THE VALIDITY OF INNOVATION PROCESSES ON OUTCOME AND PERFORMANCE

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ABSTRACT

Innovation is a nebulous and subjective field that's definitions and validity is often put into question. To study this field, it is critical to look at thought leaders within the field as well as well established institutions of innovation and analyze their processes to establish a common framework. This paper expands on common ideas presented by people within the design innovation field who write and educate the public about innovation processes. It also looks at educational institutions and departments whose goal is to establish innovation processes and engage people in the innovation process. From there, a common high-level framework of innovation is extrapolated into a map of modules. The modules can then be used as an analysis tool for past innovation engagements as well as future innovation planning. Additionally, certain innovative characteristics and behaviors are also identified from popular literature and educational frameworks and surveyed for their impact. In the study presented, financial data is collected from students who engage in a school project that requires the design, manufacturing, and sales of original products. The students are then surveyed on various innovative behaviors and asked to compare themselves to other teams within their cohort. Through anecdotal evidence and interviews, specific teams' processes are summarized. The data and analysis can offer a holistic perspective to the innovation processes as well as evidence of correlations between specific innovations and their effectiveness on financial impact.

Supervisor: Maria Yang
Title: Professor of Mechanical Engineering

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Chapter 1: INTRODUCTION

What is the secret to successful innovation? Every industry needs to innovate. Design firms are hired to discover hidden insights into human behavior and novel products. Fortune 500s invest millions into R&D efforts. Startups are formed on the back of dreams of being the next Google or Facebook. Educational institutions fund lengthy research in labs to discover and build new technology. Yet these efforts are high risk. There are countless failed innovation projects, with a small few that are applied in industry and even fewer that return value on the investment. 9 out of 10 startups fail within the first 2 years. Patents lay filed away for eternity, never collecting a single licensing check. Yet institutions and companies place high priority on innovation and throw massive amounts of resources at these efforts. They believe they have the recipe for success. Y-Combinator has rules for picking and training successful startups out of an endless pool. IDEO has a process distilled down and repeated for creating new innovations in a variety of industries. Talented startup founders don't leave 6-figure jobs without some plan for making their dreams real. Are there simple hacks that can reframe a problem or repurpose a solution to create massive impact? Do we have to nurture innovative cultures, where people are encouraged to think freely? Are some people born or made more innovative than others? How does one know something will succeed or fail before they make their first dollar or sign on their first user? The winners know something the rest do not. I intend to define and study the factors that drive innovation.

High-impact innovation is often a product of not one, but multiple factors working in tangent to create drastic outcomes. For this reason, this study and synthesis will take a high-level look at all the factors involved in creating innovation. Oftentimes a great design or solution is criticized for not producing great outcomes, which is likely due to factors within the greater scope of the project that are overlooked. Oftentimes it is not the solution itself that is critical, but how it functions within the context of the project, company, or the larger environment of the world. It is hard to determine the validity of any individual component without considering the other factors that drive innovation. However, there are also too many factors that lead to success, so it is critical to isolate innovation from externalities and look purely at the process and outcome. By looking at the individual projects and the institutions that have backed them, we hope to gain a better understanding and definition of innovation factors. We can also look at parallel innovation efforts and isolate specific factors that may have contributed to the final outcome.

Chapter 2: DEFINITIONS

2.1 Innovation

Innovation is the creation of value through novel problem solving. For the sake of this paper, we will refer to the more popular design innovation process of “research, prototype, test” and the variations of this framework. We will expand this definition to include not just the process, but the people, discoveries, and outcomes related to the process.

2.2 Outcome

The result of the discussed innovation process that ultimately yields value or solves a problem. The outcome can be measured by improved performance in the form of increased profits through performance, better experiences or ratings, increased efficiency or reduced time. The outcome can take the form of a product, service, or system that yields these increased performances. The outcome is the final result of the innovation project.

2.3 Discovery

A piece of novel information. An insight that is of uncommon knowledge that was previously undocumented. “Problem discoveries” redefine or uncover a need that was previously hidden or unidentified. Latent needs are often masked or poorly described, which can lead to a potential unknown problem to be solved. “Solution discoveries” take form in a new piece of technology or inventions that, when applied to an existing problem, can create a greater positive impact.

2.4 Process

The actions performed by the team members of a project to create the discoveries and outcomes of an innovation project. Oftentimes firms employ a process that is consistent across varying problems or projects they tackle. The innovation process referred to in this paper is the popular “research, build, evaluate” framework. Innovation processes are specifically designed to approach complex problems and discover new solutions to a problem.

2.5 People

The person or people working on an innovation project. Innovation teams consist of multiple people collaborating on a problem. Teams consist of innovation drivers who

work on uncertain problems as well as executors who perform tasks that are well established. These people have specific characteristics that influence their behavior that makes them more conducive to producing innovations. The characteristics could be a result of their training, environment, upbringing, or worldview. Certain relationships and cultures can also be conducive to innovation, where putting people in a collective can inspire one another to perform better or be more innovative.

Chapter 3: INNOVATION MODULES

Innovation is a function of multiple factors that lead to specific outcomes and impact. It is important to study innovation holistically to better understand the relationships the factors have on one another. It is also important to take an outcome-driven approach, as this is the final metric of whether an innovation project was successful or not. By reverse engineering an innovation project, we can understand what the pre-determining factors were that led to the desired outcome and isolate the root factors that led to its success. But first, it is important to define what factors need to be looked at.

3.1 Outcomes

Innovation is intended to ultimately produce a solution that is exceptionally better than its predecessor. The outcome of a successful innovation is several times better than the existing incumbent knowledge. Incremental innovation exists which generates a marginally improved outcome, but could be considered less of an innovation. Different outcomes are often interlinked and interchangeable, so creating positive impact in one will likely ripple to others.

3.1.1 Acquiring and Preserving Resources

Physical, informational, and financial resources fuel development and a higher quality of life. By increasing our access to natural resources over time, we can build more things and accomplish more activities without fear of depletion. Innovations that can more effectively collect resources or sustain limited resources on our planet lead to lasting fuel. In *10 Types of Innovation, Larry* Keeley mentions sustainability as a result of “product performance innovations” that reduces harm to the environment and preserves its future resources (2013, ch. 7). Financial resources fuel business development and human resources. The ultimate business goal is to increase the profitability of a business. This can be achieved through increasing or decreasing certain financial metrics. Increasing the revenue of a company means more money is coming in, but decreasing business costs would also improve the bottom line. Keeley also mentions the profit model, which is described as a form of innovation that can convert a firm’s offerings into cash (2013, ch. 3). Information increases productivity and the value of someone’s time. Discoveries are made off of the back of past information. “Big Data” is working to collect all of the information of the world. Google has made information sources accessible to the masses.

3.1.2 Gaining Time

Reducing the amount of time it takes to accomplish a task or goal translates into savings for overhead and more productivity within a set amount of time. The more advanced the task, the greater the relative savings due to the amount/level of human expertise otherwise required. Keeley mentions “process innovations” as a way to enable companies to function efficiently and adapt quickly, creating time saving outcomes to business success (2013, ch. 6). Many enterprise software and machine learning applications are intended to automate tasks and replace human hours with machine hours. We can also increase the lifespan of a human through better health innovations that extend our longevity.

3.1.3 Improving Quality of Life

Happiness, productivity, and human performance help us make more with the time and resources we have. Improving the overall emotional quality of performing a task or undergoing an experience offers more happiness over a set amount of time. An innovation that makes people happier is rewarded with their time and money. OXO products are a good example of an ergonomic innovation, improving the quality of experience when cooking (Keeley, 2013, ch. 7). Productivity is an essential part of how people measure the value of their time. Through access to better education, people may increase what they can accomplish in a set amount of time. Health innovations lead to a healthier population and overall improvement in mental and physical performance. Emotional quality of life comes from building empathy that is geared towards fulfilling emotional needs.

3.2 Discovery

Discoveries are novel insights that are applied to existing scenarios that produce the desired outcome. Problem discoveries underline a previously unknown issue that, if resolved, could create positive impact. Solution discoveries invent a new technology or apply a previously existing technology in a novel way. The MIT Innovation Initiative often bundles the idea of problem and solution together when referencing innovation work. (source: innovation.mit.edu)

3.2.1 Problem

The most important problems the modern world faces are ill-defined and nebulous. Problem discoveries require deep user research to uncover needs that have previously been ill-defined. The design process laid out by many design practitioners involves a step to uncover problem insights. Vijay Kumar outlines the mindset of

“looking for problems and needs” as a series of questions on what the problems are with a current situation (Kumar, 2013, ch. 3). In *Product Design and Development,* Chapter 5 is dedicated to emphasizing the importance of “latent needs” as problems or needs that are unserved by existing solutions and not widely recognized by customers. Problem discoveries lead to innovative solutions by uncovering problems previously hidden and undersolved. Problems may have existed for a long time that could still be potentially innovated on and resolved more-for instance, humans still face the problem of infectious diseases leading to global pandemics. Other problems are newly created, as a result of introducing a new piece of technology. The introduction of the internet, for example, has led to a slew of cybercrimes that cause financial damage and privacy breaches for the masses.

3.2.2 Solution

Solutions are the inventions and creations we make to address known problems or newly uncovered problems. Novel solutions are a result of building a new piece of technology or taking existing solutions or technology and applying them in a new context. Solution discoveries are often categorized into three disciplines. First, business structures, such as the ten types Keeley mentions, include the new profit model or organization structure which generates more financial value. A second variant includes designs that focus on integrating problems and solutions in novel ways, such as the OXO grip, which applies an ergonomic form to the problem of arthritis. The final category encompasses technological discoveries derived from deep academic research or company R&D efforts. Solution innovations are only valuable if they can be applied to a real problem.

3.3 Process

The innovation process includes the journey from initiating an innovation project to the final conclusion of the project. The result is either a discovery that moves onto creating great impact or a failure which will not yield a positive impact at a worthwhile cost. The steps, actions, and ideation that innovators go through to ultimately achieve their goal Requires use of a good process which may yield multiple, comprehensive, and high-quality research insights and prototypes which may be evaluated for impact. The evaluation structure must also align with the goals of the project, informed by sound research that can yield early and accurate indications for the future success of a potential discovery.

3.3.1 Research

Research is the act of acquiring information at various levels of accessibility. The process of collecting information could take the form of preexisting easily accessible information that could be found through a simple online search or secondary research. This information can also be original research with an experimental design, an original question, and where the researcher applies a novel process to answer the question. In order to efficiently research, having a good question to research is critical. The question acts as a goal for how research is conducted and what kind of information is relevant. Research also serves as a way to audit the competitive environment and make the researcher aware of what already exists and not waste resources researching a subject which has already been studied thoroughly. Kumar describes outlining the process of framing context through various research methods (Kumar, 2013, ch. 2). Broad open discovery has also been associated with successful innovation. Looking at fringe areas that were previously unexplored or being receptive to the unexpected leads to novel discovery.

3.3.2 Build

The process of creation requires attempts to produce a solution, as well as the execution of a plan or design. Prototyping is a classic building process, where innovators attempt to solve a problem through a new mechanism, experience, or organizational or financial model. Prototypes live in the context of experiments and tie directly into the evaluation process. Prototypes present potential answers to critical questions within the design and innovation process. The execution can be physical, digital, or managerial. Steven Eppinger defines prototypes as “an approximation of the product along one or more dimensions of interest” (Eppinger, 2016, p. 293). For the sake of my paper, I expand the definition from one product to all solutions. The execution of prototypes requires technical skills within whichever medium in which the desired prototype or solution takes form. Mechanical engineering or industrial design skills are necessary for creating physical prototypes. Coding skills are necessary for digital prototypes. Managerial and organizational skills are necessary for creating operational prototypes. As the project progresses, the fidelity of prototypes should increase; specifically, the amount of resources and fine detail should increase. This allows for fast/general features in the early stage and slow/detailed features later. In Maria Yang’s study, the data indicates that designers who build things early on in the process tend to do better, with the recommendation of “prototyping cheaply and early in the process”(Yang, 2013).

