THE DEVELOPMENT OF OPEN INNOVATION NETWORKS AT WPI AND THE AUS

An Interactive Qualifying Project

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"Being right keeps you in place. Being wrong forces you to explore." - Steven Johnson

The Development of Open Innovation Networks at WPI and AUS

An Interactive Qualifying Project Proposal
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by
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Abstract

The goal of our project was to propose the development of an interactive open innovation portal to allow academic institutions like WPI and the American University of Sharjah to become more involved in open collaboration efforts with other corporations, universities, and the community. In order to successfully achieve our goal, our team interviewed various organizations involved in open innovation to understand the many responsibilities, challenges and methods they face. Our team also submitted a survey to students to gauge the knowledge pool of open innovation at each institution. The interviews and survey provided essential data and uncovered suggestions to assist in the development and implementation of an open innovation network prototype at various institutions. The designed portal prototype will create a platform for corporations and universities to connect and collaborate efficiently while improving online project experiences, increasing student open collaboration involvement, and assist student-lead startups by incorporating external collaboration.

Acknowledgements

Our team would like to thank the many interviewees, faculty and individuals who were willing to volunteer their time and expertise for the success of the project. In particular, we would like to thank our project sponsor, Arthur Foutsitzis from Honeywell, for providing us with the opportunity to work on this project. Our project would not have been possible without his guidance and expertise in the world of open innovation. He was pivotal in providing us with information, contacts and feedback on our rapidly developing project. We would also like to acknowledge our brilliant advisor, Professor Joseph Doiron, for his continual support, ideas and motivation to fully investigate the potential of our project. Finally, we would like to thank our fellow AUS and B-Term UAE IQP students, Akcunya Chanchal, Mohamad Al Najar, and Hassan Khan, whose feedback, support, and shared experiences inspired us to develop and present the best possible project.

We would also like to express our gratitude to all of the interviewees, organizations, and individuals who helped set up interviews for the case studies, including Matt Colgan from Spring Theory, Reggie Ramos from the MBTA, and Eric Batista from the City of Worcester Office of Urban Innovation. Each of these organizations provided our team a better understanding of open innovation networks and shared any information they could to help the team construct our open innovation portal prototype. A special thanks to Dr. Curtis Abel for giving us the opportunity to interview him on the innovation and entrepreneurship efforts and resources at WPI. His ideas and examples of current resources have provided us with crucial information and feedback on the portal. Similarly, we would like to thank the WPI and AUS students that took the time to fill out our survey as their input and data were very helpful for the completion of the project.

Executive Summary

Background

The word “innovation” is commonly attributed to a collection of various processes that occur in today’s economy. Companies or other organizations develop a new technology or idea and begin trying to sell it to customers in order to compete in specific markets. There are several different types of models innovation may follow, including the “Linear Model”, which follows technologies as they grow from a research concept to a marketable technology along a linear path. Additionally, the “Silicon Valley Model” is a label used on technologies that go through rapid design and release periods along the cutting edge of technology. Traditionally, innovation was performed in silos: companies used their own R&D departments and their own intellectual properties to compete in the market.

Open innovation (OI) is a different model of innovation in which companies or organizations developing a product do not operate strictly within company walls. While both closed and open models of innovation each have their drawbacks and benefits, OI allows for access to a greater pool of knowledge and possible shortened development times through the use of external R&D and shared proprietary assets. Different forms of intellectual property, such as patented designs or technologies, may be carefully shared among different collaborative partners working on an openly innovated project and can be thought of as the currency of open innovation.

Multiple collaborators participating in OI endeavours may be referred to collectively as an “open innovation network.” These networks can include several types of organizations as participants, ranging from large and small companies alike to academia and government departments. They may work in different combinations to produce new projects or products. The goal of our project is to create a prototype that could be used at both Worcester Polytechnic Institute and the American University of Sharjah to make each a more effective node of a larger open innovation network.

Methodology

Our team employed various methods of data collection and analysis during our project. To guide our research, our team utilized a design thinking process. This design thinking process consisted of four key phases: the Discovery Phase, Ideation Phase, Prototype Phase, and Feedback Phase. Our Discovery Phase began by conducting conversational interviews with representatives from different organizations that participate in OI. We applied a case study methodology to each interview, including transcribing and qualitatively coding the interviews according to the different themes that were apparent in each. To do this, our team used the software NVivo for ease of code organization. Our team also submitted a survey to students at WPI and AUS in order to gauge the current knowledge pool of open innovation at each institution. The final part of our Discovery Phase data collection revolved around a recorded interview with Curtis Abel, the Executive Director of Innovation and Entrepreneurship at WPI, to understand the different innovation opportunities available to WPI students.

The Ideation Phase of our research involved utilizing the findings of our Discovery Phase to brainstorm different sets of criteria our prototype would need to be capable of satisfying. Our team used a "negative brainstorming" method as part of the ideation session to discuss several flaws we found in existing OI models. This way our team was able to decide on what features our prototype should avoid in order to increase efficiency and ease of use. During the Prototype Phase, our team discussed the different designs and forms our prototype might take, weighing the benefits and drawbacks of different layouts. We also discussed the logistics to the prototype's implementation, including who would be involved in facilitating its use and what organizations would be able to use the prototype. Our design thinking process concluded with the Feedback Phase, where our team planned how we would reach out to several different groups to solicit feedback on our proposed prototype. This would include receiving critique from our project sponsor and case study interviewees, as well as from our classroom peers - students who might eventually take part in an OI endeavour.

Findings

The main findings from our research that contributed towards our eventual network prototype occurred during the Discovery Phase. After the analysis portion of the Discovery Phase was complete, our team had various findings from the survey responses, a supplementary interview with Curtis Abel, and case study interviews. For the survey, we obtained information on the knowledge pool of open innovation at both WPI and the AUS as well as how involved students are with innovation efforts. It also provided the team with information on the distribution by each grade to understand whether resources and outside collaboration efforts are targeted to specific universities and grades. Out of over 270 respondents, only 6% understood the details of open innovation and its utilization. Additionally, only 28% of respondents have worked on collaborative projects with outside entities, and 24% of respondents make use of existing innovation and entrepreneurship resources. In terms of the distribution, as shown in Figure 20, only 9% of freshman and sophomore survey respondents have participated in any collaborative projects with any other universities or companies compared to 79% of seniors. This data proved useful for designing and mapping the logistics of the network as it provided our team with an understanding of the limitations of existing innovation endeavors.

The interview with Curtis Abel gave our team valuable insight on the currently existing innovation resources available to students at WPI. Among the resources that our team learned more about were Winter Session, an event that brings together WPI students and alumni for three days of innovation and entrepreneurship workshops, and the Foise Sandbox IQP Center, which gives student teams an opportunity to launch a startup for credit towards their degree. Perhaps the most important set of findings from our Discovery Phase was from the case study data that we coded thematically. The coded data allowed us to create our open innovation network framework shown in Table 1. The major themes of open innovation present in each case study model were communication, intellectual property, project selection, and existing network aspects like goals and challenges.

Table 1: *Open Innovation Network Framework*

Open Innovation Network Framework			
Communication	**Intellectual Property**	**Project Selection**	**Existing Network Aspects**
Advertising Intercommunication Intra-communication	IP Legality	Node Identification Problem Identification	Goals Challenges Methods

Prototype Development

After the completion of the Ideation Phase, our team finalized the four main criteria types that our prototype needed to satisfy. The prototype needed to encourage interactive communication between those managing and using the prototype, have resources for proper IP management, be advertised efficiently, and operate with complete openness with regards to who could use it. By satisfying all of these criteria, our prototype would become an effective tool for facilitating OI endeavours at WPI or AUS. To decide upon the format that would be used for our prototype, our team examined the strengths and weaknesses of the models of OI discovered during our case studies. We decided that the best prototype design would be an online portal that would be a hub for all open innovation activities at WPI and AUS. Student-lead projects could be advertised on the site, and any organization would be permitted to submit ideas they have for potential open innovation projects. The portal would also be advertised to each school's local community to increase the amount of projects done that benefit surrounding citizens.

Feedback and Conclusions

As part of the final phase, the Feedback Phase outlines the future actions for soliciting feedback for the improvement of the network portal. Some of the various methods our team plans to receive feedback include our portal's "Contact Us" page where participants can leave comments or concerns for the improvement of the network, sending the report to the case study interviewees for an industry perspective, contacting campus offices and centers for the portal setup and approval, and our IQP classroom peers for student opinions. This phase will be an ongoing process of feedback and improvement throughout the lifetime of the network portal. Although our team believes the online portal to be a good balance of the strengths we observed, there exists some possible limitations. One of the largest limitations of our portal revolves around it not being used to its fullest potential due to a lack of interest causing a shift towards exclusively profit-oriented projects. To ensure the limitations are considered and counteracted, our team highlights some key recommendations for future work with developing and maintaining open innovation networks at WPI or other academic entities. Our team recommends to keep evolving the layout of the network portal by adding and updating features to maintain operating it efficiently. Secondly, our team recommends that a collaboration assessment be performed biannually to examine the impact of new campus project collaborations. The final recommendation is to ensure that the portal remains open to all entities and participants without any exclusivity to specific organizations.

Our team's open innovation network portal will continue to benefit not only our university, WPI, and students, but will leave a lasting impact on any user of the portal. This project and portal will bring together diverse corporations, universities, and communities for meaningful collaborations as well as the development of unique and problem-solving innovations. We received a positive response from experts during our presentation as they are looking forward to following up with our team and the production of our network portal. Our team hopes that this portal will provide corporations, universities and communities with the tools to collaborate with other entities and continue utilizing the network portal to produce and market future innovations and ideas.

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Chapter 1: Introduction

Since the release of Henry Chestbrough's work in 2003, the term "open innovation" (OI) has been used to describe the nature of many companies' research and development endeavours. OI has been commonly referenced as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand markets for external use of innovation" (Choi, 2016). Essentially, open innovation may be thought of as the process of an organization innovating collaboratively with an external entity in order to develop a product or advance a project. This allows for each party working on jointly-developed projects to benefit from the other's intellectual property or advantages in the industry. However, there are many uncertainties surrounding the process of open innovation, leading to complications in the implementation of new OI networks.

While there is a large amount of literature detailing the effects OI has had on today's economy, there has been little research done on the nature of OI when operating in a network setting. There does not exist a universally agreed upon framework that a functioning open innovation network must follow. Research of OI networks is limited because there are several variables surrounding the implementation of open innovation practices that may change depending on the organization in question. There is information to be discovered regarding what is required for an organization to become a participant of an open innovation network. Specifically, our team will be examining existing open innovation models to theorize how Worcester Polytechnic Institute and the American University of Sharjah could become effective nodes of an open innovation network. We will be discovering what variables compose the framework to an efficient OI network model, as well as the types of organizations each school could work on collaborative endeavours with.

The ways in which our team set out to accomplish these goals and the information that we collected along the way are described in the various sections that follow. Our team begins with our background chapter, outlining the knowledge gained by our team during our literature review. The methodology chapter describes the specific ways in which our team conducted our research. Our findings chapter highlights the results of our data analysis, and the following

prototype development chapter describes our proposed prototype's possible features and the logistics of its implementation. In the final chapter our team offers how we plan to solicit feedback and conclude on the project as a whole.

Chapter 2: Background

In order for our team to better our understanding of open innovation and innovation as a whole, we consulted numerous sources related to innovation practices in the world today. In this chapter, we present a literature review with necessary information pertaining to:

I. The process of innovation and different innovation models that corporate entities utilize (Section 2.1)
II. Background information and the challenges present with various types of Intellectual Property (Section 2.2)
III. Open innovation strategies and the types of intellectual property collaborations (Section 2.3)
IV. The agents and entities that are involved in open innovation (Section 2.4)

2.1 Innovation

Innovation can be described as the repetition of several processes: the development of new ideas, the introduction of new technology into the marketplace, and the analysis of new technology based upon this new idea (Schmitt, 2014). Traditionally innovation has been approached in two ways, intrapreneurship and entrepreneurship. Intrapreneurship can commonly be found in large firms where they will use a department for research and development to innovate. This can be seen within companies such as Apple, IBM, Google and other 'supercompanies'. This approach focuses on increasing revenue by developing and marketing an existing technology or by creating new technologies related to the company's economic model and current products which can be marketed to existing customers. Entrepreneurship is found in startups where the objective of the company is to develop an innovation and develop an economic model around a new technology. These companies usually have very limited resources, forcing them to market and develop a single technology to develop their own market and customer base. However, regardless of the approach, the creation of new ideas and the development and marketing of existing technologies has been a large focus for companies of any size. Historically, innovation has been seen as "generally providing the focus and capability for

successful efforts to develop new products and processes", creating what has been widely known as the 'Linear Model' (Schneiderman et al., 2018). On the other hand, a study conducted by Jeffery Funk (2017) has described that in recent years the 'Silicon Valley' process has emerged, primarily focusing around the rapid improvement of existing technologies to create new forms of complex products which can be seen in the emergence of smartphones, e-commerce, social networking and other new prominent features of society.

2.1.1 Innovation Models

The Linear Model consists of five stages as shown in Figure 1. Starting with research, scientists will find new technologies and understandings of the world around us. Following this, concepts and inventions will be made to show the potential of this new technology. This prototype is then developed into an early stage technology which more accurately represents what a marketable product would be. Then, this technology reaches its final stages of development before being released. Finally the product enters the production and marketing stage where the focus transitions from developing the idea to developing the market and customer base for this technology to fund further development and research.

