrial design, human factors and business factors. Another such company is Doblin, Inc. Headquartered in Chicago, Doblin specializes in assisting companies to cross the Innovation Fence. Doblin utilizes a unique mix of product design, cultural anthropology, and business acumen to assist companies improve their performance and profitably grow their business by developing new innovations grounded in customer needs.

2. Need-Solution Pairing in Innovative Product Development

Esther Dyson encourages "creative solutions to real problems" while discouraging innovation for innovation's sake. [7] Mary Lou Maher uses genetic algorithms to create innovative

architecture designs by coevolving design requirements and design solutions. [8] Adams, et al, found empirical evidence of this coevolving iteration between problems and solutions. [9] These three approaches center on the notion of engineering problem solving. When students are introduced to problem solving in their academic training, the problem statement is typically explicit or mature. Accreditation is pushing towards training students to design for "ill-defined" problems but by definition, these are still known and defined problems. Product designers deal with the comparably fuzzier situation of discovering and fulfilling a need. In this situation, the designer must cope with a more ambiguous situation than traditional problem solving scenarios. This assertion assumes that the first problem focused upon may not be the most compelling need to be addressed. Traditional engineering approaches give the engineering designer responsibility and control over the development of the solution. In an innovative design approach, the engineering designer now has responsibility for the development of both compelling Needs and Solutions. As such, we extend the notion of problem-solution coevolution into the realm of Need-Solution coevolution.

2.1 Coevolution of Needs and Solutions in the Design Process

Feland proposed that designers are most innovative when they develop compelling couplings of Needs and Solutions. [10] This assertion is based on extensive ethnographic studies of some of the most noted product designer firms in the world as well as a few Silicon Valley start-ups. This notion is further supported by Adams, et al, [9] in their experiments with novice and expert designers. Adams found during the development of design concepts, not only did the experts iterate more between problems and solutions but also they were also more likely to couple "problem and solution elements." In an effort to be more specific on the nature of Needs and Solutions in this framework the following definitions are used. 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 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.

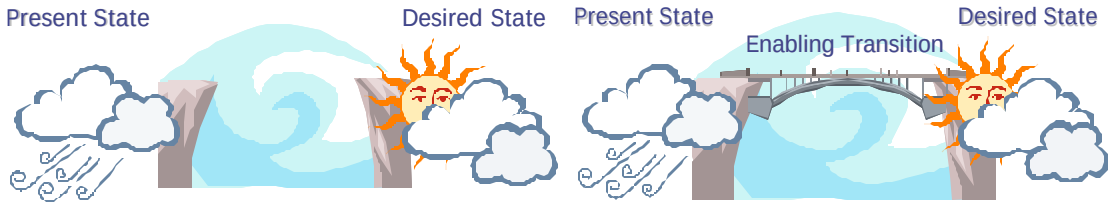

Figure 4: Illustration of Need, demonstrating the perceived gap between the present state and desired state of an entity. This perceived gap is valid for an explicitly stated context. Solutions are creations that bridge the gap between the present state and the desired state. Solutions can be Products, 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. (www.segway.com) 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. (www.listerine.com) 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 been come a run away hit – evoking multiple copycats and opening the door to a whole new category of portable healthcare products.

2.2 Modeling the Design Process using Need-Solution Pairs

This new model is used to create a new version of Wheelwright and Clark's Product Development Funnel. [11] 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.