3.3.3 Evaluation

Innovation processes require a way to measure progress and the performance of one discovery over another. Pre-existing evaluation systems are applied to a project context or created through the process itself. An example of a pre-existing evaluation system would be HCI heuristics, where sufficient research has been conducted on user behavior and an understanding of what design features are good or bad are established and applied to a new context (https://www.nngroup.com/). Some evaluation systems are built through research, such as the needs finding process. As the project proceeds, potential solutions can be tested through an experiment using the newly created evaluation system to measure their performance. Heuristics provide an efficient means to evaluate potential solutions, as experiments and extensive testing can be costly. Certain evaluation processes are more suitable at certain project levels, just as how the fidelity of prototypes is low in the beginning and increases as the project progresses. Yang's study suggests designers perform better when they evaluate with users both in the early and later stages of the design process, conducting both low and high fidelity tests (Yang, 2013). Roger Martin describes evaluation granularity as a spectrum or "knowledge funnel," where evaluation systems are more defined and specific the more a space is analyzed (Martin, 2009, ch. 1). Evaluation systems are critical to the innovation process because they determine what efforts should continue and what should stop, so as to more efficiently allocate resources and improve designs.

3.4 People

Innovation is driven by people and some people are more suitable for creating innovation in specific scenarios than others. Sometimes it's the lone visionary that drives innovation. Sometimes there are teams that create powerful innovation synergies that cannot be delivered by any individual. Certain characteristics people have outlined by innovation thinkers and in the paper make them suitable for a specific innovation project. Much of the literature on design thinking often talks about behavioral traits as well as processes to increase innovation success.

3.4.1 Experience

Domain expertise comes from extensive experience within a specific professional or academic field. Professional expertise is derived from working within a specific role or industry leading to an accumulation of knowledge specific to that industry or job. Process expertise comes from experience performing tasks or solving problems effectively. Academic expertise comes from extensive time studying and researching a discipline. They may focus on a niche subgroup of a discipline and become an expert in

that niche or have a broad knowledge base of the field as a whole. The pre-existing experience of individuals brings fluency in certain processes. A software engineer may be well-versed in coding languages and can develop an application quickly. A product designer may be skilled at sketching and can produce interesting product concepts rapidly. Managers may have strong communication skills and know how to deal with people in a productive and effective way. Wai Fong Boh outlines his research results in 3M showing that specific skills and expertise of employees are more valuable in specific contexts (Boh, 2013). These skills are developed through practice and intentional learning and are hard to supplement without the right people. It is important to understand the background and experience of a team member when engaging in innovation.

3.4.2 Personality

Many factors go into influencing a person's personality traits and world view. These are developed throughout a person's life and are a product of their upbringing, culture, and people they spend their time with. Personality affects how good someone is at performing certain tasks and undergoing a process. The innovation process requires specific personality characteristics that can help them survive and thrive within the innovation environment. An individual's personality may make them more conducive to pursue riskier, bolder ideas that lead to great innovations. It can also make someone a great collaborator and more willing to accept ideas that seem unfamiliar. Looking back on famous innovators such as Steve Jobs and Elon Musk, there are certainly common personal features that we can extrapolate. They are notorious for being polarizing, eccentric, and workaholic. Throughout her book, Francesca Gino illustrates certain personality traits various leaders have when facing challenges that require an innovative approach (Gino, 2018).

3.5 Culture & Organization

Innovation is generally done in teams, and evidence suggests that working in well synergized teams yields more successful innovation than working alone. Culture can change the personality and behavior of people. People's untapped potential can be accessed and used to drive innovation. However, broken cultures can also cause people to recede and stop their expressiveness. Creativity and risk taking can be stifled. Team members could contend with one another for selfish reasons. I have identified a handful of cultural characteristics for innovation.

- Outward looking and open to discovery: Exploration leads to greater potential for novel discoveries. Being curious and receptive to new ideas allows for people to

succeed. Innovation cultures should encourage exploration and open-mindedness.

- Cross-disciplinary or industry: Innovation is often the product of combining multiple pre-existing concepts. Having experts of different domains and industries crossbreed ideas is often the key to great breakthroughs. Innovation cultures should encourage collaboration.
- Risk taking: Innovation is highly uncertain and there is no guarantee of success. People have to be willing to take chances and face potential failure. The culture should encourage risk taking behavior.
- Creative and generative: Innovation is fueled by ideas that are effective and unique. Different ideas can often be scrutinized and hard to express. The culture needs to nurture this.
- Executing ideas: Ideas need follow-through in order to survive. Strong execution ensures the ideas see the light of day and can thrive in the way they promise. Good execution cultures encourage accountability to ideas and ensure people follow through.
- Innovate everywhere with everyone: Innovation should not be constrained, there should be no area off limits and no people excluded. Having an inclusive culture means it is accessible to anyone who wishes to participate in the process.

(Source: Keeley 2013, ch. 21).

3.6 Innovation Module Map

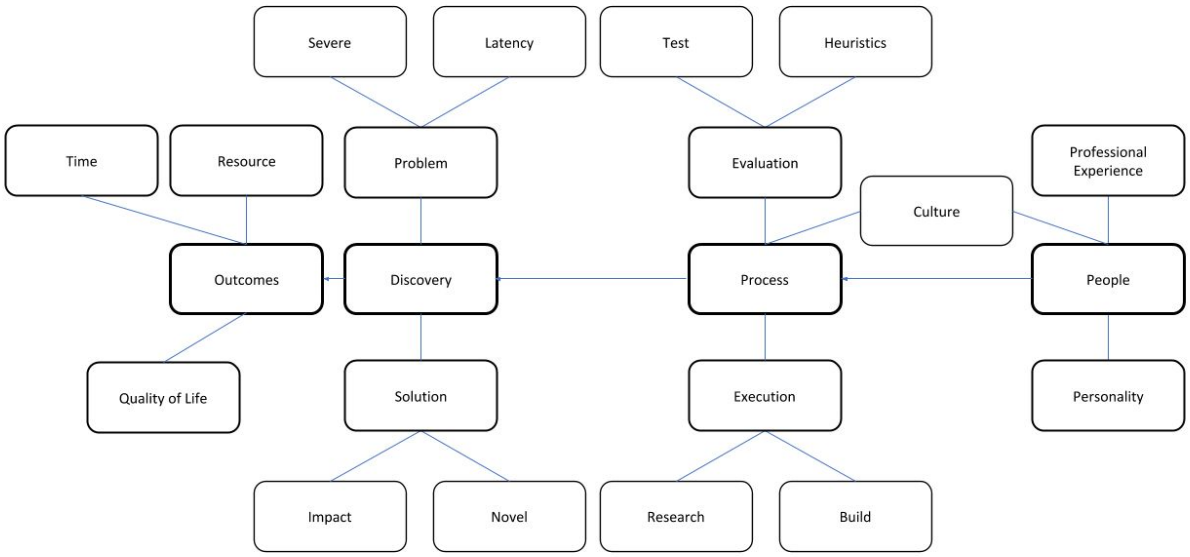


Figure 1: Innovation Module Map.

The Innovation Module Map is an original framework designed by me to illustrate the relationship between the different modules previously discussed. It visualizes the flow of the factors, starting from the people engaging in the innovation activity and ending with the outcome of the innovation. The intention is to use this framework to analyze the innovation structure with certain projects and institutions. Ideally, each module can have specific factors associated with it, such as a team member with the right expertise, or a process that is conducive to the type of discovery. The analysis can offer a positive score for each appropriate factor. Negative scores can be given to factors that do not align with the type of outcome that is desired or a missing component in the earlier stages. With possibly more testing, the framework can have a more accurate quantitative scoring system.

A possible application of the Innovation Module Map is to function as a planning framework for innovation leaders or groups to set up their innovation systems. When a new innovation project is about to begin, this can be used to determine the desired innovation factors to be used to generate the desired outcome from the innovation. The goal is to allow the innovation project to have the optimal setup before starting.

How to Use:

1. Determine the desired outcomes of the innovation project.
2. Decide on potential discoveries that generate the outcomes.
3. Brainstorm processes that would be conducive to the desired discoveries.
4. Determine the type of people best suited for undergoing these processes.
5. Describe what kind of culture you want to encourage within the team.

When I posed this exercise to a fellow graduate student, we generated a quick example on the spot to illustrate how this framework could be used. For the sake of illustrating the use of the framework, I will now describe the example using the steps provided.

Example Project: Developing a Better Battery

1. Desired outcomes:
    a. Cheaper cost
    b. Better value from performance
2. Potential Discoveries:
    a. New chemical composition for better performance
    b. New solid materials for better performance and manufacturing
    c. New manufacturing process
3. Ideal Processes:
    a. Research within specific chemical and material properties
    b. Experimentation with specific chemical and materials
    c. Research & prototyping within battery manufacturing processes
4. Types of People:
    a. Chemical researchers & engineers
    b. Material scientists
    c. Manufacturing & supply chain experts
    d. Lab technicians
    e. Factory managers
5. Culture:
    a. Outward looking and learning
    b. Making and experimentation

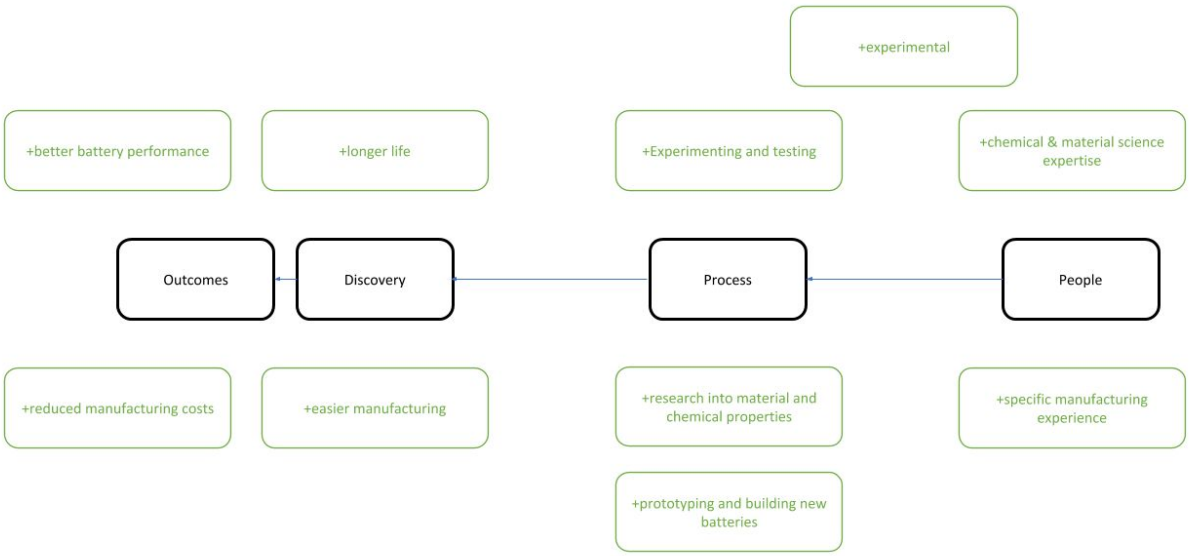


Figure 2: Example Battery Innovation Module Map

The benefit of the map in this usage is that the user can ideate systems that consider the broader innovation factors and how each factor relates to one another. This way, they can be more intentional and prioritize which factors to seek out for their desired outcomes. By analyzing the sample map, we can see various positive scoring factors that would increase the likelihood of generating successful innovation and desired outcomes. As the innovation project is being set up, the leaders of the group can look out for these factors and attempt to incorporate them into the project.

Another potential use case for the map is as an analysis and evaluation tool for past innovation projects to analyze all the factors that contributed to the outcome that was produced from the project. We can consider the people participating in the project, the processes they underwent, the discoveries they made, and the outcomes those discoveries led to, as well as the culture of the team. Ideally, there can be a quantitative scoring system for the user to score what factors contributed or detract from the final outcome. Throughout the remainder of the paper, I have inserted innovation module maps as an analysis for various innovation projects and institutions in an attempt to break down the innovation factors in these groups.

There are many caveats to this framework, and I would recommend extensive testing before applying it to serious projects. The framework has not been thoroughly tested with users and may give an inaccurate evaluation to various innovation projects. It may be difficult to give a good evaluation without a full set of metrics within an

innovation project. Projects in progress may also struggle to find the framework useful, since they have not made all their discoveries or seen the outcomes of their efforts. The framework also does not take into consideration resource access, which is a large factor in the success of innovation. I would encourage anyone interested in trying to use the framework, adjust it to suit their needs, and provide feedback for the improvement of the framework.

Chapter 4: INNOVATION WITHIN INSTITUTIONS

4.1 MIT Innovation Initiative

MITii is a collective that focuses on bringing together all of the innovation and entrepreneurial resources available to students at MIT. They help connect students to all of the innovation infrastructure available to students at MIT. They help students acquire both physical and human infrastructure for creating impact.