Figure 1: Depiction of the Linear Based Innovation model adapted from Fuerlinger and Fandl (2013)

Historically the Linear Model of innovation has led to the development of groundbreaking technologies such as transistors, allowing for the development of modern computing, combustion engines, facilitating the advent of modern transportation, or even the development of steel and other new materials allowing for humans to build the cities and infrastructure we know today. The historical success of this model has allowed for the creation of the modern education system, with the ever increasing popularity of university and colleges being focused upon creating the environment for new research opportunities and preparing students to enter the world of science-based research. Furthermore, these successes have resulted

in the increasing funding for scientific development, whether it be from federal government sources or from interest from private institutions.

Despite the success of a Linear Development model, it has not evolved to encompass the world of rapid technology development that Silicon Valley and other innovation focused regions have become accustomed to. Instead these regions have found more organic methods of remaining on the leading edge of innovation. These methods do not constrain themselves to the walls imposed by a linear development model. As discussed by Steven Johnson in his book *Where Good Ideas Come From: The Natural History of Innovation* (2010) “when one looks at innovation in nature and in culture, environments that build walls around good ideas tend to be less innovative in the long run than more open minded environments" (pg. 22). The culture of Silicon Valley and other sources of contemporary innovation has gravitated towards the edge of chaos as Christopher Langton observed several decades ago (pg.22). This intails that remaining on the edge of technology relies on being in an environment where there is high risk accompanying the tremendous potential. This system has fostered a culture where “executives are essentially free agents [...] promoting a mobile workforce that fosters a greater exchange of ideas" and where “the best of the talent is attracted mainly by work that is interesting, worthwhile and challenging” (Ryzhonkov 2013). Furthermore, larger firms choose to invest in the relevant startups. This creates a mutually beneficial relationship between the two entities, where the startup receives a significant boost to its resources to remain on the edge of innovation, while the larger company removes almost all risk for a relatively small cost with a tremendous potential for success but with an equally likely chance of failure. All together, the mix of traditional linear innovation methods and new non-traditional development has made way for many new revolutionary technologies.

2.1.2 Disruptive Innovation

It is impossible to discuss different paths of innovation and means by which innovation comes about without discussing disruptive innovation. Disruptive innovation is described by Christensen (2016) as the event in which a new type of product enters a market that has been previously established, therefore creating a new market as a result. These disruptive innovations often do not perform mainstream tasks as well as established technologies or services, but

possess a quality (such as being cheaper, smaller, or more convenient to use) that certain new customers find appealing (Christensen, 2016). The new innovations disrupt established markets over a given period of time by procedurally gaining enough qualities of the established mainstream technology/service while maintaining the new niche feature (Dan & Chieh, 2008).

Christensen (2016) describes several principles of disruptive innovation that give insight into why disruptive technologies and services can have demonstrably negative effects for competitors in existing markets. The first two principles detail struggles that large companies may have with regards to entering smaller emerging markets. For one, corporations' spending habits are largely dictated by their investors and customers (Christensen, 2016). Even as emerging markets gain more attention, larger corporations often cannot allocate resources to attempt at profit in these markets because the corporations are only tailored to compete in the large established markets. Christensen (2016) also details how corporations with strong holds on existing markets will not shift any interest towards smaller, more developing markets because corporation leaders do not believe that the small markets will increase company growth. Paap and Katz (2004) describe how large corporations are often aware of the v` `ery technologies or innovations that will eventually disrupt the markets they operate in. Disruptive innovations do not change the market landscape in a particular field overnight, but rather do so incrementally and while gaining qualities of the mainstream technology or service, as stated previously. There have been many different industries that have been revolutionized by disruptive technologies. Examples of industries in which disruptive innovation has forced the creation of smaller, more niche markets include the introduction of tabletop photocopiers into the established photocopier market and the introduction of hydraulic mining equipment into a market dominated by cable-powered power shovels (Christensen, 2016).

2.1.3 Big Data

Recently there has been a rapid development of information gathering technologies from widely used online environments such as Google or Facebook and the introduction of machine learning and artificial intelligence tools. With this newfound access to massive amounts of data and analytics (Big data), it has become increasingly easier to optimize current technology to the point where it can be marketed as entirely new technologies. Furthermore modern algorithms

have allowed for the seamless integration of these optimized technologies into society due to the ability to expose them to the ideal target audience with incredible accuracy.

The development of 'Big Data' (Hu, 2020) in the 21st Century has allowed for the development of advanced "Knowledge Economies" (which have been globally evolving since before the turn of the 21st century), where the access to information and new knowledge has begun to supersede the access to physical capital and natural resources. As discussed by Wilson (2012), this economy revolves around the company or nation's access to: a developed culture for entrepreneurship, highly skilled and educated groups and individuals, extensive information and communications infrastructure, and a developed innovation system with extensive R&D. Furthermore, this 'knowledge economy' distinguishes itself due to the fact that the benefits to consumers and society are often greater than the economic benefits the developers experience. This phenomenon is in part due to the fact that despite the value given by access to these vast stores of data and analytics, the near-zero cost of reproducing, and transmitting data with modern technology increases its long term value (Hu, 2020). Furthermore these benefits are increased by the development of artificial intelligence and machine learning, thus mitigating any ongoing cost of manpower to analyze data. This allows for extremely efficient and cost effective innovation of new products (Hu, 2020). However, with the access to the

2.2 Intellectual Property

Innovation is a key part to the success of any company; the creation of new technologies or ideas is what keeps customers interested and the economy growing. Intellectual properties (IPs) are defined broadly as creations that originate in the mind of an individual (WIPO, 2016). In terms of modern business operations, IPs are the product of innovation and can be broken into two categories: industrial property and copyright. Industrial property refers to things such as patents for an invention or a technological design, and copyright is any idea that is expressed through mediums such as literature, photography, and art. (WIPO, 2016). In order to ensure that IPs are not stolen or misused by external entities, certain IP laws were enacted to grant legal protection to creators and innovators. There is an important distinction to be made between IP ownership and the rights that protect the use of the IP. Traditionally, IP rights were used

exclusively by businesses to prevent competitors from entering the market for a given good or service (Baldia, 2013). More recently, IP rights are seen as a resource that can be used to barter with or to further the monetary gains of a firm or company (Baldia, 2013). The following sections will describe in greater detail the variety of IP rights exercised by firms participating in collaborative efforts today.

2.2.1 Patents

Patents provide sole use of an invention to the individual or individuals responsible for creating it, unless the creator gives permission to an external entity to utilize said invention (WIPO, 2016). Many countries define an invention as any new piece of technology that solves a new or existing problem in the given technological market (WIPO, 2016). Patent rights granted by a nation's patent office usually only protect the innovator's IP within the respective nation's borders (USPTO, 2019). For instance, an American inventor will have a limited course of legal action if somehow the design of their IP becomes available in the U.K. The USPTO (2019) recommends that smaller firms that may have more difficulty protecting their patented designs abroad take actions such as consulting legal teams and researching the foreign markets thoroughly where potential partnerships may be formed. That being said, it is possible to apply for patents for the same invention in other countries, but every nation has their own unique patent application process (USPTO, 2019). The World Intellectual Property Organization (WIPO) ranks nations annually according to the amount of patent applications received by each country's respective patent office. In 2018, China had the highest amount of individual patent applications by far at 1.5 million applications (WIPO, 2019). The U.S. had the highest amount of individual patent applications abroad in 2018 (WIPO, 2019).

Although the application processes to receive a patent vary from country to country, there are similar criteria that must be met by the invention to be patented no matter the location of request. In the United States, there are certain limitations on what may and may not be patented. Processes and machines used to solve technical problems are readily accepted for application review, but patents are not awarded to things like abstract ideas or natural observed phenomena (USPTO, 2020). The inventor of the design under application review must also demonstrate that the invention could be used easily by individuals with a general knowledge of the related

technical field (USPTO, 2020). If a patent is granted by the USPTO, the rights to the invention given by the patent usually last for 20 years, completely protecting the disclosed invention during this time (USPTO, 2020).

2.2.2 Trade Secrets

Another type of intellectual property that companies and firms hold rights over are trade secrets. Trade secrets are defined as any intellectual properties that hold value economically because they are not public knowledge (USPTO, 2020). Entities in possession of trade secrets may go to great lengths to protect their secrecy in order to strengthen their hold on a particular market, process, or product type. The rights regarding both patents and trade secrets that entities may claim in defense of their intellectual properties are similar, with a few key differences. The Economic Espionage Act of 1996 put in place large financial punishments in the United States for those found guilty of disseminating or replicating trade secrets they knew to be the property of another business entity. This means that, like patents, trade secrets can be protected from acts of industrial espionage (USPTO, 2020). It is important to note, however, that the rights surrounding trade secrets do not protect the company in possession of the trade secret from external entities independently discovering their secrets through legal means. Means by which an external entity could obtain knowledge of a trade secret and not be punished for it include actions such as accidentally discovering the trade secret on their own. Once a trade secret gets released outside the owning entity, it is difficult to prove who originated the idea or that the idea was misused. Patents are not secretive and have a specific end date at which the patent dissolves and the design enters the public domain (USPTO, 2020).

Industrial property, composed of both patents and trade secrets, is the division of intellectual property most commonly discussed with regards to collaborative innovation. The willingness of each participant of a business agreement to share their IPs greatly influences how the agreement will work. It is important to understand the different forms of IP that may be used during collaboration efforts in order to comprehend the considerations entities may take before beginning an open innovation endeavor. The sharing of specific technologies and designs may be integral parts of open innovation endeavours.

2.3 Open Innovation

Open innovation (OI) is an alternative to the conventional method of innovation where the ideas and designs are required to remain within the company walls. Instead, OI opens these barriers and limitations by sharing and receiving information openly from other entities and organizations. OI is still a relatively broad concept that involves a variety of innovation practices and processes. Many of these practices are discussed in terms of "inbound", "outbound" and "coupled" processes. The simplest way to understand it is by comparing it to the conventional "closed innovation". For example, Apple utilizes closed innovation practices to keep the design of a new iPhone a secret until the reveal date. They design new models internally and do not collaborate with external entities. Google, on the other hand, has their "Google for Startups" program where they share their search technology and share proprietary data and statistics to help entrepreneurs make data-driven decisions (*Best Practices & Helpful Tools for New Startups*, n.d.). These innovation strategies determine how the company can innovate for a set audience in a way that aligns with their missions and goals. It provides them a broad yet unique method for profit that can be utilized in various departments within the company itself.

2.3.1 Innovation Strategies

As mentioned, two innovation strategies that companies typically adopt are "closed" and "open" innovation. Either strategy can be implemented as neither is more superior than the other. Both strategies have benefits and drawbacks and are utilized depending on how the company wants to handle the development of the innovation and how it can maximize profit.

Closed Innovation

From the name itself, closed innovation relies on the idea that information and data is processed and practiced "inwards" and within the company or organization itself. In Closed Innovation, companies rely predominantly on internal resources to develop ideas into products and services and release them to the market (de Jong, 2016). Companies that use and favor closed innovation do so in order for the information and ideas produced to remain under the company's control.

Open Innovation

On the other hand, OI is based on the assumption that other creative individuals and resources from outside entities can provide a meaningful contribution to a company's innovation at higher efficiency and lower cost. Generally, many have agreed that OI is defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand markets for external use of innovation" (Choi, 2016). In the last two decades, many companies have been actively pursuing a greater involvement with these external resources. They believe that innovators that engage with the global innovation community will reap the highest return and profit if they are the first to market (de Jong, 2016). The more information is gained from these resources, the more educated the innovation decisions are. As discussed by Travis (2008), one of the primary models for this process has been Wikipedia, which freely draws information by allowing any user to write, correct and update all the information on the website. Other examples include Innocentive, which takes advantage of this model by posting technical and theoretical questions online while offering monetary rewards for the solution. In particular Innocentive offered a $1,000,000 prize for finding a biomarker for ALS and many smaller prizes

for potential ideas in the area. However, studies upon Innocentive's solvers' have "found that curiosity and pride motivate them as much as the prize money" (Travis, 2008), showing that including a strong moral incentive helps increase the effectiveness of crowdsourcing innovative ideas.

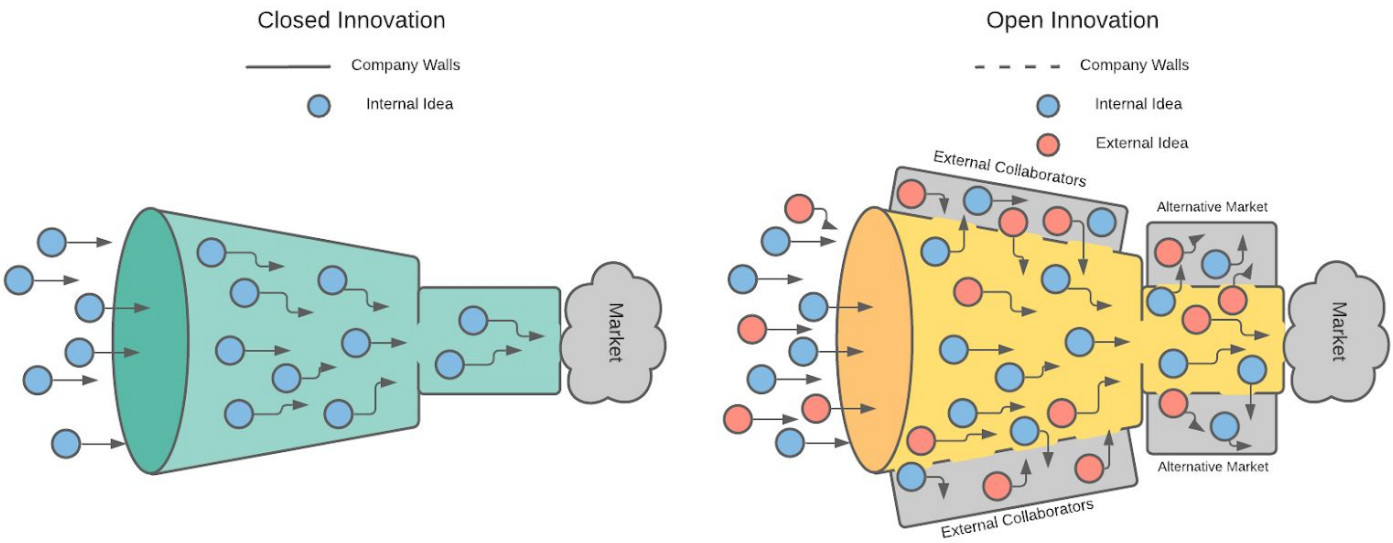

Figure 2: *Closed vs. Open Innovation Market Funnel. Made by Mostafa Chehadeh*

Both Open and Closed Innovation can be compared with the use of market funnels. As shown in Figure 2, the closed innovation funnel has solid walls representing that information remains secured internally throughout the process and nothing is received or released before the market. In the open innovation funnel, the corporate walls are porous, so external and internal resources and flow in and out of the company are various points throughout the innovation process. This allows ideas to be shared with other collaborators or alternative markets before finally released into the market.