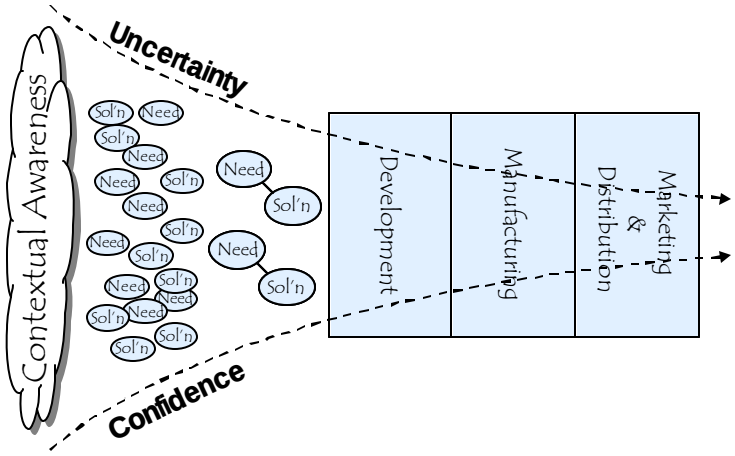

Figure 5: Need-Solution Pair Evolution represented as a Product Development Funnel. Notice that the process begins with superior awareness of a given context. This enables the greatest potential creation of compelling Need-Solution Pair.

With this framework of Need-Solution pairs we can see the benefits designers bring to New Product Development as brokers of Needs and Solutions. Traditionally engineering designers are trained to begin with a high level Need-Solution pair and then to iteration the Solution until a robust Solution is obtained to release to the market. Using the Need-Solution pair framework, it becomes apparent to the practicing designer that both the Needs and Solutions are part of their responsibility.

3. Innovation Assessment

The Need-Solution Framework assists designers in creating Need Solution Pairs but the question remains as to which is the most compelling. There are several methods of classifying innovative Need-Solution pairs. Some are taxonomies based on types of Innovations. Others are tools to assess the potential success of a candidate Need-Solution Pair in the intended market. Peter F. Drucker outlines a taxonomy of seven sources of Innovation in his seminal work on the topic, Innovation and Entrepreneurship. [12] These sever sources are: Unexpected occurrences, Incongruities, Process Needs, Industry and Market Changes, Demographic Changes, Changes in Perception, and New Knowledge. The one most commonly affiliated with High Tech Entrepreneurship is that of New Knowledge. This source has the longest lead-time of all Innovations. The technological innovations that have to cross the Innovation Fence tend to be classified as New Knowledge. Doblin Inc.

utilizes ten types of Innovation in their work with clients. Organized into four categories, research by Doblin finds that dominance across more than one type of Innovation leads to improved chances for product success.

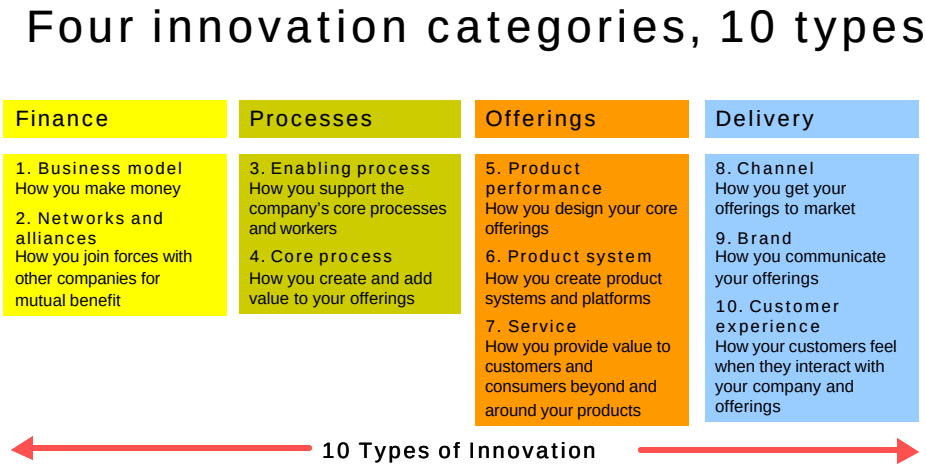

Figure 6: Doblin breaks out ten types of Innovations grouped into four different categories of Finance, Processes, Offerings, and Deliveries to assist clients in understanding where their strengths lie. [3]

Doblin employs the Ten Types of Innovation to create the Innovation Landscape™, an industry assessment tool that makes use of bibliographic data to analyze and understand what is current occurring within a client's industry. [13] Figure 7 below is the Innovation Landscape™ from the Personal Computer and Peripherals industry.