Their formula is idea + function = impact. They hope to serve as the function that can bring ideas into impact. They plan on achieving this through offering infrastructure for data, physical, human, training, policy, and exe services. They are also working on compiling a list of MIT offerings they call “Building Blocks.” The plan is to help students interested in an innovation and entrepreneurship track, and to allow them to piece together the building blocks to form a function that can turn their ideas into an impactful venture. They call this track a “pathway” where the student can select a combination of MIT programs, external programs, classes, student groups, and MIT competitions. They also provide a network of like-minded people that they can work together on entrepreneurial projects. They will also manage the new Innovation hub, a 7-story building dedicated to various MIT innovation and entrepreneurship activities. Finally, they offer human infrastructure in their Proto Ventures Program. A partner defines the problem space they need help with from MIT. A “Venture Builder" is hired to find new opportunities inside MIT. The Venture Builder prototypes problems and solutions and advances the problems with the most promising solutions. The idea is then subject to de-risking through technical and market analysis and are worked on by Venture Fellows. The venture is then independently launched.

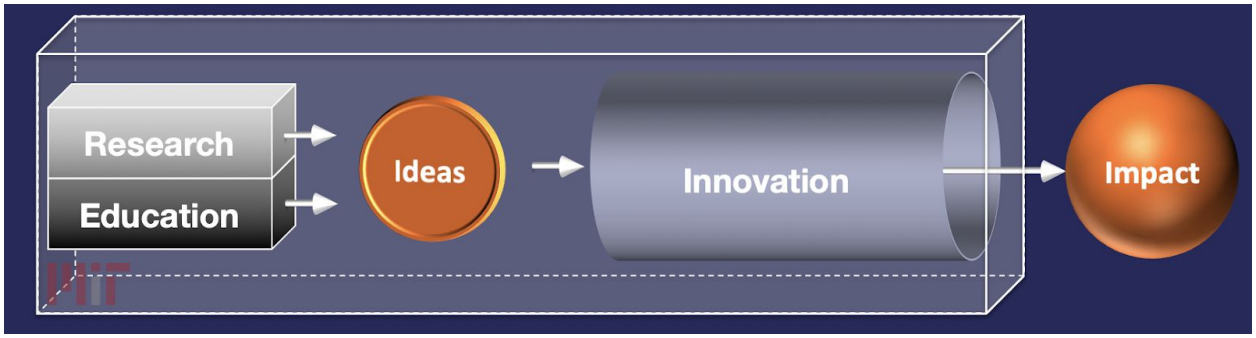


Figure 3: Imagining MIT’s Innovation Black Box.

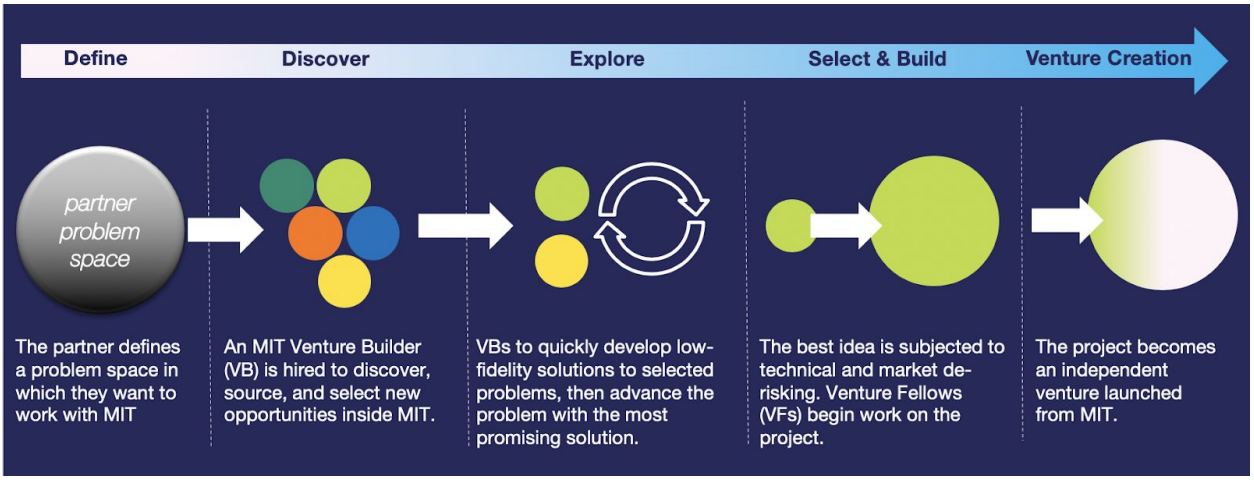


Figure 4: Protoventures process.

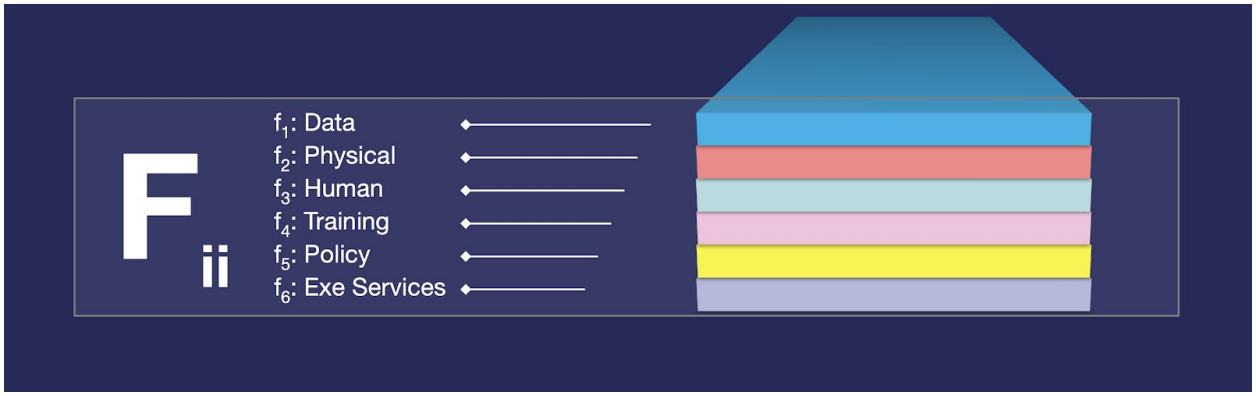


Figure 5:MITii Innovation Infrastructure Function.

	Object Name	User	Topics	Resources Provided
52	Design for America (DFA)	Graduate Postdoc Undergraduate Alumni	Arts/Design Hardware	Events/Networking Project Funds/Fellowships Mentoring Project
53	MIT Food & Agriculture Club	Graduate Postdoc Undergraduate Alumni	Water/Food	Advising Events/Networking Mentoring Hackathon/Ideation Sess
54	Hacking Arts	Graduate Postdoc Undergraduate Alumni	Arts/Design	Events/Networking Mentoring Hackathon/Ideation Sessions Stud
	MIT Electronics Research Society (MITERS)	Graduate Postdoc Undergraduate	Hardware	Makerspaces Student Club Skills Workshops
56	Marine Robotics Team	Graduate Postdoc Undergraduate	Hardware	Advising Project Funds/Fellowships Projects to Join Student Clu
57	MIT Robotics Team	Graduate Postdoc Undergraduate	Hardware	Projects to Join Student Club
58	MIT Entrepreneurs Hub	Graduate Postdoc Undergraduate	Broad-based	Projects to Join Student Club
59	MIT Formula SAE Team (FSAE)	Graduate Postdoc Undergraduate Alumni	Hardware	Advising Mentoring Projects to Join Student Club
60	MIT FinTech	Graduate Postdoc Undergraduate Alumni	Financial	Events/Networking Student Club
61	MIT Sloan Education Club	Graduate	Broad-based Education	Events/Networking Student Club Prize Competitions
62	Graduate Student Council	Graduate	Broad-based	Events/Networking Skills Workshops Career Exploration
63	MIT Postdoctoral Association (PDA)	Postdoc	Broad-based	Events/Networking Skills Workshops Career Exploration
64	Incube	Graduate Postdoc Undergraduate	Broad-based	Events/Networking Projects to Join Hackathon/Ideation Sessions
65	MIT Biotech Group	Graduate Postdoc Undergraduate Alumni	Life Sciences/Health	Events/Networking Student Club Recruiting Career Exploration
66	Energy for Human Development (e4Dev)	Graduate Postdoc Undergraduate Alumni	International Developm...	Events/Networking Projects to Join Student Club Career Explora
67	Engineers Without Borders	Graduate Undergraduate	International Developm...	Projects to Join Student Club

Figure 6: Data infrastructure - Building Blocks.
(Source: Lauren Tyger, MIT Innovation Initiative)

The MITii framework supports several elements of previously discussed innovation factors. The supply of a diverse selection of programs and courses allows innovators to undergo an iterative and educational process and mature their ideas, find collaborators, and expose themselves to multiple perspectives. The physical infrastructure brings people together and creates a culture and community of innovation. Their Proto Ventures program takes on a unified process of problem and solution discovery that is de-risked before launch. Their approach is tailored both to discovering novel insights in problem domains as well as solution domains, and define “idea” as a match between problem and solution. They take an impact focused approach as well, focusing on not just the process, but on real successful outcomes such as profitable ventures. The MITii is a fair reflection of the greater MIT innovation ecosystem, as it links together many of the already available resources and programs and works to bring a unified approach to innovation. In the following section, we will reference the MITii framework as a representation of the greater MIT innovation framework.

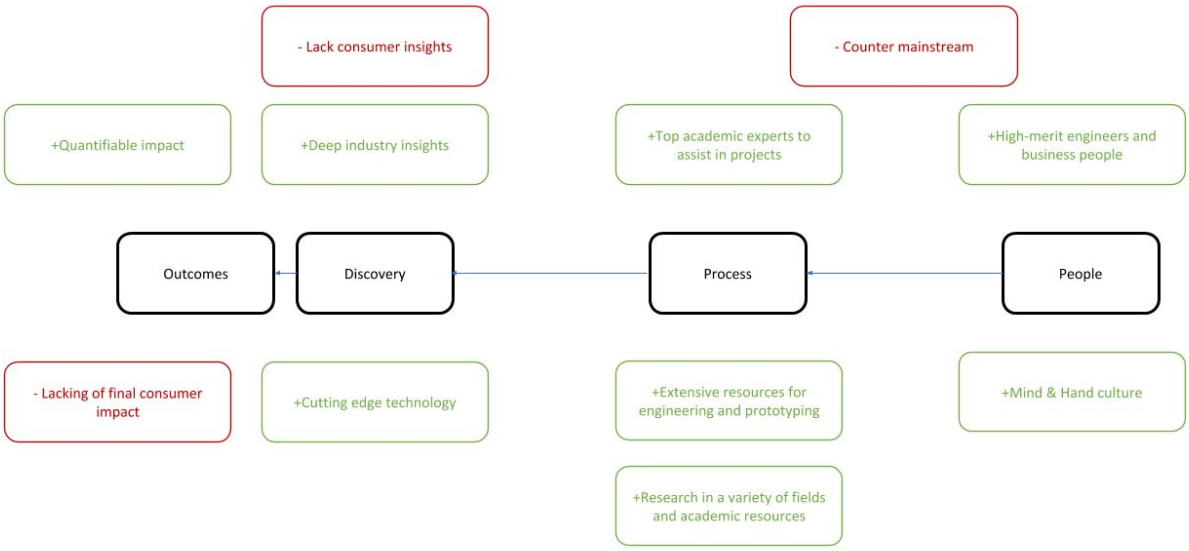


Figure 7: Innovation Module Map - MIT.

If we were to analyze the Innovation Modules for the MIT innovation ecosystem, we can see what types of impact and innovations come out of the institution and how the ecosystems support those innovations. Starting with people, much of the innovation resources are allocated exclusively to MIT students. In order to attend MIT, students go through a competitive and rigorous application process, no matter what school or

program they attend. It is fair to say that all students bring a level of excellence and expertise, with a desire to explore technology. MIT emulates a unique culture of “mind and hand,” emphasising the balance of academic research and executing ideas. Through coursework and academic resources, students are prescribed a specific process that balances evaluation, research, and build. By working at the forefront of research and technology, students uncover many industry insights previously out of reach, or new technology that has never been invented. The nature of technological innovation and industry insight is that it leads to enterprise impact that is often required to be quantifiable. However, this is not conducive to consumer impact, which can be harder to quantify and may be of a more intuitive nature. The MIT ecosystem often leans more towards industry applications rather than consumer insights and perception. The sales class “15.387, Entrepreneurial Sales” only covers cases of enterprise sales and talks little about consumer sales. As a result of being more industry focused, MIT innovation outcomes tend to be less consumer facing and more enterprise specific.