2.3.2 Types of Open Innovation

As an innovation strategy, companies can utilize open innovation by following and introducing various innovation practices. Since open innovation is a broad concept, each company has its own way of practicing open innovation. Some companies use terms such as "Intercompany", "Intracompany", "Core" or "Adjacent" as various ways of describing their innovation methods. As Spithoven describes, all of these terms fall under the hat of either "inbound", "outbound" or "coupled" open innovation practices (Spithoven, 2013). These practices are the center of open innovation implementation every company using open innovation follows.

Inbound OI

Inbound OI refers to the strategy of exploring information from external sources and collaborators to help strengthen or speed up R&D activities that are performed within company walls. Spithoven explains that firms do not operate as a vacuum, rather "they are always scouting for new ideas and information in order to capture a higher market share or enter new market segments" (Spithoven, 2013). Other researchers also refer to it as an "outside-in" process where information and knowledge is brought from the outside and implemented inward. The external sources include activities such as "external networking, external participation, external collaboration, customer involvement, outsourcing R&D and IP in-licensing" (D'Angelo, 2020). Additionally, the use of external sources can be important to improve or speed up innovation as the complexity of the innovation increases. Complex problems and roadblocks could be solved when diverse information and perspectives are brought inward into the company.

Outbound OI

On the other hand, outbound OI focuses on different external paths to monetize technology that was previously developed by the company. This way, companies can commercialize internal innovations that are not used to develop new products or services (Spithoven, 2013). This type of OI has not been given as much attention as inbound and coupled OI. Remneland explains that "there has been comparatively little academic emphasis on better

understanding the challenges of embracing outbound innovation activities" (Remneland, 2019). In his report, he analyzes how a company attempts to engage in outbound open innovation. In the studies of outbound OI, the emphasis has been mainly on a transactional view in which firms reveal, sell or out-license their IP rights (Remneland, 2019). A prominent strategy, as Spithoven describes, for earning money from company's previously developed innovations is through patenting. As described, the purpose of patents are to provide the sole use of a design or innovation to the entity that created it. By patenting, companies can own their designs and be able to commercialize their internal innovations before releasing them to the market.

Coupled OI

Coupled OI focuses on the efforts of strategic alliances that unite both inbound and outbound OI, resulting in a transfer-in and transfer-out of new knowledge and technologies (D'Angelo, 2020). Combining both the strategy of the inflow of external information and the outflow of commercialized internal innovations will allow a company to maximize R&D speeds and innovations while maintaining higher profits in the markets. Spithoven explains that the key to profiting from coupled OI is to focus on cooperation (Spithoven, 2013). Since OI is filled with inflows and outflows, working independently on managing those will lead to drastic failure. Cooperation between entities is important as it can "improve the learning effectiveness in absorbing external knowledge … [and] provide a mechanism to reduce outgoing spillovers by helping to internalize these among a limited number of alliance partners" (Spithoven, 2013). Although coupled OI seems like the most desirable method, there are challenges present, so it is important to understand the benefits and drawbacks of open innovation practices and determine effective and efficient methods of collaborations.

These innovation practices make up the principles of open innovation and can be utilized in various ways for companies to market their innovations. Inbound strategies allow companies to use outside information and resources to speed up development and solve internal problems from a diverse perspective. Outbound strategies often assist with externalizing and comericalizing inner technologies by patenting and monetizing these ideas. Other companies can see these patented ideas while the innovating company profits from it. Merging these strategies together creates a coupled open innovation where companies can collaborate and utilize each

other's resources to maximize research speeds, obtain diverse perspectives, and develop stronger innovations for the marketplace. Commonly, collaborating companies are challenged through the determination of intellectual property rights. Introducing methods of IP collaboration allow for effective collaboration and the protection of IP rights.

2.3.3 IP Collaboration

When companies decide to utilize OI or collaborate on a product or project, much consideration is put into how intellectual property is to be shared or divided. When collaboration is to be performed in a formal sense, business entities will often create Joint Development Agreements (JDA) that legally bind the specifications of the collaboration (Ponchek, 2016). An example of a title page from a JDA given to us by our team's sponsor can be seen in Figure 3. The introductory paragraph begins by describing the entities responsible for adhering to the JDA and the dates through which the JDA will remain active. The title also details the sections that will appear throughout the document, like the terms and conditions of the agreement and the actual material to be jointly innovated. If trade secrets are to be shared on a basis of necessity for project completion, then certain nondisclosure agreements (NDAs) must be signed to ensure confidentiality. Ponchek (2016) also discusses the importance of informal collaboration between different knowledge-possessing entities, citing the importance of businesses that may be considered "peers" advancing technology in a particular market or industry through the sharing of proprietary information. These informal collaboration efforts are one of the many various connections that may take place in an open innovation network. Different agents and entities of open innovation each approach the practice differently, cooperating with different types of organizations for the development of various projects and technologies.

JOINT RESEARCH AGREEMENT

FOR

Researching Fuel, Engine, and Vehicle Technology

This Joint Research Agreement ("Agreement") is by and between XXX ("Company") with its principal offices at <Address> and YYY a limited liability company organized and existing under the laws of the <State>, USA, with its principal offices <Address> (" CONTRACTOR"), to be effective as of the last date of the last party to sign below ("Effective Date"). The term of the Agreement shall commence on the Effective Date and end on the third anniversary of the Effective Date ("Term").

The purpose of this Agreement is to establish, under the terms and conditions set forth hereinafter, a contractual co-operation project between the Parties to develop catalysts for onboard reforming of fuel engine exhaust gas and after-treatment applications (the "Joint Development Project").

This Agreement consists of this signed document and the following attached schedules and attachments:

SCHEDULE A General Terms and Conditions

SCHEDULE B Scope of Work

Attachment I – Research Schedule

Attachment II – CONTRACTOR's Background Intellectual Property

Attachment III – COMPANY's Background Intellectual Property

SCHEDULE C Compensation and Payment

XXX (Company)		YYY (CONTRACTOR)	
By:	_____	By:	_____
Name:	_____	Name:	_____
Title:	_____	Title:	_____
Date:	_____	Date:	_____

Figure 3: Sample Joint Development Agreement provided by Arthur Foutsitzis

2.4 Agents of OI

Open innovation is a model for collaboration that has seen much implementation in various industries and markets across the globe. The networks formed as a result of OI contain various "nodes" or agents that contribute to the flow of innovation and a boosted knowledge economy. While large firms are able to externalize R&D the most, different types of innovation centers (e.g., academia and federal R&D departments) play an important role in forming cohesive OI networks (Spithoven et al., 2013).

2.4.1 Small and Medium-Sized Enterprises

One of the entity types responsible for facilitating an inflow and outflow of R&D are small and medium-sized enterprises (SMEs). Spithoven et al. (2013) contend that SMEs face more barriers to entry based off of a smaller resource pool and the risk of becoming too reliant on R&D or innovation that doesn't originate within their own company. That being said, one of the best ways for SMEs to increase their stake in a particular technological market is by looking to external research for additional ideas (Spithoven et al., 2013). Commonly, SMEs will turn to resources such as academia or the government in order to forward their productions (Wilson, 2012). SMEs do not utilize open innovation in the same magnitude as large companies, but the impact that the SMEs feel financially as a result of outsourcing R&D is proportionally higher than large firms and much more important to their success (Spithoven et al., 2013). Teixera and Lopes (2012) comment on the need for OI to flourish in countries that are not at the technological forefront like Japan or the United States and that contain mostly SMEs for business entities. Their study on Portugal, a technologically-developing nation, showed that while 40% of surveyed firms admitted to absorbing information from external sources, only 10% stated that they willingly shared their innovation with external entities (Teixera and Lopes, 2012).

A particular case study examined by our team revolves around open innovation practices among small and medium-sized enterprises in South Korea. As South Korea is similar to the United States in terms of technological advancement, the data in the case study was deemed appropriate for use in this project. The data collected and used in the case study was published by

STEPI (Science and Technology Policy Institute), an organization dedicated to improving innovation-based policy in South Korea. A survey was sent by STEPI to 2743 different Korean enterprises, of which 2414 were small and medium-sized. One of the first steps taken by the authors in analyzing the innovation practices of the firms was to deconstruct the practices into various activities, such as innovation marketing or utilizing external R&D resources. In every category created by the authors, the large firms who also answered the case study's survey performed each innovative activity at a higher rate than the small and medium-sized enterprises. For instance, 84% of large firms surveyed reported that they train employees specifically for innovation endeavours, compared to 63% of the surveyed SMEs. The surveyed SMEs marketed for innovation 47% of the time, while 61% of the large firms in the study reported that they allocated resources to marketing their innovations. As the authors contend, SMEs are less likely to perform certain innovation activities because SMEs partake in open innovation endeavours in order to complete a project or produce a product for one single customer. Large firms often may commercialize their openly-innovated products, and SMEs do not commonly have resources for bringing products to market on a mass scale (Lee et al., 2010).

With regard to what kinds of organizations SMEs become involved with for collaboration on a product or service, the researchers of the case study examined different entities SMEs both purchased technology from and formed alliances with. Overall, the Korean SMEs in the case study purchased technology at a higher rate than the rate at which they formed strategic alliances. The propensity to buy technology likely stems from the fact that SMEs do not normally have the resources required to develop a required technology. Technology was bought from competitors in industry by 56% of surveyed firms, with 49% of surveyed firms purchasing technologies from non-competitors. When the Korean SMEs did form strategic alliances to develop technologies, they did so with universities more than any other partner (competitors, private research companies, etc.). In fact, 45% of surveyed firms answered that they had collaborated on product development with a university at one time (Lee et al., 2010).

The final set of data examined by the researchers for this case study revolved around the challenges that SMEs in a technologically developed nation may face when trying to collaboratively innovate. For these data, those firms who participated in strategic alliances (opposed to only buying technology) were selected for study. The top two barriers that the

Korean SMEs reported as a barrier to innovation was a lack of labor available in both the market and within the firm itself, to actually innovate and create new technologies. Market uncertainty surrounding the innovated technology also played a large role in acting as a barrier to entry for the SMEs in the study (Lee et al., 2010) Many of the problems faced by the SMEs relate directly to the size of the firms; the SMEs often do not have enough knowledge or resources to openly innovate for large scale commercialization. There is evidence that highlights SMEs as a kind of "supporter" during collaborative relationships. SMEs serve as a valuable node of open innovation networks around the globe.

2.4.2 Large Firms

Unlike SMEs, larger firms are viewed to have a better grasp on how to implement OI into their companies and external collaborators. Due to their abundance of resources like employees, money, and greater networking opportunities, large firms have an advantage compared to SMEs. However, studies have shown that "bigger firms can often be locked in their organizational routines and bureaucratic constraints producing inertia towards undertaking innovative activities" (D'Angelo, 2020). Larger firms sometimes lack the ability to effectively use different OI practices simultaneously when introducing new products on the market (Spithoven, 2013). It is observed that Inbound OI practices are more common in larger firms and they benefit more from their search strategies. Due to their size, larger firms are able to create wider networks within their OI practice.

While many large firms feel the need to keep all innovation practices proprietary, our team examined a case study conducted by Hafez Shurrab in 2013. The objective of this study was "to expose some aspects of a real case, where open innovation became central practice in"(Shurrab, 2013). In this particular case, Shurrab details Whirlpool's unique approach to innovation, particularly in their development of the affresh line of appliance care products. Whirlpool approaches innovation with a 'triple diamond' approach, where they focus on 3 aspects of innovation: idea generation, idea development and commercialization. While these three aspects are not unique to open innovation, the details of how Whirlpool approaches each one that exhibits the open-ness of their innovation process. When approaching their idea generation process, Whirlpool deviates from the usual closed innovation approach and uses

crowdsourcing "to internalize and learn from outsiders including their existing end-customers, suppliers, business-to-business partners, and other related actors to their industry"(Shurrab, 2013). After collecting these ideas Whirlpool practices a traditional development strategy by using a question evaluation criteria. However they apply an open innovation mindset by communicating with customers about which ideas would fill their needs, without the considerations about the feasibility of each idea. After this process, they work alongside suppliers to develop the product that was picked by some basic criteria, and the interest of the customers. After developing the idea, Whirlpool focuses on the commercialization of the product. By openly using external sources Whirlpool was able to extend the reach of this new product into many different markets.

This study highlighted that based upon Whirlpool's model, to develop open innovation practices, a large firm does not need to revolutionize the manner in which they go about innovating. Rather, a large firm has to change their approach to their current innovation process to become more open to see the benefits that come about from open innovation. Furthermore you can adjust the open-ness at all stages of the innovation process to see the most improvements for the corporation's needs.