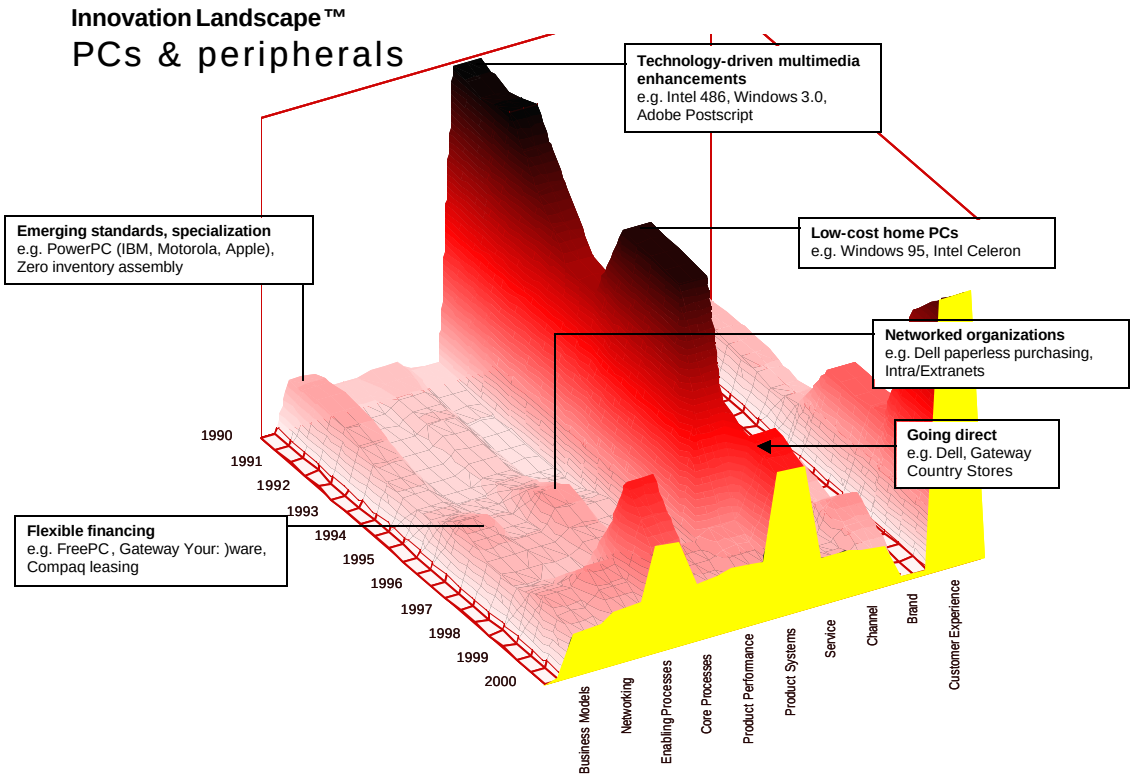

Figure 7: Doblin's Innovation Landscape for the Personal Computer industry. Doblin can help the client in identifying what their competitive advantage is and what areas are neglected by the industry.

The Drucker and the Doblin perspectives tend to be applied once an innovation approaches or crosses the fence. Drucker's taxonomy pools the types of Innovations we are concerned with into one category and therefore provides little assistance to the designer trying to create the new. Doblin's Landscape is based on bibliographic searches in existing markets and breaks down when a radical innovation creates a new market. There is a need for an assessment method to assist the designer in assessing opportunities in a comprehensive fashion.