4.1.1 MIT Case: Secure AI Labs

Secure AI Labs is a MIT startup aimed at allowing researchers to access health data that would normally be unavailable due to privacy laws such as HIPAA and GDPR. The founders consist of a diverse group of experts from different backgrounds around MIT. The former CTO was a masters student from course 6.7 - Computational Biology, who had researched the technological premise of the company while at MIT. The former CEO was a masters student at the Sloan School of Management with a background in biomedical engineering. The final two co-founders include a PhD from Harvard Medical School and PhD in EECS working out of the Stata Center at MIT. The team’s hybrid mix of technical expertise and entrepreneurial engineering experience made them a strong candidate for the technology-heavy and industry-specific venture.

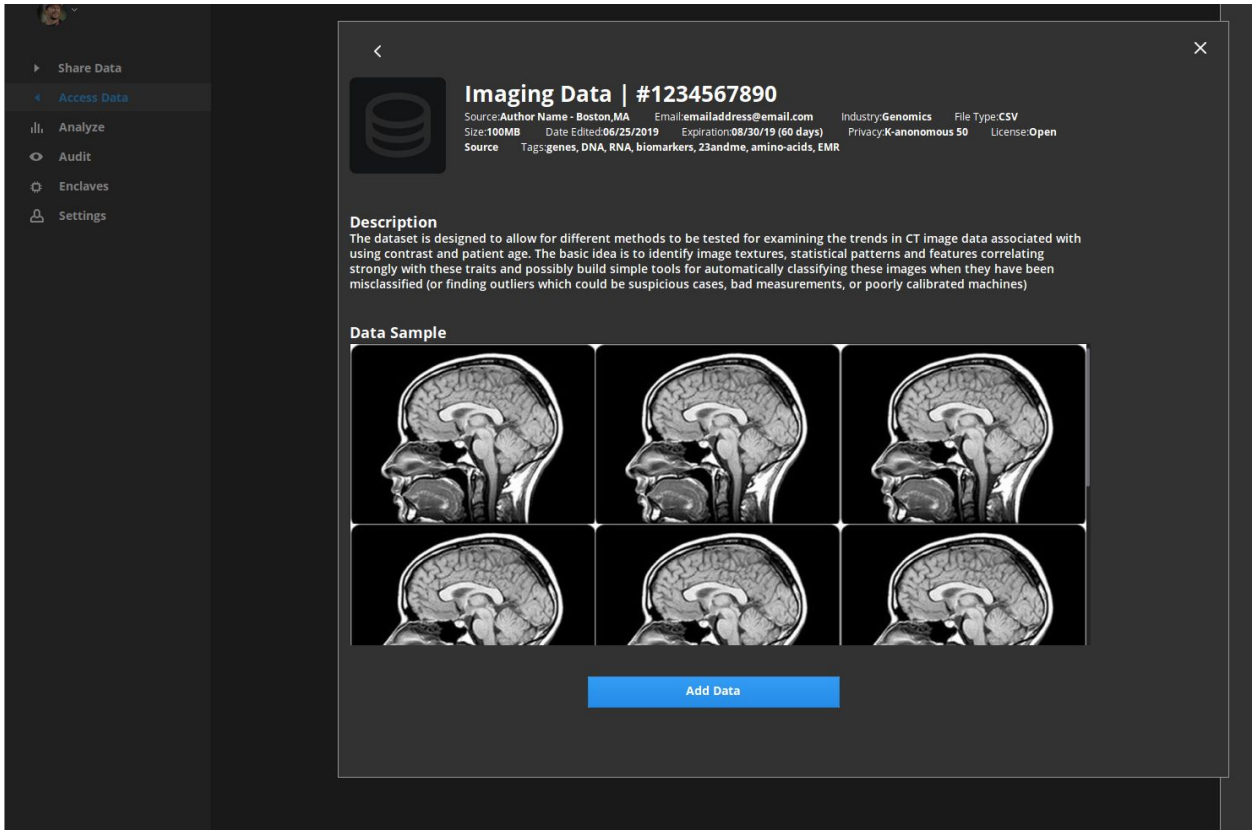


Figure 8: Product screenshot from website.
(Source: https://secureailabs.com/)

They followed the traditional MIT innovation framework, taking a research-driven approach and attempting to bridge a theoretical concept into an applicable venture. They had gone through the Delta V Accelerator program and learned about the entrepreneurial process of talking to customers and iterating on an offering. They had a suite of advisors in business and technology to guide and evaluate them through the process.

The type of discoveries they were able to make also fit into the MIT innovation profile, focusing on an industry specific problem within the field of computational biology and the technological discovery of integrating blockchain and federated learning. However, they struggled to make discoveries within the end customer and hone down on a specific use case and market to enter. They would be approached by customers not in their target market. They weren't able to fully layout the landscape of stakeholders they needed to satisfy to close a sale.

They have been operating for over 3 years now and haven't yet found significant customer traction. They were able to create a functioning product that delivered on what it promised, but haven't yet found the customer and market they need to be viable. As a

result, they will likely need to move towards a licensing model, rather than capturing the full market value of the end customer.

There are many similar cases coming out of MIT's entrepreneurship ecosystem. Innovators are technologically- and industry-centric, and are able to discover novel insights from those areas. However, there is a lack of customer discoveries compared to technological discoveries that are key to scaling their ideas and making greater impacts. MIT has lately implemented a lot of programs to encourage a more customer and human-centric approach to innovation. Combined with existing technological expertise, resources, and culture, MIT could build a far more impactful innovation ecosystem.

4.2 RISD Industrial Design

RISD has been consistently one of the top-ranking art and design universities in the world, with infamy within the design community. Undergraduate students must claim their majors the second semester of their first years, and switching majors is notoriously difficult, requiring extra credits and years of schooling to complete a degree. Industrial Design is the second most popular major to study, behind Illustration. In order to receive a BFA in Industrial Design from RISD, a student must complete foundational studies which includes coursework in drawing, design, and spatial dynamics. The foundation year is notoriously rigorous, with 8-hour classes and weekly assignments that can take just as long to complete. Upon entering the Industrial Design Program, students must then undergo a year of Design Principles, which focuses on the foundations of industrial design. Within Design Principles, students undergo a foundational drawing section, learning about 2-point perspective and how to draw 3-dimensional objects from imagination. They also undergo the human-centered design process which involves interviewing users and designing a new product. After a year of Design Principles, students may choose various coursework to take, but must balance technical making courses such as Wood 1 and Solidworks with strategic and innovation courses such as Design for Impact or Disruptive Creativity. On top of taking design courses, RISD students must continue to take liberal arts and social science courses that follow a more traditional academic setting and structure. (Source: https://www.risd.edu/academics/)

4.2.1 Outcomes

The mission of the Industrial Design Program is to "bring value to companies, communities, and citizens" through the creation of "objects, products, and systems that make everyday lives easier." The outcomes they hope their students will leave in the world are outcomes of quality of life. Better experiences means greater happiness from the users of the products RISD ID graduates will design. An easier experience may also

save time for the end user and a well manufactured product may also save resources. RISD ID has always been grounded in industry impact, with much of their teaching staff coming from industry backgrounds with many years of design experience. They emphasize how design is done in a professional setting and how to be the most impactful designer in any group. The school is also highly entrepreneurial, encouraging students to create their own impact, rather than relying on opportunities from others. The program is designed to produce people who will go out into the world and make an experiential impact. (Source: https://www.risd.edu/academics/industrial-design/)

4.2.2 Discoveries

The discoveries the ID students make take form in both the designs they produce and the problems they uncover through the design process. Since this is strictly a design program, the problems students focus on uncovering are human problems around the experience of a product or system. They may also uncover problems of the mechanical nature, such as how to assemble a certain product or how will the manufacturing of the product be resolved. Design students will deliver highly finished concepts that address the minute details of the experience which will naturally uncover latent problems within the construction process. When generating solutions in the form of products and experiences, they will look back at the problems that have uncovered through research and use that as a frame of reference for impact. Novelty and creativity is also an important factor to them when creating new designs. Often the more original the design, the more praise the designer receives, even if the craft or details are not as well constructed. No design student produces the same outcome and goes through the same experience as their problems and objectives differ within the same project. However, they subscribe to the same process and culture that is unique to RISD.

4.2.3 Process

Throughout the RISD training, we are embedded with a universal design process that can be applied to any prompt or design challenge. Through the years of critique and lessons, we are imbued with a set of heuristics that we follow when no users are available to critique. “Form follows function,” was something that my Design Principle teacher echoed to me, encouraging us to prioritize the utility of the product before the aesthetics. “Work smart, not hard,” was another classic adage, encouraging us to be strategic with our efforts and not waste time. On top of these broad heuristics, we develop a natural sense of right and wrong through critiques. If we did something and got a good critique, we would allocate that as a correct action heuristic. If we received a bad critique due to a poorly conceived detail in our final presentation, we would know to improve that aspect next time. This was a form of iterative learning through trial and

error. The critique is a unique component of a design education that trains students to both give and take criticism and feedback. This trains the receiver of criticism to be more aware of their design's impact out in the world, but also breaks down the ego and removes emotional attachment to their work. Giving feedback is another important exercise in analysis and evaluation through critical thinking. A good designer must also be able to identify potential improvements in existing designs as well as executing those design improvements.

The balance of knowledge acquisition and execution is also emphasised in the RISD ID curriculum. As part of their degree requirement, RISD students must balance a certain number of courses in workshop and critical design thinking. Workshop requirements may include skills using the metal shop or designing packaging. Workshop courses focus on technical execution and the craft of the final result. Critical thinking courses require more readings and understanding of design theory. Students must also produce designs, but are evaluated more on concept than craft. On top of coursework that is project based, students must balance that with classroom courses in Design History or art Literature, building upon their academic skills. A RISD ID graduates with capabilities in a variety of research from reading academic publications, researching mechanisms and processes, to primary market research and business research. They also leave with a wide range of technical skills from physical shop skills in woodworking, metalsmithing, to digital tools such as the Adobe Suite and CAD programs. It is through this balanced process of research and building are ID grads capable of discovering novel and important problems and solutions.

4.2.4 Culture

The RISD culture is defined by hard work and creativity. Art students generally have a quality of eccentricity and no boundaries. The RISD sports mascot is Scrotie, the penis. There are no rules when it comes to the outcome of an artist or designer, only in the process to arrive there. RISD students tend to be cultured and are up to date on current events and trends. RISD also has a culture of criticism, where students are not shy about voicing their opinions. This can often be misconstrued as rudeness or harshness to a non-RISD person who is used to the façade of niceness in normal human interactions. RISD students work hard. Foundation year is notoriously demanding and requires long hours in the studio to produce high-quality work. It's normal for students to return to the studio to work on projects after class or a quick dinner break at home.

Team projects are quite common in the RISD ID curriculum. It is important for students to know how to collaborate and work together to produce a single body of work. The only issue is that their skill sets often overlap because they receive the same training. However, tasks are usually divided up so that students will not overlap with one

another within certain aspects of the design. Through this co-design process, teams are able to produce more complete designs vs. something fragmented and incomplete as individuals.

4.2.5 People

Before entering RISD, students must go through a competitive and rigorous application process. The RISD application requires the same materials as a typical liberal arts college such as good grades, test scores, and essays. However, RISD also requires students to submit a portfolio and take-home assignments in the form of the infamous bike drawing. If you want to go to RISD, you have better start preparing early on. By the time a student is ready to apply for RISD, they will need to have produced a body of work that is of high-quality craft and unique. For my RISD application, I had produced 3 years of ceramics work focusing on functional ceramics series. My art teacher helped me photograph them in a semi-professional setting and produced high-resolution digital images. I had also spent several hours working over the details of 3 24x36 inch drawings using pencil. These assignments on top of my general application was a significant workload that didn't happen overnight. This form of preparation pre-selects certain types of people to go to RISD. They must be dedicated from an early age in the art and design field in order to produce a body of work good enough to attend the school. They must be hardworking in order to put in the extra hours to produce a quality application drawing. And once they are accepted into RISD, they must make the committed decision to pursue art and design. There are limited options of viable majors at RISD, and they make you choose early. It's hard to speculate what circumstances produce a RISD student. To be successful at art and design at a young age requires great support from family and a committed time investment from an early age to develop those skills in craft and creativity. Passion is important as it produces the motivation to do well in art and design.