2.4.3 Academia

Academia is another type of entity that may serve as a node of an open innovation network. Universities and Academia are filled with research opportunities especially from professors on a research tenure track and students working on project work. Students are a key component for research as they could provide a different and unique perspective to many issues that are not addressed by industry researchers. Universities want to introduce innovations into the marketplace of ideas to achieve their educational and social goals. Entities that form OI networks can connect with academia and discover the potential that they have to boost innovations from the unique academic perspectives as well as some resources, such as libraries and databases, that are not available to SMEs. Wilson (2012) states that those who attend higher institutions of learning will be many of the same individuals who shape innovation in a nation in the future. As a result, it is in the best interest of the government and industry to do things such as fund research at universities for doctoral candidates or release information to students in order to

receive feedback on a project (Wilson, 2012). Cheng et al. (2020) describe how enterprises can also limit vocational training costs by releasing projects to students in order to strengthen the technical skills of their potential hiring pool. The incentives for enterprises to encourage research based in universities around the world are present. It is important to note, however, that adequate incentives must be made available for the students to actively participate in the research and development of enterprises (Cheng et al., 2020).

In the academia sector, Yuliya Shutyak, an analytical researcher and consultant in SMEs and entrepreneurship, conducted a case study on the practice of open innovation of university spin-offs (Shutyak, 2016). Spins-offs are business ventures that are founded by academia faculty to transform technological inventions developed from university research. As a main research strategy, Shutyak used a case study by contacting and conducting interviews with university spin-offs such as ones of the University of Liege in Belgium. The purpose of the study was "to contribute to literature on the OI activities of university spin-offs by the interpretation of induction results rather than testing a specific hypothesis" (Shutyak, 2016). The results and data from interviews showed that not many university spin-offs know about the concept of open innovation despite being assumed to be closer to advanced knowledge and practices. She analyzes the openness of spin-offs and describes that the most effective spin-offs do not have "a choice between Open and Closed Innovation, it is a mixture, it is not exclusive" (Shutyak, 2016). Additionally, there are challenges present in the collaboration efforts between these spin-offs and SMEs, such as poor planning of resources, a lack of clear objectives, trust, ethical conduct as well as the difficulty to integrate external innovations into existing products (Shutyak, 2016). Due to their limited use, their motivations, benefits and disadvantages are conducted on a relatively small number of observations. Shutyak explains that it does not allow for generalization but rather points to the important issues of open innovation practices in university spin-offs (Shutyak, 2016).

Studies, like Shutyak's, often deal with what is currently known and the limitations of university collaboration, but do not provide them with methods and processes of implementation, so they are not widely used in the academic sector. Universities, especially private schools, tend to keep research and resources internal and within the school. There are not many efforts in facilitating collaboration between corporate entities and universities. This creates room for some

uncertainties in the practice of open innovation among universities where there is no proper structure and many obstacles have not been overcome. More research involving larger universities with access to the resources would test the current results more rigorously and extend the existing models. Universities and Academia want to introduce innovations into the body of knowledge and marketplace of ideas to better achieve their educational and social missions. Utilizing the various innovation goals of other agents can potentially assist with facilitation and collaboration and could considerably strengthen the current knowledge to create a strong yet flexible structure for open innovation processes.

2.4.4 Governments

Governments often act as proponents of OI networks, working with higher institutions of learning and firms of all sizes to increase the size of the knowledge economy and drive technological progress forward. In general, it is in the best interest of governments to protect the strength of the economy by acting as opponents of monopolies and encouraging competition in the economy's markets (Wilson, 2012). Rogers et al. (1998) discuss the manner in which federal R&D labs may establish what are essentially joint development agreements with firms to boost innovation as a whole. The authors discuss how federal R&D laboratories incentivize their innovators by offering limited commercialization from any products developed during collaboration (Rogers et al., 1998). One particular relationship discussed by Chen et al. (2020) is the one that forms between SMEs and governments in nations with transitional economies. The authors advocate for some level of state ownership of SMEs, citing how it can allow the smaller firms to utilize government-subsidized resources to increase open innovation and therefore increase profits from newly developed technologies (Chen et al., 2020). These mutual relationships increase competition and the knowledge economy in their respective countries.

A case study by Lee, Choi, and Hwang focuses on the many different ways in which governments around the world encourage or participate in open innovation endeavours. They begin by stating how many governments have begun open collaboration efforts with non-profit organizations and their citizens, but have not yet brought the efforts to the forefront in terms of marketing or resources. One of the examples of a government providing opportunities to outside collaborators is through a process called network governance, where citizens can have a hand in

influencing things like governmental services. These network governances can be either community or government-driven (Lee et al., 2012). It becomes apparent through network governances like these that open innovation practices are used by a multitude of entities and are actively applied by governmental institutions.

With regard to country-specific examples of public sector open innovation, there are several in some of the world's most innovative nations. Innovation is measured by the World Intellectual Property Organization (WIPO) in their Global Innovation Index and ranks nations by their innovation capabilities on the basis of economic statistics (Cornell University et al., 2019). In the United States, for example, the Obama administration put in place the Open Government Initiative, which released data sets to the public on the website data.gov and gave the public opportunities to comment on policy on regulations.gov. There are also many community-driven open innovation efforts related to waste cleanup and disaster aid in America, such as the All Hazards Forum which incorporates the public and academia in dealing with disaster management. In the United Kingdom, NESTA (the National Endowment for Science, Technology, and the Arts is responsible for the Public Services Lab, which takes in ideas from the public in order to improve public services provided by the government. A final example of government-based open innovation is the National Institute for Materials Science in Japan, which works with numerous research centers abroad in order to advance policy and technologies (Lee et al., 2012). Although governments may not practice open innovation on the same scale that large firms, SMEs, and academia do, they may still serve as nodes of open innovation networks and the interactions they have in external collaboration are worth analysis.

2.5 Summary

There was much available literature surrounding types of innovation, who is performing open innovation, and the reasons that companies may choose to openly innovate. Our team now has a much better grasp on these subjects, and as a result can begin to develop questions regarding what information is pertinent to designing and implementing an efficient open innovation network to be used by any corporate or academic entity.

Understanding the many challenges and obstacles that various entities experience will be crucial in determining the logistics of our proposed open innovation network. Corporations want to exploit the introduction of innovations to make the largest amount of money possible. Universities want to introduce innovations into the marketplace of ideas to produce more learned students and increase recognition. Governments want to encourage the development of innovations to increase economic strength. Each faces different challenges and strives to complete different objectives. Our work will allow these entities to understand their current limitations and will effectively incorporate various entities and improve innovation strategies to create a lasting impact.

With our literature review complete, our team was able to combine the knowledge we gained with data we collected during research to create an Open Innovation Network prototype. This prototype will allow academia, like Worcester Polytechnic Institute and the American University of Sharjah, to become part of innovation networks between various entities to prepare for the future of innovation.

Chapter 3: Methodology

As previously stated in chapter 1, the general goals of this paper are to highlight the reasons for the growth of open innovation in today's world and to showcase the manner in which an open innovation network may be implemented at WPI and AUS. To assist in completing this goal, the following objectives were utilized for guiding our research:

1. Understand the various barriers to the creation and implementation of open innovation networks and the nodes that comprise them.
2. Visualize how an open innovation network could take form at Worcester Polytechnic Institute and the American University of Sharjah and understand what entities could comprise the nodes of the network.

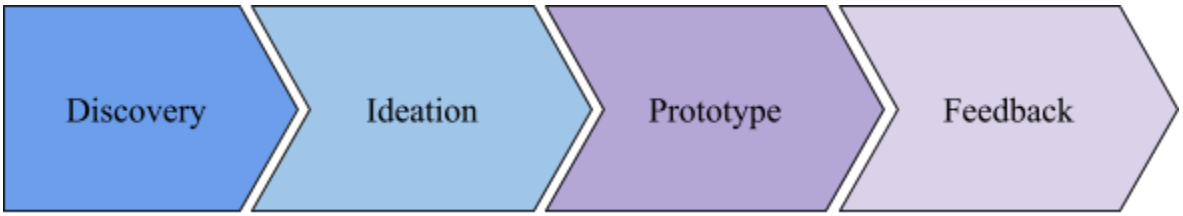

Figure 4: *Design Thinking Methodology Process*

To achieve our research objectives, our team set out to utilize a design thinking methodology consisting of four key phases: the Discovery Phase, Ideation Phase, Prototype Phase, and Feedback Phase. Figure 4 shows the order of the phases of the Design Thinking model. Using this model, we were able to collect data using various collection methods in our Discovery Phase and analyze it to theorize the prototype in our Ideation Phase. In the Prototype Phase, we detail the process and logistics for executing our theorized OI network. We then finally describe how feedback could be solicited for it in our Feedback Phase. With each of these phases playing an important part, it is important to detail each phase in the methodology to obtain a greater understanding of our findings for the analysis in our discussion. The following sections detail the steps followed in each specific phase.

3.1 Discovery Phase

The first phase of our Design Thinking methodology was the Discovery Phase. Our Discovery Phase was an opportunity to explore the problem and solution spaces related to the research objectives of the study. We explored potential ways to make WPI and AUS successful open innovation hubs through interviews about OI with industry and academic experts, as well as through gaining information on student body familiarity with OI concepts and practices. The following sections provide insight into the methods our team utilized during our Discovery Phase. This includes how our team selected and contacted each interviewee and how we submitted our survey to the student body of each institution.

3.1.1 Case Study Selection

In order to complete the first research objective highlighted at the beginning of this chapter, it was necessary to decide how relevant data could best be obtained and analyzed in order to draw meaningful conclusions and generate theory. The main deliverable of the project is an open innovation network prototype that facilitates OI endeavours. The best way to develop this prototype would be to explore OI networks that operate in the real world and speak to leaders of innovation at each institution. A case study-style of research was selected instead of other methods (e.g., an experiment or archival analysis) for three key reasons. First, our research questions consider the mechanisms of OI networks and seek to answer mainly “how” and “why” questions related to the nature of open innovation. According to Yin (2018), case study methodologies are appropriate for the exploration of these types of questions specifically. Second, a case study is best suited to study phenomena that researchers have little control over (Yin, 2018). Finally, OI networks and the variables controlling their creation and operation may act as cases to be analyzed on the grounds that OI networks are phenomena . Open innovation is constantly changing and evolving in today’s world, and it is neither an entirely theoretical idea nor a practice of the past (Yin, 2018).

3.1.2 Case Selection Criteria

To ensure that the cases selected would provide data that assisted our team in answering our research questions, it was necessary to make sure each case satisfied various criteria before being sought after for the study.

Figure 5: *Representation of the case selection criteria*

Figure 5 outlines the criteria for selecting each case study node. The first criteria that had to be satisfied was that the case either had ongoing OI endeavours or had concluded any open innovation endeavours within the past six months. This helped to ensure that the data collected revolved around practices that are currently in use by different OI network nodes. The second selection criteria was that the case must have participated in open innovation with at least one entity outside of its innovation boundaries. This criteria ensured that the entity was able to provide our team with data about the variables leading to external joint innovation. Thirdly, cases must have been innovating with external nodes for at least one year to ensure that enough data on their open innovation process could be collected. That is, each case would have significant experience in open innovation practices to better comment on the challenges and benefits surrounding OI. The fourth and final criteria for the cases to be considered for study was that the case was willing to disclose information about their OI practices for data analysis.

In order to identify the different cases for study, our team used Google to search for different organizations that take part in open innovation and that satisfy the criteria listed above.

A search term like “companies performing open innovation” yielded links to web pages listing active OI participants. From there, our team could directly search for a company’s website. If an organization looked promising in that they were participants of open innovation, we would go about finding the proper contact information to get in touch and introduce our project. Our team would ask about individuals who could help us advance our research through conversational interviews. The actual steps involved in conducting the interviews are described in the following section.

3.1.3 Conversational Interviews

As part of our IQP, our team employed various means of data collection in order to generate detailed theory. For the portion of the project regarding case studies, conversational interviews were used as the primary data collection method. It was important to make sure that data collected were from individuals and experts involved in innovation development. Interviews allowed for broad questions that yielded detailed data that can be analyzed to draw meaningful conclusions. Commonly, the questions and answers evolved during the interview and allowed for the collection of rich descriptive data that was later analyzed. The results from these case studies helped our team to understand the mechanisms that take place when nodes of OI networks decide to practice open innovation.

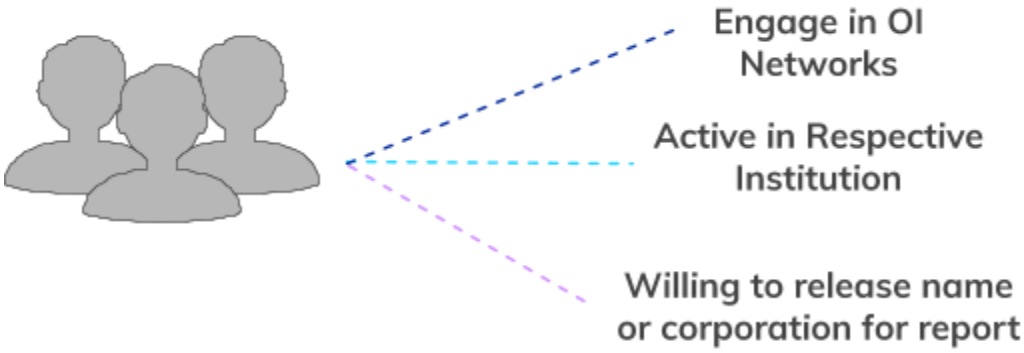

Figure 6: *Diagram of required interviewee criteria*

Similar to when selecting cases for research, criteria was also applied to the interviewees at each OI network node in order to make sure the individual can accurately answer the questions asked by our team. Figure 6 outlines the required interviewee criteria for the selection of interviewees for each case study node. The first criteria for the selection and inclusion of

interviewees was that they were actively engaged in and have experience working with the given entity's open innovation operation so that they could provide a firsthand account of how open innovation occurs for that entity. The second criteria that was satisfied by the interviewees was that they were currently employed by the organization being studied. This assured accurate data on the entity's practices in open innovation was collected. The final criteria for the interviewees was that they were willing to interview, and also to give the name of their entity when discussing open innovation practices. It was important that the interviewees felt comfortable and understood all of the procedures that were followed after data collection and analysis from their interview question answers. When reaching out to the node, we made sure that the contact emailed satisfied this criteria or asked for a contact that would satisfy the criteria.