4. Innovation Impact Map

The Innovation Impact Map seeks to enable a comprehensive opportunity assessment by evaluating candidate Need-Solution Pairs in the technical, human, and business domains. The Innovation Impact Map assisting in making a qualitative assessment of the potential market impact and success a particular paring of Need and Solution. The Innovation Impact Map utilizes an assessment framework that explores the quality of life improvements afforded by the innovation, the number of entities impacted by the innovation, as well as the ripple effects of the impact through the value chain. Within this construct, innovations are modeled as networks of need-solution pairs. An automobile is a system of many solutions addressing many needs. These networks are mapped against the three axes of the Innovation Impact Map to assess or explain market potential. Figure 8 below reveals the Innovation Impact Map (IIM) and it's three axes of assessment.

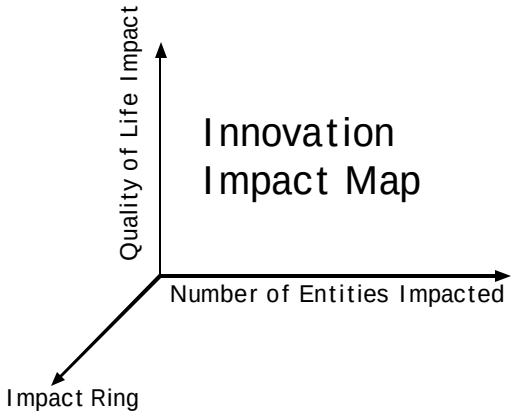

Figure 8: The Innovation Impact Map detailing the three axes of assessment, Quality of Life Improvement, Number of Entities Impacted, as well as the Impact Ring.

The primary axis is the quality of life benefits provided by the need solution pair. A cure for a terminal disease would have a larger impact than an improvement to the life of light bulbs. The second axis is an assessment of the number of entities impacted. These entities could be people, organizations, or systems such as, HR managers, fast-food restaurants, or servers. The final axis is the Impact Ring. Imagine the innovation as a rock tossed into a pond. There are rings that ripple from the point of impact. For example, a reduction in the cost of accelerometers used in airbag systems would allow the automotive industry to include airbags in all of their models. The initial impact ring is with the automotive companies. The second impact ring would be the automotive dealers that can use this new safety feature to increase sales against their competitors. The last impact ring is the automotive owner that has increased their chances of surviving a major automobile accident.

The Innovation Impact Map utilizes near peer comparisons for the assessment of the impact the innovation could have. This allows for contextually sensitive assessment of the

opportunity. One would not compare the Internet to the seat belt. They exist in drastically different contexts. In examining the benefits of the IIM we will utilize a different product, snowboard bindings.

When snowboard bindings first entered the market, they utilized the now common strap-in bindings. In the past five years, the market has seen the introduction of step-in or clip-in bindings, similar to the clipless pedals of cycling. The step-in bindings were considered to be a tremendous innovation by snowboarding enthusiasts. These new bindings drastically reduced the time spent at the top of the mountain, therefore allowing boarders to get more rides down the hill during the day. We can use the classic strap-in binding as the near peer comparison to the newer step-in bindings as we assess this new sports product using the Innovation Impact Map. For the purpose of this explanation we will only consider the Need of attaching oneself to the snowboard in a rapid and rigid fashion. Both types of bindings offer the corresponding Solution paired with this Need to form an Innovation. If we explore the number of entities impacted by this change at the user level. We can easily see that the number of entities impacted by the strap-in bindings is roughly the existing population of snowboarders. The new bindings would impact the existing population, specially given its entry enhancements, as well as open the sport of snowboarding up to additional people that did not want to deal with the extra effort over ski bindings. With this assessment, there are actually more people impacted by the step-in bindings.

Figure 9: These are this year's Burton Snowboard bindings. The classic strap-in binding is on the left and the more advanced step-in binding is on the right.

For this Need-Solution pair, the Quality of Life Impact of the step-in bindings is a substantial improvement over the strap-in bindings. Riders no longer have to wallow in the snow for 20 minutes trying to strap their boots to their board. As a result, in the first two axes of the IIM, it is apparent the positive impact the step-in bindings had on the market.