4.2.6 RISD Case: Hello Velocity & msft

Viral internet creation Bitelabs is a fake business where artisanal meats are grown in a lab from celebrity DNA. Visitors of their website are meant to believe they could purchase deli meats made from the cloned cells of James Franco, Taylor Swift, and Kanye West. The project was meant as a commentary on how we "consume" celebrity media and potential future applications for lab-grown meats. Hello Velocity is comprised of 3 RISD-Brown class of 2015 dual degree students. The creators conceived of this idea after attending a talk at Brown Universities about lab grown meats. The creators of this meme are part of a group known as Hello Velocity, a media group that creates cultural commentary through ironic products and businesses. They take a contrarian approach to their ideas, using Slack to play games or making a

typeface out of the logos of companies. They now hold several cease-and-desist orders, including one from the McDonald's corporation. Their skill sets come from a unique education that sits between academic and artistic. They attribute their critical methods to their art training at RISD, where critique is a critical part of the artistic practice. However, their brown education brings the intelligence to their projects, allowing for more meta concepts. The 3 friends are a team of their own, but attempt to find powerful synergy with msft by accessing their experience in major media companies such as Buzzfeed. HV provides the process of creative critique while msft provide cultural expertise.

This is an example of the type of impact RISD graduates produce. Through their training, they have been instilled with the innovation process and culture which allow them to consistently produce impactful projects that become viral and provocative.

(Source: Kevin Weisner, Hello Velocity & msft member)

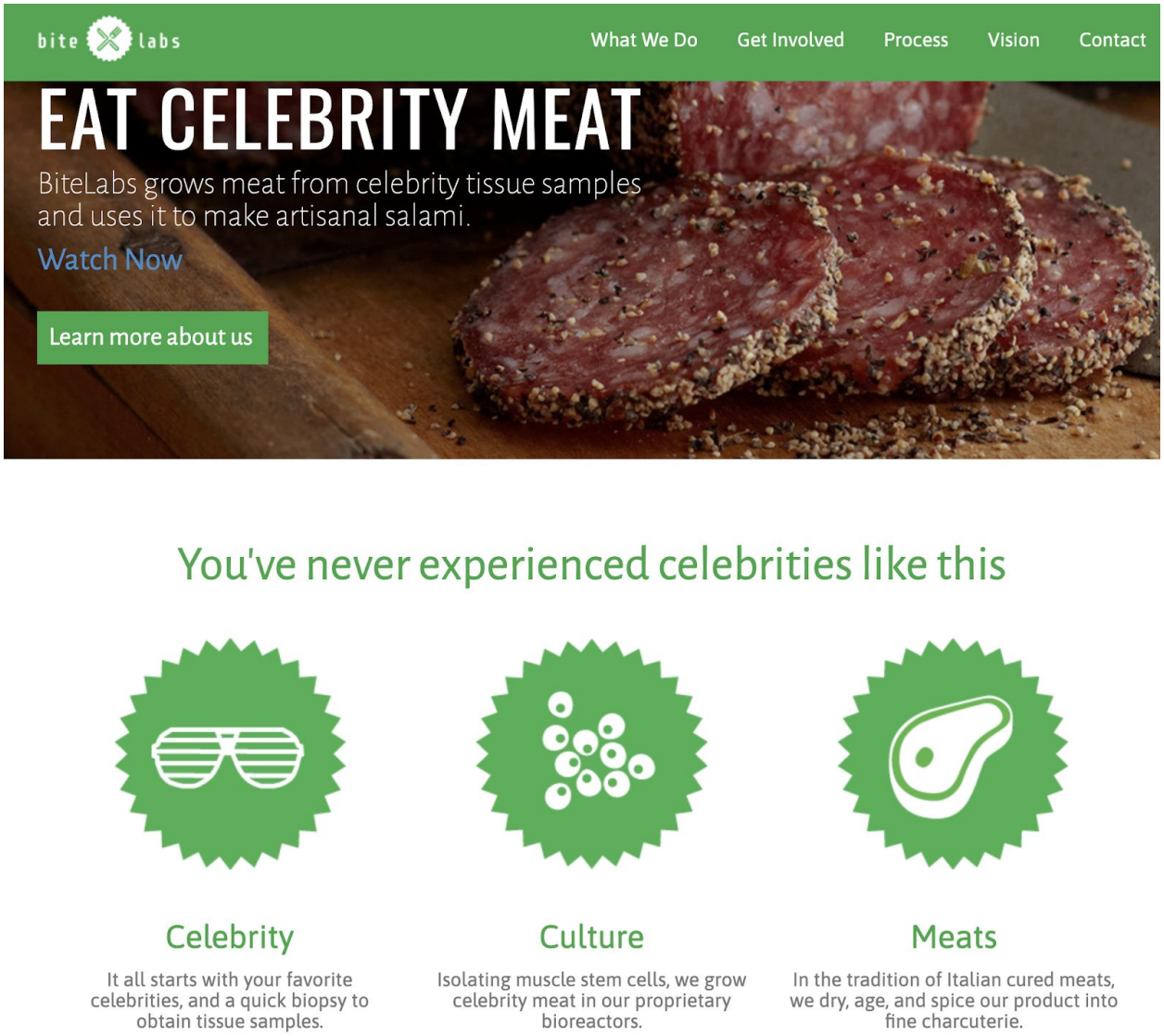


Figure 9: Bitelabs Home Page.
Source: bitelabs.org

Understanding the background of the group, we can extrapolate characteristics of their innovation group. We know the type of technical skills and cultural characteristics they bring to the table. As both RISD and Brown students, they bring strong design and aesthetic skills to the table while having critical thinking skills that add the “smart” element to their smart critique. They follow a creative process that includes blue-sky generative thinking and heuristics to quickly identify potentially viral ideas. The discoveries and outcomes are specific for the type of process and background they bring, but lack the financial outcomes they desire.

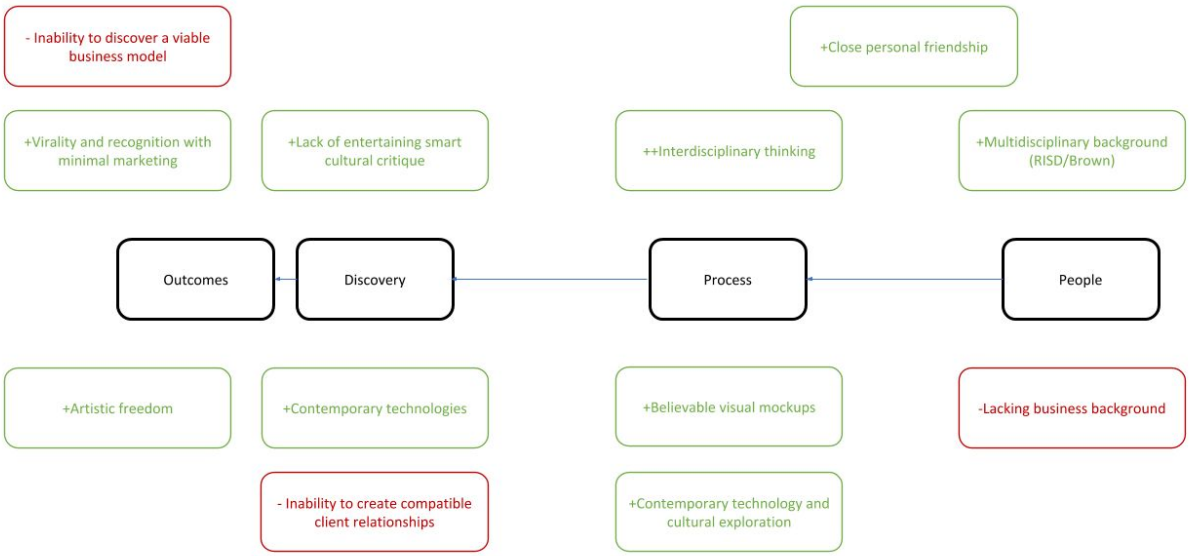


Figure 10: Innovation Module Map - Hello Velocity

4.3 Integrated Design and Management

IDM is a master's program at MIT. Started in 2015, the program aims to train students in an integrated design approach to product design and problem solving. Every year, they train a small cohort of students who go onto work for innovative companies as well as start their own ventures. (Source: https://idm.mit.edu/id-lab/)

4.3.1 People

They attract and admit students of a broad background, from finance and sales, to product and UI/UX design, to mechanical and software engineering. The program is grounded in professional practices and requires students to have deep experience in various professional disciplines. Students are required to have a minimal 3-year work experience. This is to ensure they have sufficient professional exposure and know how to work in an industry environment. Additionally, they have to produce a portfolio of past projects. The portfolios are evaluated on process and beauty to ensure that students are capable of producing tangible solutions. In addition to professional and academic experience, the program vets students on their emotional intelligence and empathetic abilities. The program director interviews all candidates for these attributes personally. In addition to having a diverse student body, IDM has a diverse faculty. The program director and technical instructor have design backgrounds, with many years of technical

design experience. Lecturers who teach at the Sloan School of Management come in to talk about strategy and business principles in the context of product businesses. They have extensive experience working with MBA students as well as ventures outside of MIT. The studio instructor studied mechanical and electrical engineering at MIT and Stanford and has extensive work experience bringing products through production and manufacturing.

4.3.2 Culture

IDM culture deviates from the greater MIT engineering focused culture. There is a strong emphasis in real-world action learning and design intuition. Students are encouraged not to care about grades at all, instead focusing on the outcomes of projects and learning experiences. There is a heavy emphasis on interpersonal skills, where students are encouraged to work in teams of people they are unfamiliar with and with very different backgrounds. There is also an emphasis on the guerilla entrepreneurial attitude; to ask for forgiveness over asking for permission. Students have to decide their own approaches and paths to their projects and solving problems. No two students have the same experience and can tailor their education and efforts to what they feel is priority. When conducting user research, students undergo a design research approach around fast and casual interviews and observations with users. They are encouraged not to wait for materials to arrive, but to go out now and build things as soon as possible. There is also an emphasis on social impact. Many of the students have a strong sense of do-good, tackling issues of sustainability, ethics, and development.

4.3.3 Process

Although every student chooses to tackle different projects and problems, they follow the same framework of design. The first project is a human centered research project. Students are all given the same high-level prompt of “carrying things” or “travel”. The second project is about a holistic entrepreneurial design process. Students must design, manufacture, and sell a minimum of 50 units of a product. The second semester project allows students to work through the entire semester on self-proposed prompts and problems. At the end, it culminates in a final design presentation. The students follow the cyclical design process of propose, research, ideate, prototype, test, and present.

Students primarily engage in primary human research where they must find target users to interview and observe. However, many of the projects require additional research in a broad range of formats. They may conduct surveying to gather targeted primary data from more people. Secondary research into articles and other information

pertaining to their subject. Technical research into materials and mechanisms for product components. Process research into different methods to execute a task.

Building things is a core component of their process. Projects require a broad range of prototyping fidelities for addressing various questions. There is a workshop component to the core class centered around technical making skills that students can take and apply to their bigger projects. Students learn how to work with foam, renshape, wood, plastics, and other hand model making processes. They also learn introductions to design programs such as Illustrator and 3D CAD as well as programming electronics. Final prototypes can be high-fidelity and students can put a lot of work into making the outcome professional grade. The 50 units project is making intensive, where students usually personally hand make all of their units. Students roughly spend up to an additional 20 hours a week on the project outside of class.

Although the projects students tackle are different and have different specific goals and solutions, they follow the same evaluation framework applied by the teaching staff. The evaluation framework used in IDM is “DFV(desirability, feasibility, viability)”. Desirability rates how good of a user experience does the product have. Does the product provide great emotional value? Is it beautiful and attractive? Does it solve a human problem? Feasibility addresses the ease of executing the product. Can it be manufactured? How easy is it to make? How easy is it to be executed? Will it be expensive or cheap? Viability addresses the financial success of the venture. Could this product be profitably made and sold? Is it sustainable? Is it scalable? These factors compound with one another. Desirable products are easily sold at a higher price. Easy to manufacture products are cheaper to make. Desirable products are a result of a well-conceived manufacturing process. Students are evaluated at high touch throughout the course with a lot of one-on-one time with teaching staff. Instructors and Tas alike review student’s projects and offer feedback and ideas to improve the direction. Every case is treated uniquely with the same lens of DFV.