After finding different organizations our team wished to speak with, our team used convenience sampling by means of directly reaching out to WPI alumni who worked at each institution. That way, we had a higher chance of receiving a response back and getting connected to interviewee candidates involved in the open innovation network. We found WPI Alumni through LinkedIn for their name and CareerShift for their contact information. When reaching out, we detailed our project and mentioned that it is for our Interactive Qualifying Project, and we asked for any potential contacts following our criteria that would be willing to interview within a set time frame. If an organization did not have any WPI Alumni, we contacted candidates that have been a part of innovation at their corporation through Google and LinkedIn. This allowed us to have a wider range of contacts while considering the fact that some of them may not respond.

During our study, specific interview questions (see Appendix D) were prepared based on the type of entity/agent of the OI network that was interviewed (e.g., an SME versus a government department). The interview questions were unique to each node to make sure that the most relevant data possible was extracted from the interviews. The questions revolved around the factors that determined the entity's open innovation practices. These interviews were conducted over Zoom or Microsoft Teams at times that were comfortable for the interviewees, and were recorded in order to be referenced and analyzed later.

In this section our team described the ways in which we selected and contacted various organizations in order to interview industry experts of open innovation. By using Google to

discover different organizations participating in OI and reaching out to WPI alumni at each organization, our team was able to find candidates willing to interview. The methods we applied to creating and submitting our survey to students at WPI and AUS are described in the next section.

3.1.4 Survey

In addition to collecting rich descriptive data through our case study interviews, we sought to understand the level of familiarity that students at WPI and AUS had with open innovation. We created a Qualtrics Survey for students and individuals who would be interested in getting involved and learning more about open innovation at their university (see Appendix B). The survey was used to help us understand how much information is known about open innovation networks among students, undergraduate and graduate, and how they think an open innovation network could be implemented. This survey allowed us to obtain information about what the current knowledge is about open innovation networks to help us analyze which components of open innovation networks need more focus. Figure 7 shows the format of the survey questions as well as a sample question asking the survey-taker if they know about open innovation.

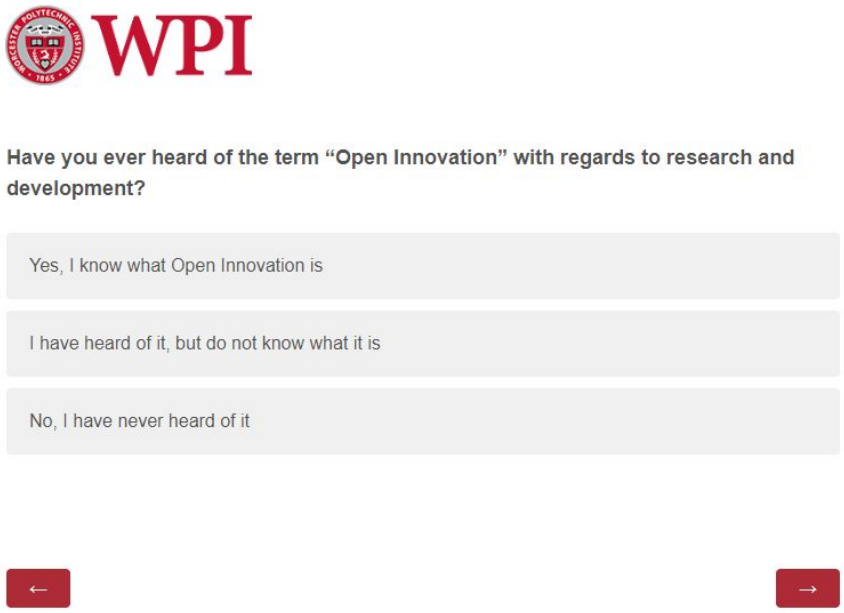

Figure 7: *Example survey question from Open Innovation Networks Qualtrics Survey*

To ensure that the audience and all survey-takers were considered, the survey was designed in a simplistic manner to allow any student to completely fill out the questions. Most of the questions asked were yes or no questions to attract students to fill out and complete the

survey and only took about two minutes to complete. The survey also captured some demographic details to classify and analyze trends within the survey respondents. The survey ensured that any undergraduate student at either school could take it by asking for their university and grade level. If the respondent attends neither university or is not an undergraduate student, there are options to select that allow the respondent to continue the survey, as displayed in Figure 8.

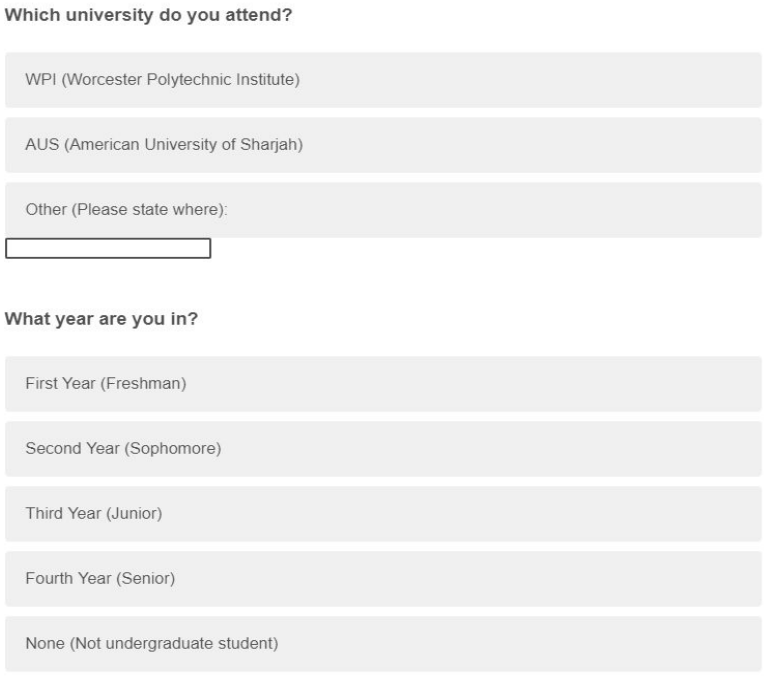

Figure 8: *Survey demographic questions from the Open Innovation Networks Qualtrics Survey*

To send the survey out to students, we utilized various platforms where large amounts of WPI students are involved, such as the WPI Reddit page and the WPI Discord Server. Additionally, our team sent the survey to members of various clubs we participate in as well as roommates, friends and housemates. With the help of our AUS student teammates, we were able to send the survey out to various colleges and departments at the AUS.

3.2 Data Analysis

After recording the interviews with the various experts we contacted for our project, it became necessary to analyze the collected data. To begin analyzing the data obtained from the interviews, our team first downloaded each recording of the Zoom meetings as mp4 files and then transcribed them. Although there were many transcription software programs to choose from, our team chose to use Otter.ai, which was both affordable and easy to operate from a user

standpoint. The software was also able to handle a variety of accents and intonations in people's voices, giving a clean, readable transcript of the interview. The mp4 files were uploaded to Otter.ai and the resulting transcript was moved to Google Docs. After the audio files were transcribed, we edited each transcript, correcting any phrases that were not properly transcribed by the software. This was done by listening to the recording of each interview again and editing the transcribed text in real time to correct any obvious errors in the transcription. After the transcribed text was edited, our team began the coding process for further analysis.

In order to code the data obtained from the interviews, our team was able to use the software NVivo with a WPI license from a remote desktop. NVivo is a software that helps researchers organize, analyze, and draw conclusions from qualitative data. It is regarded as one of the best qualitative analysis softwares and was deemed suitable for our project. Using NVivo allowed us to quickly and efficiently code the transcribed data we obtained from the interviews.

To begin, each edited transcript was downloaded as a txt file from Google Docs and was uploaded into NVivo (see Appendix E). Our team combed through the larger chunks of text that made up the interviewees' responses, looking for groups of sentences that could be assigned a theme related to open innovation, as shown in Figure 9. In NVivo, these themes are called "nodes", and groups of text can be quickly assigned to as many nodes as needed. For example, if an interviewee included an idea in one of their responses about the different intellectual properties they deal with when practicing open innovation, those few sentences would be highlighted and added to the node "Intellectual Property" as a code. The nodes are listed out on the left window and when selected and opened, they display all of the codes attributed to that node.

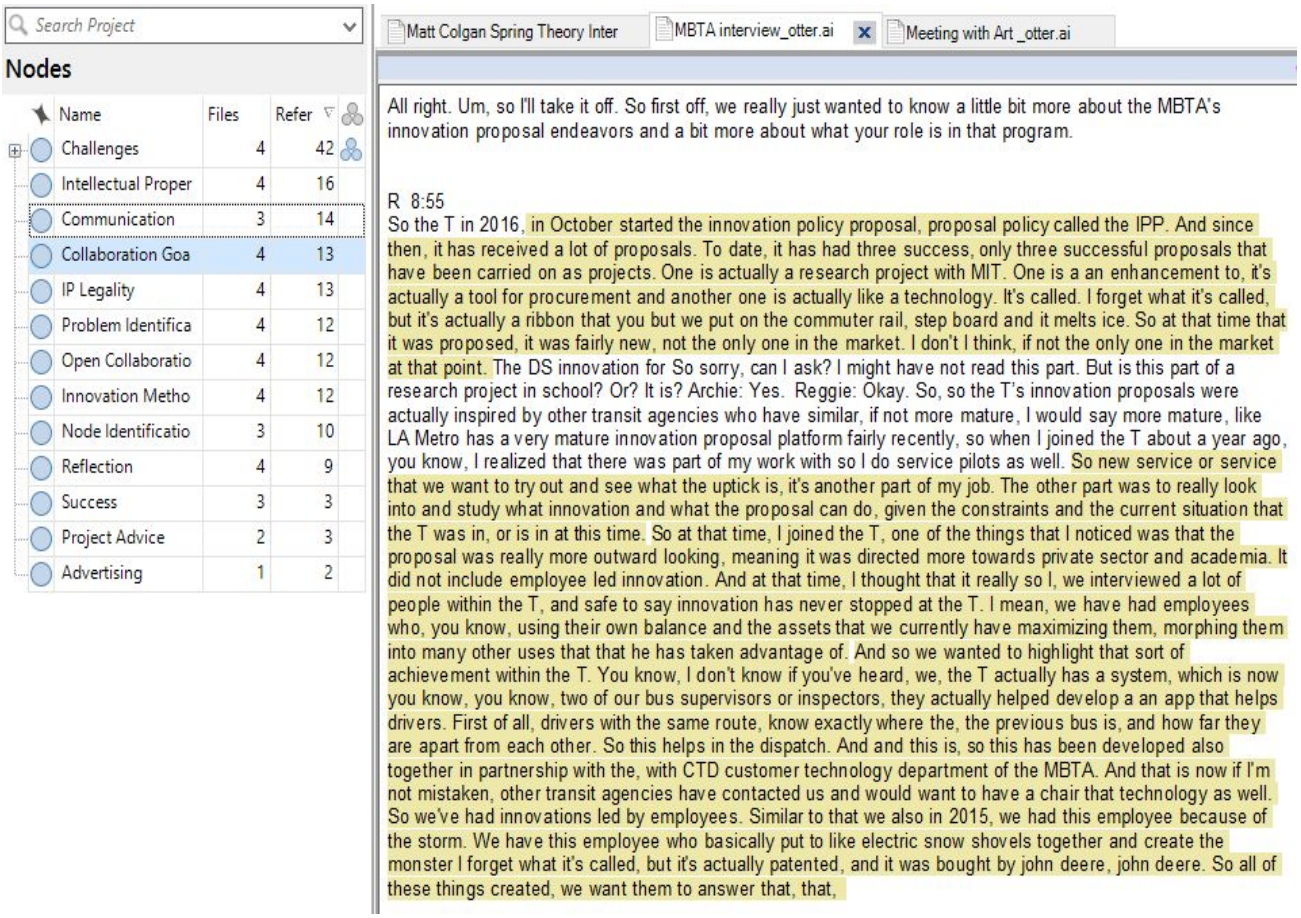

Figure 9: *Example coding passage with NVivo, a qualitative coding software*

Initially, the interview transcripts were read and the groups of sentences were assigned a broad node. After all of the interview transcripts had been coded, NVivo allowed us to create node hierarchies in order to more specifically attribute themes to the data. For example, the codes in the parent node “Challenges” were more specifically coded to fall under nodes titled “Internal Challenges” and “External Challenges.” Once the data of transcribed interviews was analyzed, the results were summarized and reported on in the findings chapter.

The survey created by our team yielded over 270 responses about the state of open innovation knowledge at WPI and AUS. The survey was an important part of our Discovery Phase and the data contained within the survey responses was analyzed for ideation and prototyping. To analyze the data from the surveys, our team used a combination of qualitative and quantitative analysis. For the qualitative analysis, the surveys’ open response questions were examined for themes consistent with those found from the conversational interview data. The

quantitative analysis focused on examining the percentage of respondents that had heard of open innovation, participated in an open innovation endeavour, etc. Within Qualtrics, as shown in Figure 10, there are ways to create reports and outline them with a variety of graphs. We examined the data by creating reports with the integrated filtering system which allowed for efficient quantitative data analysis. The survey data analysis as a whole became important during the Ideation and Prototyping Phases when determining how best to get the student populations of each institute involved with open innovation endeavours.