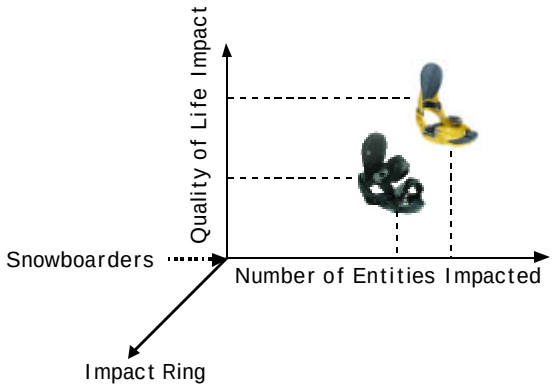

Figure 10: This figure shows where the strap-in and step-in bindings fit in the Innovation Impact Map. Based on our assessment, the step-in binding is has a significant impact on the snowboarding market.

The last axis of assessment is the Impact Ring. Imagine the Innovation as a stone dropping into the pond. The ripples of the impact stretch far from its initial entry into the water. The same is true for Innovations. The Impact Ring allows the designer to consider other members of the Value Web that are impacted by the Innovation. In this case let us consider the role of the ski hill and the impact the new bindings had on the owners and operators of the slopes. We now move away from the center and find that for the operators, there was not difference in the number of entities (ski hills in this case) impacted be either type of binding. When judging the Quality of Life Impact, we find that with the new bindings, the snowboarders do not stop by the lift to strap in their bindings. This drastically reduces congestion and increases safety; two very important needs of the ski hill operators.

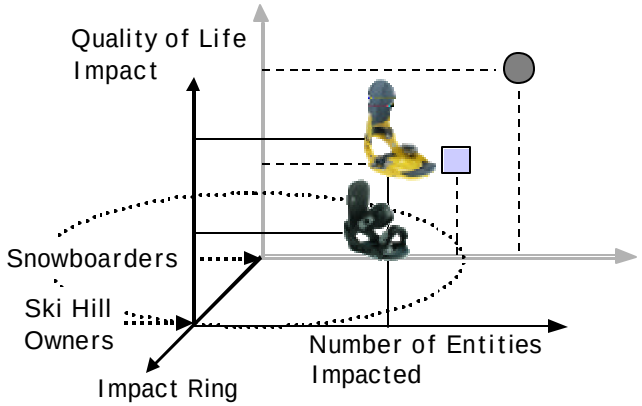

Figure 11: By including the owners of the Ski Hill in our analysis we can see how far the impact of this product innovation can reach. All members of the value web for a particular innovation can be mapped on the IIM.

It should be noted that an innovation could also have a negative impact on the quality of life for some stakeholders. In this case consider the rental businesses that provide snowboards. With strap-in bindings, most any snowboard boot will fit any binding. With step-in bindings, only certain boots can be used. This increased the cost and complexity of the rental inventory. As such, there is still resistance by the rental market to adopt step-in bindings as part of their standard offerings.

5. Current Results

The Need-Solution Framework and the Innovation Impact Map have already been used with success in assisting novice designers in two courses at Stanford University improve students' ability to innovate. In ME297x, Innovation with Emerging Technologies [14], 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. In both courses, the Innovation Impact Map provided an elementary heuristic to guide the designer decision-making. Professional designers at Doblin, Inc. and

IDEO have expressed interest in making use of the Innovation Impact Map to improve their own assessment of potential innovations for their clients.

6. Next Steps for the Innovation Impact Map

Additional steps will be taken to develop the model; given the initial positive feedback from academic and industrial testing. The next evolution of the Innovation Impact Map will be the creation and implementation of a formal decision model based on the methods of Ronald Howard [15] to guide designers in choosing which of their compelling Need-Solution pairs would have the greatest market impact. This model will be used in a set of experiments designed to assess the ability of novices trained by these methods against the innovation abilities of novices that do not have such training. Additionally, the decision model will be deployed into corporate environments at IDEO, Doblin, and a few Silicon Valley start-ups in an effort to assist professional designers in their everyday quest to cross the Innovation Fence.

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