4.3.4 Discovery

The output of IDM projects are often novel and reviewed to be highly impactful if taken forward. From the research process, students are very likely able to acquire a baseline expertise on certain subjects and problem domains. Through their primary research and observation methods, they are able to uncover novel insights and latent needs from the users they study. From my own project one research, I was able to shadow a group of scuba divers and uncover a latent need that the divers themselves did not express. When observing divers as they entered the water, they could not walk with fins in the sand and had to put on fins in the water with difficulty. This insight led to the design of an expandible fin that could be worn on shore and deployed easily in the water.

Through the prototyping process from workshop skills they learn and strategic knowledge from lectures, they are also able to create novel solutions to address the problems they face. Students are equipped to generate a broad range of ideas and build experiments to address the validity of a particular solution. Past solution discoveries include a marketing campaign to encourage less screen time, a pizza box engineered to preserve heat and crispness, and a therapy pod designed for hospital waiting rooms. Because students are equipped with making skills and strategic frameworks, they are consistently able to generate novel solutions to problems.

4.3.5 Outcome

The program is relatively new, but there has been evidence of significant impactful projects out of the program. Due to the entrepreneurial and experiential emphasis of the program, students join highly innovative companies after graduating such as Nest or IDEO, or start their own ventures, gaining traction and creating impact. Due to the diverse nature of the program, the ideas that come out have broad aspects. Businesses and roles that come out integrate elements of technology, business strategy, and human-centered design. One IDMer went onto work for Nest as an experience designer, helping them design innovative experiences for their tech products. Another IDMer started her own skincare product that utilized machine learning to recommend products. Because of the generalist nature of the program, they tend not to produce outcomes that are niche as a result of deep knowledge within an industry. Most of the outcomes are a result of combining multiple factors to create something novel, creating broad impact as opposed to a greater impact in a specific area.

Chapter 5: INNOVATION CHARACTERISTICS AND BEHAVIORS

Although industries and disciplines differ, there are several common practices innovators undergo no matter what they are working on. These characteristics have been identified by investors and entrepreneurs as key characteristics for successful innovation. These characteristics are behavioral and could be generally applied to a wide range of industries, disciplines, and projects.

5.1 Risk Managing

The process of taking calculated risks is critical for maximizing the success of a project. De-risking can take the form of testing the waters before diving in or passing the risk onto parties that are more tolerant to large losses. Cheap and fast tests are common in many industries. In design, whether it is a logo, product, or wireframe, they

start as quick sketches with little investment from the designer, tested at an early stage. In the MIT class, IDS.333, we learned about the process of de-risking by building flexible systems that can be adapted in the future to capture the most potential value. Innovators need to be willing to take on more risk than average people if they are to create game-changing impact. Often the relationship of maximum success potential is inversely related to maximum potential failure. Because the risk is so great, it is especially important for innovators to understand and manage these risks. Thiel makes the argument that even startup success should not be considered a gamble, emphasising the importance of understanding the risks being taken (Thiel, 2014, ch. 6).

5.2 Novel Seeking

Something needs to be different, whether it is in the process, model, or people involved in the innovation project. When an innovation is different, the impact is greater relative to its competitors and incumbent solutions. Different isn't always better, but the same is never better. The innovation can either be exceptionally effective, cheap, or attention grabbing so long as it is exceptional in some way. Design processes are also designed to create unique innovations. Design research is about uncovering the source of problems and latent needs that even the user does not know he has. Ideation is about exhausting all possible solutions to uncover the most obscure solution no one else has thought of. Gino shares multiple examples of leaders taking a novel seeking attitude that potentially lead to innovations down the line (Gino, 2018, p. 199). It is not just a professional practice, by an attitude or cultural spirit that is organic. Having a contrarian attitude can give innovators the ability to look at the world in a counterintuitive way leads to more innovation. Peter Thiel once said that the best ideas sound bad on the surface but are really good and rooted in hidden problems (Thiel, 2014). This mindset helps innovators go where none other dare go, and mine new innovations. Contrarianism is used to create disruptive products and businesses, producing things that incumbents cannot due to being counter to their main value proposition. The process of contrarianism is about taking something that exists in the world and thinking "what if I did the opposite of what I am supposed to do."

5.3 Personally Motivated

Having a personal stake in a project can motivate innovators to succeed beyond the traditional money and fame. Oftentimes innovations are spurred from inspirations of problems faced within a person's life. Think of the countless Shark Tank stories about products stemming from personal problems. A woman's lack of vitamin D led her to start a sun lamp company. Personal experiences can allow innovators to have a deeper understanding of the problem and stronger empathy towards the people who

experience it. Although that one person is not the full population, the personal motivation can plant the seed to start the journey towards successful innovation. Often that one person needs to have sufficient business training and network to make it happen. However, when all else is equal, a personal motivation can give an innovator a competitive edge.

5.4 Deep Expertise

Much of innovation is derivative of deep research into a specific field. Domain expertise comes from extensive experience within a field that has built up more knowledge in the field than other people working within the field. Many research-based innovations come from academics who have focused heavily in a specific field and explore the margins for potentially unresearched areas to learn and discover from. This is related to personal innovations where individuals who have personal experiences within a field understand the space and problem better than others. There are also process experts, who have gone through a process many times and have learned the nuances through experience of a particular process. Interviews with 3M revealed that many roles and positions required specialization to make them sufficient at solving problems for their job (Boh, Evaristo, Ouderkirk, 2013).

5.5 Adaptable

The innovation process is unpredictable. Startups face the toughest question of pivoting or persevering (Reis, 2011, ch. 8). Pivoting allows people to try something different if their current method is not working. Does the innovation team's ability to adjust rapidly and decisively lead to a greater chance of successful innovation? Or does the lack of focus and commitment to a single path lead to all ideas feeling before they are properly validated? The bigger opportunity innovators face does not change, but the problems they uncover and attempts at solving these problems do. Usually it takes multiple attempts and iterations to create a solution that was appealing enough to convince customers to buy or switch from an existing solution to the new one. This preparedness to change allows certain innovators to perform better in the long run.

5.6 Learning

It is often said the most important skill an innovator can have is the ability to learn. The ability to acquire knowledge and skills in subjects previously unknown allows innovators to make connections between previously unconnected ideas. The process of research within innovation is critical for learning about problems as well as solutions. Learning about processes is also critical for executing successful research projects, prototypes, and frameworks. Certain people are more conducive to learning, such as

people who are open minded, curious, and have a broad exposure to the world. A broad perspective makes them more receptive to innovative ideas and processes. Learning should not be purely for specific tasks or processes, but also exploratory. Gino's 5th principle of rebel leadership advises us to learn everything and forget everything; emphasising the balance of understanding fundamentals and rethinking old methods (Gino, 2018, p. 206). Having a breadth of information and understanding the basics can lead to novel discoveries and cross disciplinary learnings.

5.7 Conflict Tolerant

Oftentimes ideas are unhardened and perform poorly when they enter a real-world application. Sufficient conflict and critical systems need to be put in place in order to test ideas and processes. Teams either prioritize the comfort and civility of the team dynamic and will avoid conflict. Through criticism by people who think differently can an idea be tested at an early stage and improvements and iterations to the idea can be implemented. Top performing teams often have teams of differently minded people who are willing to argue and challenge one another. There may be interpersonal conflict, however the results are often better than of teams who avoided conflict. Gino provides another example of President Kennedy's response to the Cuban Missile Crisis, detailing how he looked for disagreement from his advisors (Gino, 2018, p. 201). Conflict generates multiple perspectives and helps look at a problem from a more complete picture. Innovation is often a product of very different disciplines integrating to form new ideas and processes. A single innovation within any particular discipline may not succeed alone. A technological innovation needs design innovation to make it useful to people and business innovation to commercialize it. Innovations in different fields can compound the effects of the other, making each other more impactful. These synergies are created by people of different expertise collaborating and coordinating with one another.

Innovation is often a product of very different disciplines integrating to form new ideas and processes. A single innovation within any particular discipline may not succeed alone. A technological innovation needs design innovation to make it useful to people and business innovation to commercialize it. Innovations in different fields can compound the effects of the other, making each other more impactful. These synergies are created by people of different expertise collaborating and coordinating with one another. However, diverse teams generate more conflict and the ability to survive the conflict leads to capturing the benefits of conflict.

Chapter 6: IDM KITCHEN PROJECT STUDY

6.1 Introduction

The IDM 50 units project is an assignment given to teams of 3 students with 1 from each cohort (business, design, engineering) where the teams have to design, produce, and sell a minimum of 50 units of a product. The overall goal of the project is to get a good grade, generate a profit, and have a positive experience. The performance of each team is heavily monitored, from their early research to their final financial outcomes. This makes this project a prime candidate for studying innovation and performance within a business context. I identify the teams that perform the best in a variety of categories (net profit, margins, time, number of sales) and identify the factors that led to that exceptional performance. 100% of the projects are profitable by the end of the project and some extend beyond the semester.

Figure 11: Shot Drop, product designed, manufactured, and sold for the project. (Source: https://kevinyudesign.com/shotdrop)

6.2 The Study

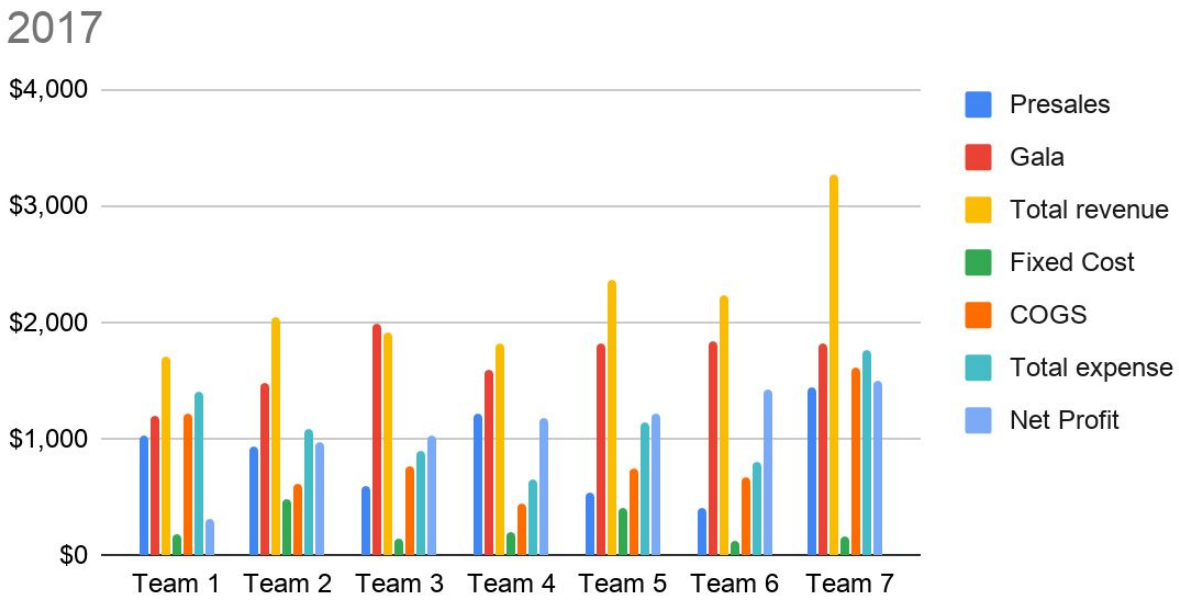
The goal of the study on the IDM Kitchen Project was to identify specific innovation characteristics that lead to more impactful outcomes. The project is unique in the sense that teams are under very similar conditions in that they have the same deadlines and time allocation, same number team members, and have to take on a