Figure 10: *Example survey data report from the Open Innovation Networks Qualtrics Survey*

3.3 Ideation Phase

During the Discovery Phase of our IQP, our group focused on tailoring our research methods to gain the largest amount of relevant data possible. After obtaining data by performing conversational interviews and creating a survey for students to fill out, our team analyzed the data and recorded relevant themes to be reported in the findings chapter of this project. The second phase of our project methodology, referred to as the Ideation Phase, involved using all of the findings and analyzed data to begin theorizing about the development of our prototype open innovation model. One method employed by our team to ideate was a "negative brainstorming" method. This method involved generating bad solutions to the problem, and then seeing how those could be transformed into usable and good solutions. By using this brainstorming method, it allowed our team to come up with reasons why the solution will not work or why the problem

could not be solved. Instead of brainstorming for possible solutions, our team brainstormed everything that could make the problem worse, and then thought about how to eliminate these aspects. Once the Ideation Phase was complete, our group moved forward with turning the most important ideation creations into a potential solution.

3.4 Prototype Phase

After using the data to brainstorm solutions during our Ideation Phase, the Prototype Phase focused on the design and implementation of our final solution. From the negative brainstorming in the Ideation Phase, possible ideas and solutions were designed along with any logistics for implementing the design. To achieve the final layout, there was a constant design, review and reiteration process that utilized the negative brainstorming to ensure that the solution considered all the negative aspects. Ways to eliminate the negative aspects were listed out and incorporated into the final design. To help with the implementation, existing solutions were examined to further improve the final design. After designing the final solution, we plan to come up with ways to solicit feedback from various sources and utilize them for the implementation of the prototype.

3.5 Summary

In this section, we presented the methodology that we developed and followed in order to successfully address our research problem. We followed a Design Thinking process that began with the Discovery Phase, during which we conducted conversational interviews with the nodes of our case studies, spoke with WPI faculty, and conducted a survey for WPI and AUS students to gauge the knowledge of open innovation at each institution. Using the data that we collected and analyzed in this phase, we were able to begin our Ideation Phase, in which we employed techniques such as negative brainstorming to agree upon who would benefit the most from an implemented open innovation network. After the parameters of the network were decided upon in the Ideation Phase, the Prototype Phase commenced and the implementation planning began. The findings from our Discovery and Ideation Phases are presented in the next chapter.

Chapter 4: Findings

In this chapter our team reports on all of the findings collected by our team during the Discovery Phase of our research. The findings from the Discovery Phase include the data from the various conversational interviews performed by our team and also the data taken from survey responses submitted to students at WPI and AUS. At the end of this chapter, all of the findings from our research are summarized in our open innovation network framework table.

4.1 Discovery Phase

As detailed in our methodology, conversational interviews and survey responses from individuals who are interested in being involved with open innovation endeavours at WPI and AUS comprise the findings of our team's Discovery Phase. Each transcribed interview was analyzed several times by the members of our team, and the major findings (e.g., challenges, benefits, and considerations) of the interviews are reported on below. Each interview brought with it a different perspective on open innovation procedures, and so there were a multitude of different findings that would go on to influence our Ideation and Prototype Phases. Additionally, findings discovered by our team from both conversations with WPI faculty and the responses to our survey are reported in the supplementary findings section. Our team begins by presenting the findings of each conversational interview.

4.1.1 MBTA

While trying to discover potential cases to investigate, our group found the MBTA and their Innovation Proposals program where they accept innovative ideas from users of the MBTA's transportation services. This turned out to be one of the few instances of a local open innovation network that was advertised to the public and was not limited to individuals and programs in academia or other usual entities in open innovation (as described in section 2.4 Agents of OI). After reaching out to several WPI alumni, we were able to interview the Deputy Director of Pilots and Innovation at the MBTA. This interview provided valuable information

about the inner workings of the MBTA's Innovation Proposal program. The questions discussed centered around the interviewee's role in the MBTA's Innovation Proposal program, as well as the challenges and improvements that the MBTA have encountered in their open innovation endeavours.

Figure 11: *MBTA Innovation Proposal Form (MBTA, n.d) https://docs.google.com/forms/d/e/1FAIpQLScZZMwhrpI17whbTVp2cBcMOIXwIbYUsU-0zhJCJYKAwWFeQw/viewform?c=0&w=1&usp=send_form&usp=embed_facebook*

The MBTA's Innovation Proposal program has facilitated the development of three proposed ideas that have been developed into full projects being pursued by the MBTA. Figure 11 shows the official MBTA Innovation Proposal Form that is posted on their website for innovators to propose designs. One of these has resulted in a ribbon that is put on the step boards of the commuter rail to melt ice. It was also discussed that previously this program was very outwardly or externally focused, seeking ideas from passengers and the general public. However recently this program has also been extended to actively seek ideas from employees of the MBTA. This endeavour has been very successful, for example, two of the MBTA's bus supervisors/inspectors helped develop an app that helps drivers on the same route know where the other buses are so they know how far apart they are. The interviewee explained how her goal

was to make this program more organic and to have an environment to allow innovation to develop whether they end up being used for the MBTA or not. This was shown in how an employee created a new snow blowing machine from other equipment available to the MBTA so that the tracks could be cleared in the massive storms known to hit Boston and other New England cities.

Following this discussion, the interviewee discussed some of the remaining challenges that programs similar to the MBTA's. Primarily, in recent times the COVID-19 pandemic has posed many challenges to the MBTA's ability to promote their innovation program. Since the major outbreak of the COVID-19 in the beginning of 2020, many of the MBTA's efforts to advertise their Innovation Proposal program have been overshadowed. Furthermore it was noted that they have been able to maintain a steady flow of proposals which has allowed this program to remain operating through 2020. Another challenge discussed was the need for the MBTA to reach out to more startups, innovation labs and educational institutions, as many of the proposals come from these entities. Furthermore, it was discussed that an external campaign was not needed at this time, since the MBTA has received plenty of proposals so far (close to 200). This was further discussed when the interviewee expressed that she would like to develop this program to encompass a MBTA innovation lab of sorts where they could offer apprenticeships or summer internships.

Ultimately this interview helped our understanding of open innovation and how an entity in open innovation needs to constantly monitor its open-ness to maintain the benefits of OI. It also showed how innovation can be found outside of the usual entities found in open innovation. Furthermore the success of the MBTA's Innovation Proposal Program shows how impactful community engagement can be when seeking improvements to a system. However, it became apparent that more resources need to be invested to be able to pursue proposals to their full potential. To gain a more open perspective on OI, we would benefit from interviewing another node that deals with multiple types of OI entities and understands how to form those connections in a systematic fashion.

4.1.2 Spring Theory

Spring Theory is an innovation consulting firm that facilitates open innovation projects among various entities. Spring Theory's role is to connect universities and companies around meaningful collaborations that enrich real world experiences for students and provide unique solutions for companies. The company satisfied our case study criteria (as described in section 3.1.2) represented in Figure 5, and operates with open innovation among academia. They have been a company for almost 11 years, and have a constant, long standing network utilized by dozens of universities and corporations. As operators and facilitators of open innovation networks, Spring Theory is uniquely positioned to understand the challenges and opportunities that accompany implementing an open innovation network that includes companies and academia. After reaching out to multiple contacts from Spring Theory found through LinkedIn and CareerShift, we were able to interview the Senior Client Development Manager.

During the interview, the questions asked pertained to understanding Spring Theory's role as a facilitator of open innovation and any challenges they experience in terms of communication and intellectual property. The development manager explained that Spring Theory's role is to facilitate "almost like a recruiter in a way to set up the project opportunity between the university and the company". In a sense, it is a two sided market where Spring Theory makes sure that the universities involved are engaged in projects where, at the same time, the companies are the clients. Similar to the MBTA, as shown in Figure 12, Spring Theory has a "Contact Us" form where collaborators can reach out to Spring Theory about potential projects. Their process relies heavily on communication where they initially start out with educating the client on what the opportunity is and with what course they will be working with through an introductory call. If the client wants to move forward through the process, they will communicate with a professor of the course to understand the roadblocks and expectations for the project. Then there might be some paperwork involved such as Non-Disclosure Agreements (NDAs) involved or some Intellectual Property (IP). There are constant communication chains between Spring Theory and the collaborating entities though weekly check ins as they are important for keeping the students or professors who are not within the company involved and aware of the

information. Spring Theory remains engaged in the collaboration and goes ahead with any course corrections that need to happen.

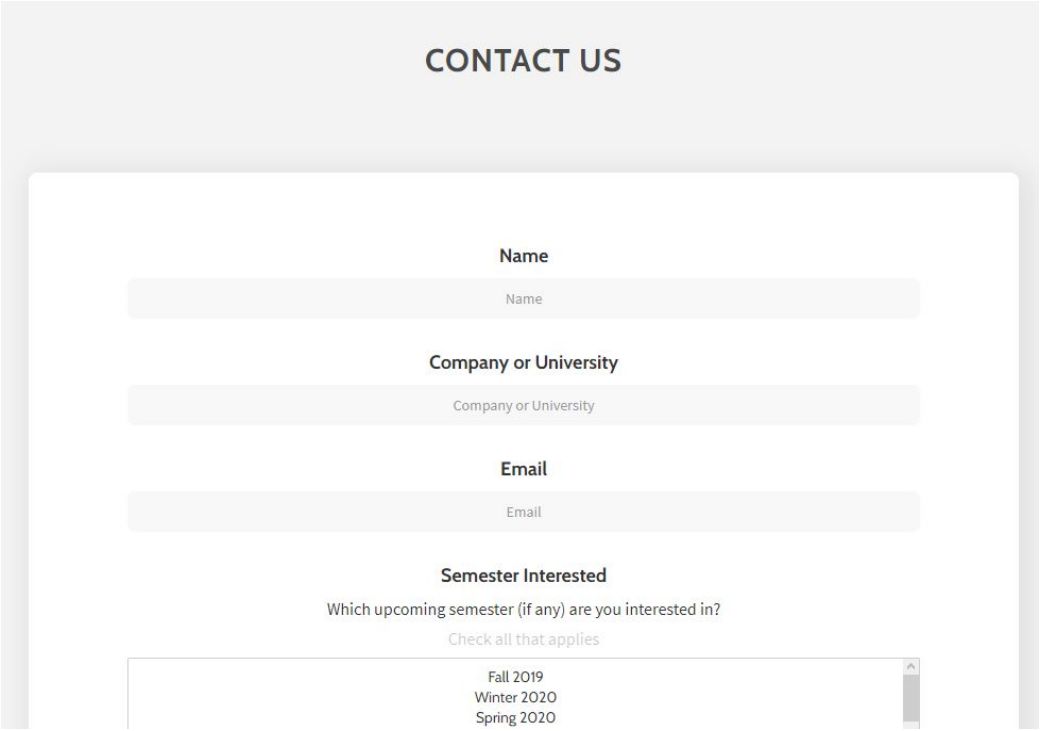

Figure 12: *Spring Theory Contact Us Page for Communication (Contact Us, n.d)* https://www.springtheory.com/contact-us

Spring Theory has collaborated with hundreds of leading companies such as Amazon™, Coca-Cola™ and Bose™ along with prestigious universities such as the University of Pennsylvania, Cornell University and USC. Some of the most successful projects with these entities are usually the ones where there is a good cadence of communication because the client can see how the team is progressing. The strong connection through Spring Theory allows the collaborating entities to produce a successful final product that gets the clients to return and proceed with another venture. Additionally, the affordability of connecting with Spring Theory's network creates an incentive for universities and companies to return and collaborate through Spring Theory. Through these successes, their goal is to provide useful strategies, innovation, and insights to these companies and create mutual collaboration to help students develop during their academic career.

On the other hand, there exist drawbacks and challenges to the facilitation of open innovation projects that Spring Theory experience. One of the larger challenges specific to this

year was the COVID-19 Pandemic. Due to COVID-19, companies and collaborators were not utilizing the network due to lower funding and spending freezes that were placed that took them out of the pool of collaborators. Another challenge Spring Theory faces is the identification of potential nodes or collaborators. Sometimes "the course was not the right fit, or something else to where the project is still valuable, but maybe missed the mark in an area". Similarly, some companies might not believe that working with students can benefit their projects, so there is the challenge of finding the right company to work with that values these kinds of projects and developments. Additionally, Spring Theory does not market their network due to the uncertainty of where the marketing return will be. It highlights the challenge of trying to communicate the network and facilitation and allowing it to reach the right people such as the lead decision makers at companies. This communication is important as it provides an understanding of how the project should be advertised and run. Sometimes if a project from a professor is put online then have someone try to work on it, the project is set up to fail because of the lack of communication where they are looking at the brief online and not working through it.

Understanding the successes and challenges that an open innovation project facilitator, like Spring Theory, face will allow our group to create an open innovation network that considers Spring Theory's limitations and further improves them. To gather a wider range of challenges and limitations, interviewing a governmental entity would provide us with insight that differs from a corporate or academic perspective.

4.1.3 City of Worcester

Upon searching for case study nodes that would potentially have an interest in interviewing with our team about open innovation practices, we learned of Worcester's Office of Urban Innovation. This office manages the improvement of all types of technology used in the city of Worcester, with the ultimate goal of turning Worcester into a Smart City that relies heavily on data transfer and openness between different implemented technologies. While the Office of Urban Innovation is a governmental entity with innovation experiences that differ from those of corporate entities or academia, they also have a keen focus on transparency with their Open Data Portal and a connection with local universities. After reaching out initially to a WPI

alumni who works for the city, we were redirected to speak with the current Director of the Office of Urban Innovation.

As each interview's questions were tailored to fit the type of node our team would be speaking to, the bulk of the questions asked during the interview aimed to understand the different projects a governmental entity might take on during open innovation endeavours. With regards to internal practices with an open aspect, the aforementioned Open Data Portal is a large contributor to the City of Worcester's contemporary take on transparency in government. The interviewee described the ways in which the Office of Urban Innovation is aiming at growing this portal into a tool to be used by the public and outside collaborators in the future.