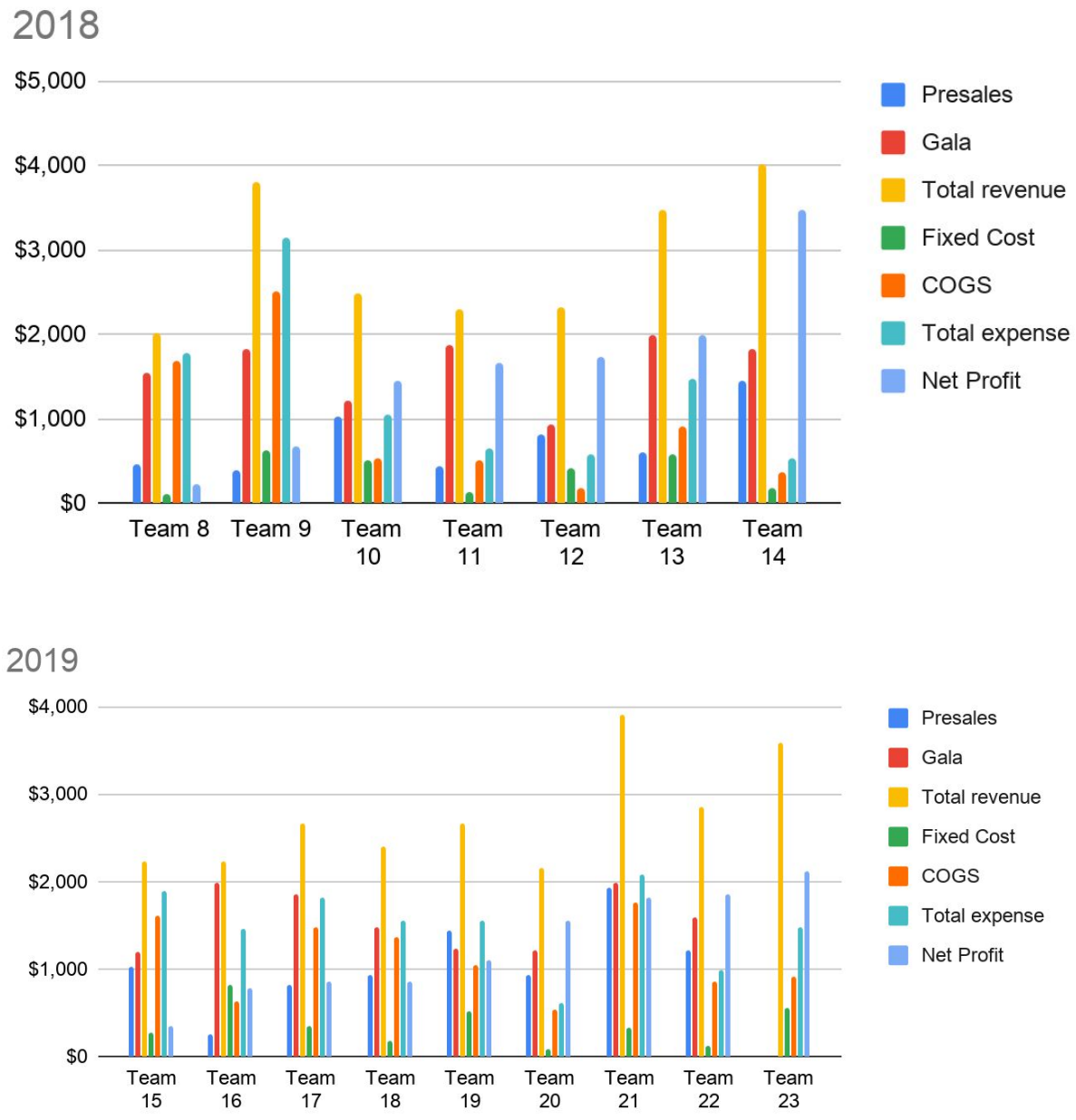
similar capital risk. They have similar goals; to work to generate the most profit, receive a good grade, work efficiently, and have a good experience. This allows us to discount interfering factors such as industry, time, and available resources, and study behavioral characteristics that lead to more profit.

The method I employed was a combination of collecting existing financial data from the IDM teaching team, surveying students who have undergone the project, referencing observations as a participant and TA of fellow students who have undergone the project, and interviewing key students about their experiences. The cumulative data could potentially lead to correlations between certain innovation characteristics and certain project outcomes.

6.2.1 Financial Data

The financial data was the driving data of the study, as it is the only source of information I use to measure the impact of teams. Through IDM teaching staff, I was able to source 3 years of financial data from the 2017, 2018, 2019 cohort. The data is a one-time report of total presales, gala sales, fixed costs, COGS, and profit at the end of the project. From the provided data, I have calculated the total revenue, costs, and profit and I have ranked the teams by total profit for each year.





Figures 12-14: Financial results of 3 years of project.

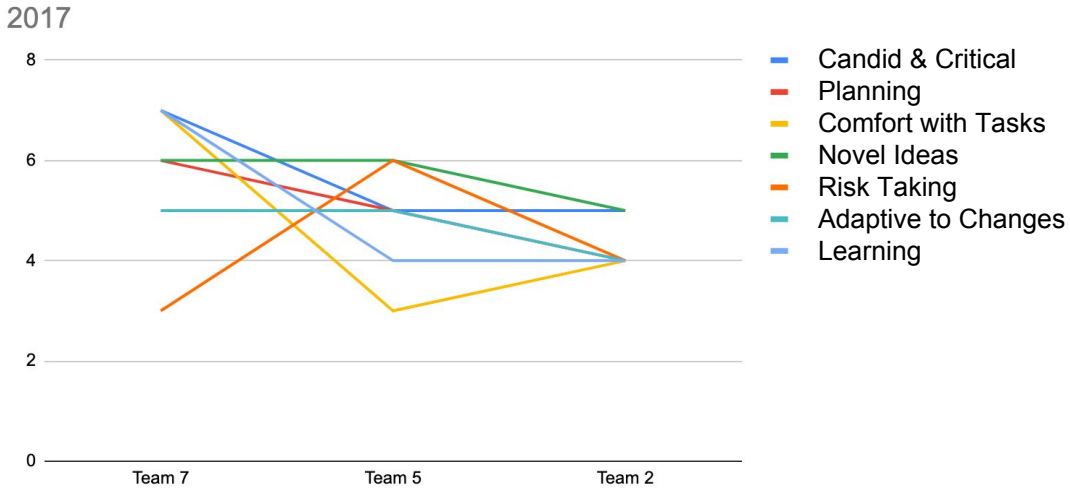
Through the financial data, I was able to rank the teams based on financial outcome. A caveat of the data is that it was self reported by students, who may have made errors or reported inconsistently from one another. This data was also reported at the end of the project, and students may have continued to sell units and generate more profit after the fact.

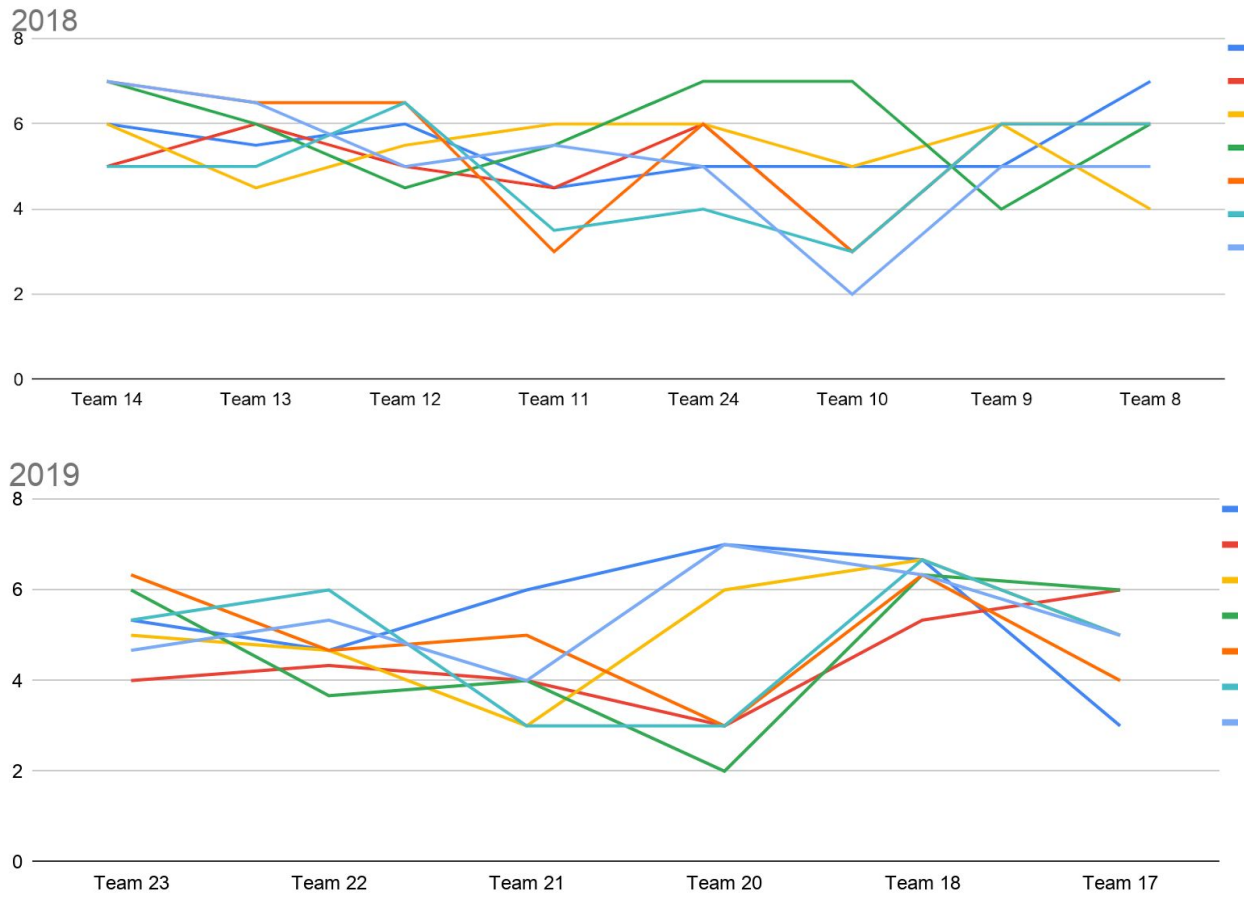
6.2.2 Survey Data

Another source of data was surveyed data about innovation characteristics that were discussed previously. I identified certain characteristics that were more reasonably surveyed such as risk taking, novel, deep experience, adaptability, learning, and conflict. I also wanted to survey for independent factors that could have influenced the financial outcome including average number of hours per team member per week, how time and resources were allocated to design, manufacturing, and sales, as well as sentiment of the project outcome. At least one member of every team has responded to the survey from the 2018 and 2019 cohort. The 2017 cohort was mostly unresponsive and may not produce reliable data due to the amount of time elapsed from their project.

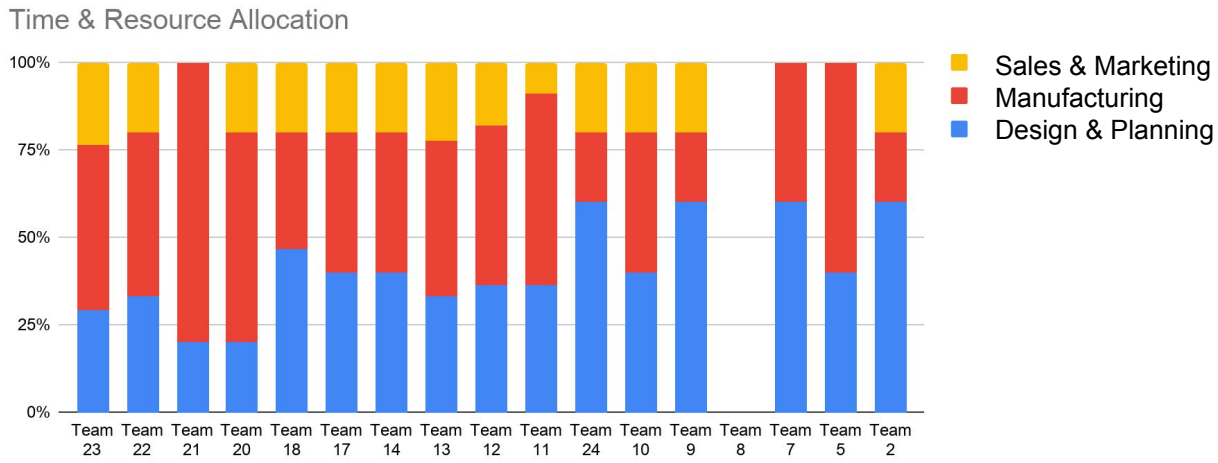
Survey Questions:

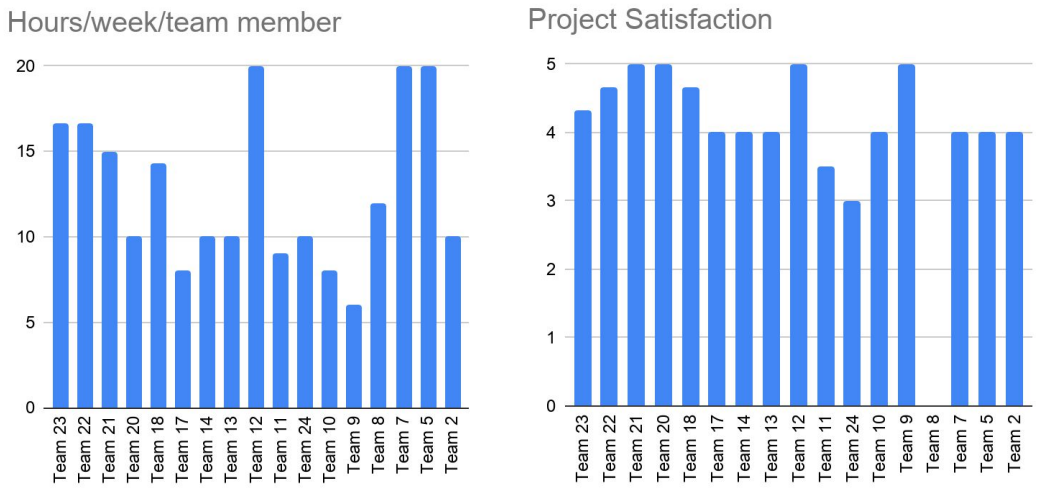
1. What was your team?
2. Roughly on average, how many hours did each team member work on this project per week outside of class?
3. Rate the outcome of your project?
4. What percentage of time and resources was spent on planning & design?
5. What percentage of time and resources was spent on manufacturing?
6. What percentage of time and resources was spent on marketing and sales?
7. Compared to other teams, how candid & critical were your team members with one another?
8. Compared to other teams, how much planning did your team do?
9. Compared to other teams, how comfortable were team members with their tasks?
10. Compared to other teams, how unusual were the ideas generated by your team?
11. Compared to other teams, how many risks did your team take?
12. Compared to other teams, how often did your team adapt to changes?
13. Compared to other teams, how many new things did your team learn?
14. Would you be willing to speak with me(Kevin Yu) in person?
15. Any other comments?