Figure 13: Pericot, M. (2013). *Elm Park, Wooden Bridge, Worcester, MA* [Photograph]: https://commons.wikimedia.org/wiki/File:Elm_Park,_Wooden_Bridge,_Worcester,_MA.JPG

Perhaps the most interesting finding of our interview revolved around the fact that the Office of Urban Innovation has often already collaborated with multiple colleges around Worcester, including with WPI in past student projects. The interviewee detailed how Worcester's local government has worked with Clark University as a research partner on Worcester's Youth Violence Prevention Initiative, and also with Worcester State University on

projects surrounding urban planning and data analysis for the city. They pointed out that the wooden bridge in Elm Park, shown in Figure 13, near WPI was actually the result of a collaboration between civil and architectural engineering student teams at WPI and the City of Worcester. After analyzing the transcription of this portion of the interview, our team was struck by a finding that we had not yet thought of: our team had not yet considered open innovation collaborations between academia and an external entity as a pathway to giving back to the community through jointly developed projects. This was the most important finding our team discovered during this interview, and the implications of this finding are discussed in the next chapter.

While it was made clear that the City of Worcester had collaborated with IQP teams in the past, the interviewee informed our group that there is a desire within the Office of Urban Innovation especially to collaborate more with WPI on future projects. When asked what would be required to make the facilitations of projects between the Office of Urban Development and WPI smoother, the interviewee stated that having a singular individual to work with or reach out to could be highly beneficial. They stated their belief that WPI students have many innovative ideas that deserve attention and criticism, and having a sole contact or outreach point would allow for more ideas to be heard through project coordination. Our team found that this would be a great way for WPI students to get involved in project development as Worcester moves closer and closer to becoming a fully integrated Smart City.

4.1.4 Honeywell

The fourth case study interview that our team conducted was with the regional R&D Director for Honeywell UOP, based out of Saudi Arabia. This particular interviewee is an expert on open innovation from a corporate R&D standpoint. Our team prepared a list of interview questions about open innovation practices that were appropriate for a representative of a large corporate entity to answer. Many of the findings from this interview enforced the information our team learned during our literature review and gave us a better understanding of some of the challenges corporations may face when choosing to work with an external partner.

Early on in the interview, the interviewee emphasized the importance of intellectual property ownership. There are many challenges associated with collaborating in an open nature

and being protective of intellectual property. Our team found from the interview that one of the main challenges of sharing intellectual property is being able to apply shared technology to only one project. For instance, if a company shares technology or information with a partner for a collaborative endeavour, then that company has a choice of whether or not to allow that partner to use the knowledge gained in future solo innovation projects. The use of the technology is not always permanently allowed by the company that originally developed it. Our team found from our sponsor that oftentimes companies may employ non-disclosure agreements to keep information learned during an open innovation endeavour to individuals, opposed to sharing it with an entire external entity. Another challenge discussed regarding intellectual property was that oftentimes graduate students in academia will want to publish information learned from open innovation endeavours in their theses or other similar papers. This can create problems for the companies who own the IP being discussed, as it essentially gives free information to competitors. Non-disclosure agreements are also a tool commonly used in these scenarios by companies looking to protect some aspects of their intellectual property. The interviewee also emphasized that it is important in partnerships to make sure that partners are only collaborating directly with one company at any given time (for a specific project), and not feeding proprietary information to other innovation teams or groups. Finally, our team also found from this interview that quality assurance procedures may change depending on the company, and so that is something that must be taken into account when working with external partners.

After describing some of the challenges faced with regards to IP management, the interviewee also described to us some of the benefits that corporations enjoy as a result of working with academia. Our group found from the interview that academia is oftentimes leading the way in cutting-edge research for a great variety of technologies. As a result, corporations will partner with academic teams in order to heighten the baseline of their technological knowledge. Academia often has many individuals dedicated towards developing a new technology or solving a problem, and corporations have ways of utilizing those technologies or solving said problems on a mass scale. They explained to our team that corporations will often scan scientific publications in order to get a better grasp on what technologies universities are working on. Larger companies will sometimes cut down or reshape a project being performed by academia in order to make it more economically viable. As was expected by our team, financial stability is

one of the most important considerations any company will make before pursuing a joint development endeavour.

When asked why a large corporation like Honeywell UOP would choose to work with an external partner opposed to working in-house, the interviewee pointed out the fact that companies simply may not have the resources to execute certain projects. If a company does not have enough scientists, engineers, or developers to begin a project then there is a chance that a project will remain unbegun for an indeterminate amount of time. Our team found that companies strive to push out as many projects as possible and get to market fastest in order to increase profit. Our sponsor again explained to us that external innovation may also be required when a small company or academic professor has a highly specialized technology or set of information that cannot be found or used elsewhere. Overall, the interview with our sponsor gave our team much insight into how an R&D-focused individual analyzes and selects open innovation endeavours. We learned about the benefits of selecting open innovation and some of the risks that may be associated with relying on external partners. The next portion of our Discovery Phase findings deals with supplementary data that was helpful to the development of our project.

4.1.5 Supplementary Findings

In addition to the data collected from the various case study nodes, our group collected supplementary data from WPI Faculty and students that do not fall under a specific case study. WPI Faculty, such as Curtis Abel and Joseph Doiron, provided us with information specific to WPI and their innovation and entrepreneurship endeavors and elements that have not been researched in our literature review. Additionally, survey data from both WPI and the American University of Sharjah (AUS) provided us with an understanding of who knows about open innovation and who is interested in getting involved in open innovation efforts.

Faculty Interviews

Dr. Curtis Abel is the Executive Director of Innovation and Entrepreneurship at WPI and has been working on ways to help students and the community build an entrepreneurial mindset. He explains how entrepreneurial skills are critical and important for future sustainability and

have a sustainable impact. His goal is to not only assist students, but faculty and extended Worcester communities as well to come up with new ideas, find and evaluate opportunities, and look at problems as opportunities in a developing marketplace. To do so, Dr. Abel is trying to incorporate the innovation and entrepreneurship ecosystem of resources into the fabric of WPI, in the curricular, extracurricular and research sides. He mentions how "it is about value creation, solving problems that matter, and less about starting up a business that will come". The innovation and entrepreneurship center has many resources available for all students on campus, such as the Foisie Sandbox IQP Center that incorporates a credit-based opportunity to create and work on a business that fulfills the IQP requirement. Another is the Winter Session where it brings together the WPI community of students, faculty, staff and alumni for three days of innovation and entrepreneurship workshops. These workshops range from design thinking to negotiations to customer segmentation in order to bring the community together in a fun community-based learning environment. All of these resources are channels of integration that can be done through extracurricular, curricular, or research.

In terms of our prototype and project, Dr. Abel describes potential methods and challenges that would assist us in our prototype development. One of the larger challenges and problems that he has encountered is the idea of problem identification. Many students are chasing innovative solutions but they are not knowing whether it is a need or if it is a problem worth going after. Some student innovators are not equipped with the tool of identifying whether a problem is a problem and what some questions should be asked. They are often expected to know what the problem is or come up with the problem themselves. This is a skill that is not necessarily taught in classes that could be learned through external resources. Similarly, communication is an important part of problem identification. Understanding people's desires, their mission and incentives from their perspective help with identifying key problems together. Another challenge is team dynamics and intellectual property where there could be some issues in terms of idea generation that now needs a patent involved which oftentimes ruins the openness of collaborating and innovating with other entities. Dr. Abel suggests that our prototype solve these problems by creating a platform for design thinking that revolves on Human Centered Design. Pulling people from various schools, corporations or communities could offer tons of opportunities that might be done for credit to get more students involved. Utilizing Dr. Abel's

suggestions, comments and information about current innovation and entrepreneurship endeavors will help strengthen the prototype development.

Professor Joseph Doiron is the Director of the Center for Global Public Safety at WPI as well as our project advisor. He has provided valuable input in assisting the development of our project from his involvement in the Innovation and Entrepreneurship Center at WPI. He has helped us with communicating our ideas and solving problems that have been beneficial since the start of the project. With his work with Dr. Curtis Abel, he has been an instant point of contact to answer some of the questions with regards to innovation and entrepreneurship resources at WPI. We were able to bring up any concerns and he asked us questions about our project that helped refine our choices and decision making.

Survey Data

As part of our data collection, we gathered data from students at both institutions in the form of a Qualtrics survey. At the end of our data collection, we received over 270 responses from students at WPI and the AUS (see Appendix C). As shown in Figure 14, about 56.7% of respondents were from WPI and 42.3% were from the AUS.

Figure 14: *Distribution of the survey between WPI and the AUS*

The survey asked if the students have heard of open innovation and whether they are interested in learning more or participate in open innovation projects. As shown in the figures below, only 6% of survey respondents from both universities understood the details of open

innovation (see Figure 15). Some people have heard of the term before, but 94% did not know what open innovation was. Additionally, only 28% of respondents have worked on any open collaboration efforts with outside entities (see Figure 16). This includes optional co-ops with other corporations or IQP projects that require working with outside sponsors. With regards to innovation and entrepreneurship resources, only 24% of respondents utilize any of these resources, whether it is participating in the Winter Session or attending the various workshops available to the community (see Figure 17).

Figure 15: *Percentage of survey respondents who have heard of open innovation*

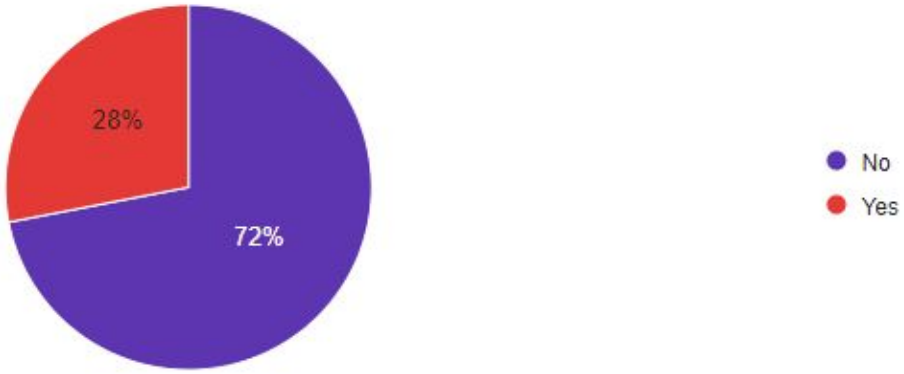

Figure 16: *Percentage of survey respondents who have worked on collaboration efforts with other entities*

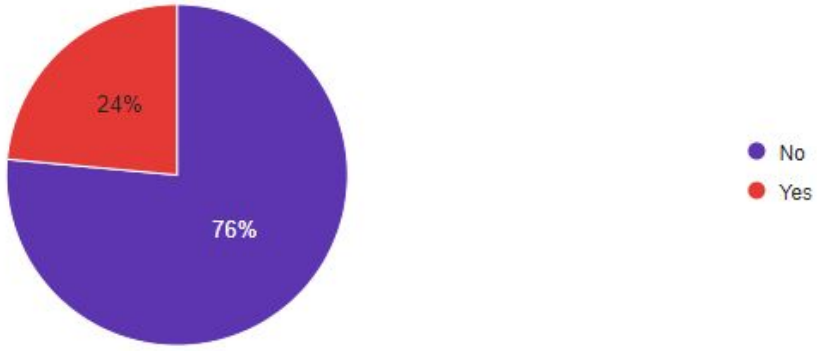

Figure 17: *Percentage of survey respondents who use existing innovation and entrepreneurship resources*

It was also discovered that 81% of the survey respondents are interested in participating and learning more about open innovation and getting involved with projects with outside companies, universities and communities (see Figure 18). Although not all respondents who are interested will end up participating, the high percentage indicates that there is some interest within the student body.

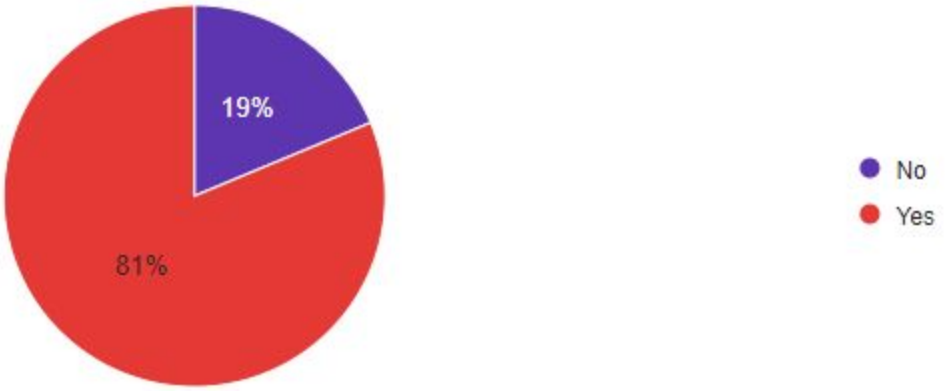

Figure 18: *Percentage of survey respondents who are interested in participating in open innovation endeavors*

In addition to the numerical data collected such as the percentage of interested students and knowledge of open innovation, it asked if the students have any ways to implement open innovation in their respective institution. This qualitative question allowed us to obtain valuable ideas and information that our team had not yet considered. Considerations, such ways to advertise or people to talk to, were helpful for outlining our framework. Many students suggested having a heavily advertised portal or center with specific opportunities where they could be on-boarded onto projects. Some suggested modifying the existing required projects, like regular class projects or the Major Qualifying Project (MQP), to connect with other schools and companies on a regular basis. Overall, students would like to see more collaboration efforts with existing WPI offices, such as the Innovation and Entrepreneurship Center, and external collaborations, and encouragement from the school or professors to openly innovate. This will allow them to learn skills and gain experience from sources outside the university walls that will be beneficial for their future careers.