Figures 15-17: Survey results of IDM students questions 7-13.
Note: Teams are ordered from most to least profitable for their cohort.





Figures 18-20: Survey results of IDM students questions 2-6.

The survey showed there was a general pattern of more time being allocated to the project by top performing teams than bottom. However, in the 2018 cohort, the top 2 profitable teams reported to spend less time on the project than the bottom profitable team, suggesting there are significant outside factors leading to profitability other than time. There was also a pattern of successful teams allocating more time to manufacturing than planning and design, while sales and marketing efforts remained consistent across all teams. However, this was also not a direct correlation, which suggests there were other impacting factors. It is unclear if there is correlation between sentiment of the project outcome with the profit outcome.

With the innovation characteristics, it is unclear if there is any correlation with the responses and the actual financial outcomes. There is a slight dip in the middle profiting teams, with low profit and high profit teams reporting the highest scores in their responses. This could indicate the risks of extreme behaviors as something that could potentially yield great results or cause great failure. For example, teams that exhibit greater risk taking behaviors may achieve a novel product or process that gave them an edge in the project. Meanwhile, other teams that took risks experienced failures and had to scrap their designs multiple times. Team that took low risk experienced middle-of-the road outcomes. An alternative cause could also be an indication of Dunning Kruger effect, where less profitable teams may have evaluated their performance higher relative to their peers. The questions are framed with a slight positive connotation, which may bias towards a high rating. Lower performing teams may not have been able to evaluate themselves accurately. There are a few caveats with the study that may have influenced the results. The questions are subjective and open to interpretation. Although asked to compare themselves with other teams, It isn't always clear what

other teams are doing when engaged in the project. Some respondents experienced the project more than 2 years ago and may not have a strong recollection of their experience. Additional iterations of the study may be necessary to address the subjectivity of the study.

6.2.3 Interviews and Observations

In addition to the quantitative data, through personal observations and interviews, I have had a closer in depth look at the path certain teams took. Here are some of the summaries of these observations and interviews for high-performing teams.

Team 14:

This was the top performing team of the 2018 cohort. The team faced several setbacks and red flags throughout the project. A team of 4, faced interpersonal conflict throughout the project. They initially struggled to get consensus on a final product idea, ultimately settling for a simple tray with an aesthetic twist. However, even with a simple product, they struggled to develop a reliable manufacturing process that could produce sales ready trays. Yet, when the final scores were in, they were the most profitable per person team. Despite their conflict and simple product, the team was able to create a massive cost savings advantage over other teams. An ordering error led to the delivery of twice as much sheet metal material as originally ordered. Through persistent negotiation of one team member with past experience working in procurement, they were able to receive this excess material, worth around $1,000, for free. This extra material motivated the team to produce more units and to sell those extra units. They pre sold to restaurants and had flexible pricing to maximize sales, knowing any extra sale was profit. Many of the other teams planned to sell the minimum 50 units and relied on predictable suppliers for materials. By seizing a lucky opportunity presented to them and capturing the upside, they were able to financially outperform all other teams.

When speaking to team members, their goal from the onset was not to perform well financially well, but to make something beautiful that they would be proud of. Their attitude was to “screw HCD” and do what they wanted. There seemed to be one team member who was the most critical and polarizing of the team, who was not afraid to critique other team members on performance such as tardiness. Their personalities were very different. They didn’t plan much and very quickly deviated from their initial Gantt chart. Many details were not fully flushed out. Their roles were formed organically and they each naturally leaned into their strengths. One team member pushed for more novel ideas when others were more pragmatic. Because their team was so divided, they were able to learn a lot from the different perspectives. Though they had done little planning, didn’t follow HCD, and had heavy interpersonal conflict, they were able to seize a golden opportunity and produce the highest amount of profit.

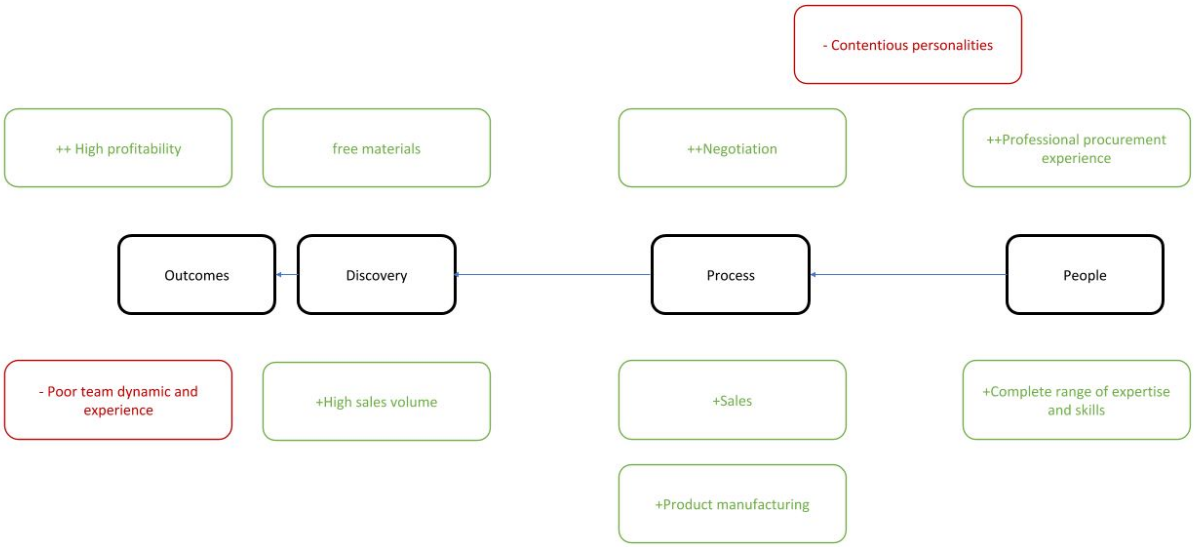


Figure 21: Innovation Module Map - Team 14.

Team 12:

Though a seemingly simple product, they were able to achieve the highest profit margin of the year. Though the product was simple, they were able to use high-quality materials and sell the product at a reasonable price. Yet, despite their low price, they were able to make $32.5 of profit per unit, a %93 profit margin. This was achieved through an innovative sourcing strategy. They were able to find a lumber yard with scrap wood that the lumber yard was unable to sell. They gave the wood to the team for free which would have been the highest material cost to them. Their manufacturing required a combination of gluing, cnc milling, and finishing that was relatively inexpensive. Their supply innovation was able to give them the largest profit margin and perform well. However, because they were driven by low material costs, they spent significantly more time on the project; reportedly twice as much as Team 14.

Team 7:

They were a team of competent makers, two engineers and a product designer with extensive 3D experience. They crafted a beautiful artisanal product that was trendy and premium with a novel component that made it all the more intriguing. The quality and novelty of the product positioned itself for the marketing advantage they were able to receive. They were able to be the top upvoted post in reddit for the craft subreddit group. This allowed them to achieve viral sales and presell their maximum units without

spending much time or resources on marketing and sales. With good manufacturing techniques, they were able to achieve high yield without spending exhaustive hours on manufacturing. They focused on creating a well-organized manufacturing chain and ensured little of their expensive materials went to waste.

Team 23:

This was a team of experienced individuals that were both strategic and creative with their approach to the project. They were able to come up with a product and design very early into the project that was novel, easily manufactured, and beautiful. The design was aesthetically attractive, using natural materials and a bespoke surface finish. The manufacturing only required the assembly of a few off-the-shelf components. This gave them ample time to work out the details of the product, manufacture, and work on sales and marketing for their project. The teaching staff felt strong about their project from the beginning, believing they had satisfied the critical project factors of feasibility, desirability, and viability. There were some conflicts in the later parts of the project between team members. One team member also fell ill in the middle of the project and had to take a week off. However, they were able to easily sell out of their units and generate a lot of revenue and ultimately the highest gross profit.

Chapter 7: CONCLUSION

If you ask someone what innovation is, you will likely get different answers. However, the impact people hope to see is often undisputed. Innovators want to change the world, and in order to do so, must take the right approach to invent the new. Many different factors go into innovation such as the people, the processes, the culture, the discoveries, and the final outcome. There are also external forces that can alter any one of these factors that are sometimes out of the control of the people engaging in innovation. By looking at innovation holistically, we can better understand how each individual component interacts with another and leads to certain outcomes. These factors are often dictated by our thought leaders and educational institutions whose business is to produce innovators and innovations. These factors determine what people engage in innovation, what processes they undergo, what kind of discoveries they make, and ultimately the type of impact they have. Using the innovation module map, we can potentially analyze the individual innovation components to make good strategic decisions when deciding on the structure of the component. This could potentially lead to a more optimal innovation structure and organization.

There are many characteristics and behaviors that are claimed to lead to more innovative outcomes. As a test to these characteristics, we have looked at a school project where students must innovate to generate profit. The students were surveyed for these characteristics and their answers were compared to their financial performance. Due to the subjectivity of the characteristics and setup of the survey, it is inconclusive whether there is a correlation between the characteristics and financial outcome in the context of the project. However, there are insightful cases where certain teams succeeded more than other teams. Hopefully, with more data collection and a more well-structured study, there can be more insights drawn from the innovation project and the innovators who engage in it.

REFERENCES

Larry Keeley, Helen Walters, Ryan Pikkel, Brian Quinn, (2013)
Ten Types of Innovation: The Discipline of Building Breakthroughs
John Wiley & Sons, Book

Francesca Gino, (2018)
Rebel Talent: Why it Pays to Break the Rules at Work and in Life
HarperCollins Publisher, Book

Vijay Kumar, (2013)
101 Design Methods: A Structured Approach for Driving Innovation in Your Organization
John Wiley & Sons, Book

Steven Eppinger, Karl Ulrich, (2016)
Product Design and Development 6th Edition
McGraw-Hill Education, Book

Roger Martin, (2009)
The Design of Business: Why Design Thinking is the Next Competitive Advantage
Roger Martin Publishing, Book

Peter Thiel, (2014)
Zero to One: Notes on Startups or How to Build the Future,
Crown Business Publishing, Book

Eric Reis, (2011)
The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses
Crown Business Publishing, Book

Marisa Dziallas, Knut Blind, (2019)
Innovation Indicators Throughout the Innovation Process: An Extensive Literature Analysis
Technovation 80–81 (2019) 3–29, Article

Wai Fong Boh, Roberto Evaristo, Andrew Ouderkirk (2013)
Balancing Breadth and Depth of Expertise for Innovation: A 3M Story

Nanyang Technological University, Nanyang Business School, Article

Maria C. Yang, Anders Häggman, Tomonori Honda, (2013)
The Influence of Timing and Exploratory Prototyping and Other Activities in Design Projects
IDETC/CIE 2013, Article