4.2 Open Innovation Network Framework

After completing analysis on both the transcribed interviews and the supplementary data, our team compiled the acquired themes in a concise table for reference. This table was referred to as our team's open innovation network framework. The framework displays the major themes and subthemes that were deemed relevant to our research and eventual prototype development. Each theme played a role in determining the points of focus of the brainstorming sessions and is displayed in Table 2. Within the major themes, there are smaller subthemes compiled from each interview that reference specific aspects of open innovation.

Table 2: *Table outlining the Open Innovation Networks Framework*

Open Innovation Networks Framework			
Communication	**Intellectual Property**	**Project Selection**	**Existing Network Aspects**
Advertising Intercommunication Intra-communication	IP Legality	Node Identification Problem Identification	Goals Challenges Methods

4.2.1 Communication

Initially, our team found that a common aspect between open innovation networks is the communication involved in the project development or collaboration effort. There are three forms of communication that corporations are typically involved in: Advertising, Intercommunication, and Intra-communication. Advertising deals with the external outward

communication of the network to other entities or platforms in order to attract potential collaborators. This could be done through email marketing/sales, commercial advertisements, or posting on various platforms. Advertising is generally the first step for collaboration that is an important aspect for open innovation networks to be sustainable. On the other hand, intercommunication is the two-way communication between the collaborating entities whether it is between the corporate teams or the larger separate corporations. Intra-communication is the communication within each specific team inside the corporation. This largely deals with team dynamics and is important in terms of the other aspects of the open innovation prototype. Aspects like Intellectual Property and Project Selection rely heavily on the communication within the project for understanding the logistics of the project and any roadblocks involved. Sometimes communication issues could lead to getting intellectual property involved where some ideas could be kept secretive and legality issues would arise

4.2.2 Intellectual Property

As mentioned above, another aspect is the intellectual property and legality issues that arise when developing innovations especially openly when ideas are shared internally and externally. In order to protect ideas, intellectual property or other legal forms must be involved so other entities or collaborators do not steal ideas. This is an important aspect of open innovation as it can determine how successful the endeavor ended and whether the collaborating entities will return for another project. Communicating and negotiating these rights can be difficult for both parties trying to profit from the collaboration. It is important to identify and understand these roadblocks and negotiate the specific rights so each entity can be satisfied.

4.2.3 Project Selection

Project Selection before beginning an OI endeavour was another major theme that our team extracted from the different case study interviews. Broadly, this refers to each node analyzing specific variables of joint development agreements before beginning them. The subthemes that arose from this major theme included both node identification and problem identification. As the name implies, node identification as a subtheme was applied to any code that dealt with selecting organizations or entities to participate in open innovation with.

Similarly, problem identification was used as a subtheme when any interviewee talked about how they determine which problems to solve through open innovation.

4.2.4 Existing Network Aspects

The final major theme assigned to the transcribed data was labeled as existing network aspects. Perhaps the most broadly applicable theme, its meaning becomes more specific through its subthemes: goals, challenges, and methods of open innovation that were present in the transcribed interviews. The codes assigned these subthemes are some of the most technical with regards to how open innovation is actually performed and what roadblocks or challenges they face. For instance, if an interviewee outlined one of the open innovation methods their organization utilizes, it benefited our team's findings with specific examples of OI that were applied to our prototype. Table 1 was used repeatedly as our team began the brainstorming sessions that lead to prototype discussion and development.

4.3 Summary

This section detailed all of the findings our team discovered throughout the Discovery Phase of our research. The data reported above was collected from the interviews arranged by our team and from supplementary experiences with WPI faculty and students from both WPI and AUS. Culminating in representation through our open innovation network framework, our team referred to the findings of our research numerous times while forming our OI prototype. Our team examined the framework especially closely while completing the Ideation Phase of our project. The feasibility of our prototype and the different variables affecting its implementation and use are described in the following chapter.

Chapter 5: Prototype Development

In this chapter our team presents the findings from two of the remaining three phases of our project and research: the Ideation Phase and Prototype Phase. Using all of the findings from the previous chapter, our team began the Ideation Phase by examining the criteria our prototype would need to satisfy in order to efficiently facilitate open innovation at WPI and AUS. By doing this, our team was able to ideate forms our prototype could take and what features the prototype would contain.

5.1 Ideation Phase

The Ideation Phase of our research consisted entirely of a brainstorming session aimed at listing the various criteria our prototype should satisfy to be considered an efficient tool at facilitating open innovation at WPI and AUS. The Ideation Phase was completed while using the framework created as a result of the Discovery Phase as a reference. By doing this, our team was able to focus our brainstorming ideation session on coming up with criteria for our prototype that combined the strengths our team found from each case study node. The different features that our team decided our eventual prototype should have and the objectives it should aim to complete are described in the following section.

5.1.1 Network Criteria

In order to successfully ideate as a team and come up with a potential open innovation facilitation prototype, it was pertinent to decide on the criteria for our prototype. The first characteristics of our prototype that were decided on by our team were those that ensured open innovation would actually be taking place (see Appendix F). The main criteria that satisfied this and that served as a general principle was that our prototype must attract companies or entities that are willing to work with WPI and AUS students. As obvious as this fact is, it is fundamental to ensuring that more open innovation endeavours occur at each school. Another general criteria that our team believed our prototype should satisfy dealt with the scope of external entities

allowed to participate in the use of our prototype. That is, attention would be given to all projects proposed through our prototype regardless of the organization that submits them. This meant that large corporate firms, smaller companies and startups, governmental departments, and even other schools wishing to collaborate on a given project would all at least have a voice through our prototype. These two ideas served as the most general criteria for our team. As mentioned previously, the framework created by our team highlighted at the end of the last chapter was used as a reference during the Ideation Phase. The major themes that our team found and compiled from the collected data on OI networks included communication, intellectual property, project selection, and other existing network aspects (e.g., goals, challenges, and methods of innovation) that gave our team insight into why and how open innovation is utilized. The more specific criteria that our team ideated by using our created framework are highlighted below in Figure 19.

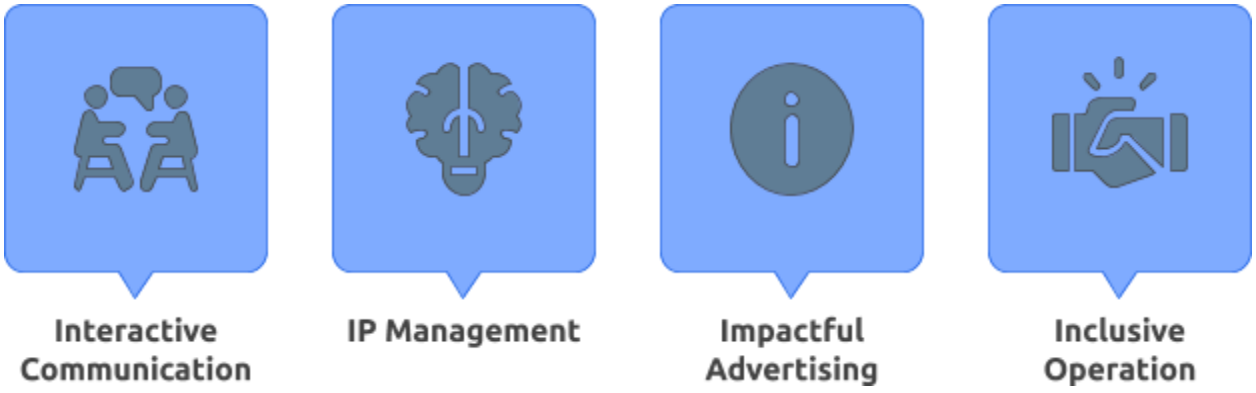

Figure 19: *List of network criteria that the final prototype needs to address*

Interactive Communication

The first criteria theme our team ideated for use in our prototype design dealt with the need for interactive communication. Interactive communication was defined by our team as a communication system that is efficient and fast-answering, getting projects off the ground sooner rather than letting them go without attention for weeks. We believed this to be an evolution of the communication theme in our framework, and used some of our additional interview findings to create criteria that our prototype should satisfy. The first interactive communication criteria our team decided upon was a directory listing professors and faculty of each school who are interested in collaborating on a project. This would allow for outside organizations who are

interested in working with WPI or AUS to quickly reach out to specific individuals directly about project opportunities that originate at one of the schools. The directory would eliminate any sort of need for talking to multiple people to begin planning project execution, and could instead streamline the process to the point that only talking to one professor or faculty member is necessary. Another detail our team ideated would be to designate a sole office or individual who would handle the project ideas that are introduced into the prototype from an external entity. This way, instead of having to move a project proposal up or down a command chain when an outside organization submits it to the prototype, a single individual or small team can quickly communicate potential options to the outside organization. Interactive communication methods were the first important features of the eventual prototype that our team ideated. The ways in which intellectual property would be managed through the prototype are described in the next section.

Intellectual Property Management

Stemming from the interactive communication is a well-managed intellectual property sector. The network must have resources available for strong negotiation of intellectual property. During a collaboration, there will be constant disputes on who receives which intellectual property rights, so understanding the methods of negotiation will be beneficial for both parties to properly obtain legal rights to an idea or innovation. A library of resources, such as example Joint Development Agreements or Non-Disclosure Agreements, or negotiation workshops would help anyone participating in the network learn more about how to handle intellectual property. Additionally, the intellectual property sector would need some integration with another party, whether that be an agency or a university patent department. This agency or department would assist the network in providing collaborators with access to lawyers and patent submission. For these resources to be utilized, the network itself must attract potential collaborators through creative and impactful advertising.

Impactful Advertising

In addition to intellectual property management, the network must have impactful advertising to attract external partners and the public and create meaningful collaborations. It is critical for the network to have an appropriate advertising base where corporations, students, faculty and the community are informed of the network and any corresponding events or workshops. It must be advertised in a way that reaches all potential or interested individuals who would like to be a part of the network and become involved with open innovation projects. Currently, some networks struggle with attracting potential collaborators due to their lack of direct advertising whether it is through marketing, emails, or posters. Specifically from the academic perspective, a way to accomplish this would be to advertise and encourage university faculty working on any research projects to include and incorporate them into the network. This allows for the creation of a faculty connection in the network that is open to different majors as well as promote cross-collaboration between majors. Additionally, the advertisement must create a path to act as a two way street between collaborators. This would create a way of accepting inbound ideas and share internal developments by advertising some of the research done internally through the network in order for potential collaborators and corporations to view them and consider negotiations. Proper advertising is important for the development of the network as it will determine the participants of the network as well as attract collaborators to assist in the growth of the network. This advertisement will allow the network to remain inclusive and completely open to all majors, backgrounds and experience levels.

Inclusive Operation

To ensure an open innovation network remains completely open, the inner operations of the network management must remain inclusive to many experience and background levels. One way to accomplish this is to have student involvement with running the open innovation network through work study or student employment/volunteer programs. This allows for the inclusion of new contemporary viewpoints on the operations of an open innovation network, while simultaneously exposing students to a professional open innovation environment providing applicable skills for their future careers. Another way to maintain an inclusive operation is to

integrate curriculum based projects into open innovation ventures. This will allow for students to gain experience with open innovation while simultaneously receiving credit towards their degree. Furthermore this method can benefit students who do not have the spare time to take on an external project but are interested in participating in open innovation and exploring its benefits. Additionally an open innovation network at WPI should be active in projects that are driven in community improvement and involvement. This should include projects in the Worcester area as well as those in Boston and Massachusetts. This ensures that the open innovation projects are able to address issues and needs of local organizations and community members. A final way to accomplish this would be to incorporate online learning and projects into the open innovation efforts. This allows for these projects to reach students and community members who are not able to be on campus or for companies to work with the school remotely and efficiently. Ultimately these criteria outline the necessary requirements for not only an open innovation network to operate but for it to succeed when being integrated with WPI and the AUS.

5.2 Prototype Phase

After the completion of our Ideation Phase, our team was left with an extensive list of different criteria our prototype design should satisfy. These ideas were a result of the many different findings our team compiled from the conversational interviews and supplementary experiences we conducted during our Discovery Phase, using our ultimate framework as a reference. With the Ideation Phase finished, it became time to begin our Prototype Phase. In this section of our project, our team decided on the format for a theoretical prototype, weighing the benefits and drawbacks of several currently-existing design types. Additionally, once a prototype format was decided upon, our team discussed and agreed upon the logistics of said format. That is, how the prototype would be set up, who it would be advertised to, how it may look, and so on. The work completed during the Prototype Phase of our research is highlighted in the following section.

5.2.1 Current Model Analysis

When examining the list of criteria that our team created during the Ideation Phase, it was concluded that there were several forms our prototype could take to satisfy the various criteria. Our team considered the currently existing innovation resources at each educational institute, as well as the open innovation methods utilized by the organizations we interviewed. Among the different prototype forms that were discussed, each was an innovation As stated in the introduction, each current design is described in the sections below alongside their respective strengths and weaknesses.

WPI Project-Based Learning

Currently, WPI has various project-based innovation methods that constitute its unique project-based learning university experience. In addition to regular in class projects, some of the core required projects are the Interactive Qualifying Project (IQP) and the Major Qualifying Project (MQP). The IQP is typically done with a project sponsor who is the one that proposes the project for the students to research and complete. Although this is considered open collaboration, it is restricted when it comes to project proposals as it is only one directional. Additionally, the project is only open for juniors to complete, removing the inclusive operation and restricting it to a certain group. As shown in Figure 20, only 9% of freshman and sophomore survey respondents have participated in any collaborative projects with any other universities or companies compared to 79% of seniors. Similarly with the MQP, it is not an open project that is restricted within WPI with one advisor and open only to seniors. With regards to the eProjects portal for the IQP and MQP, it is only closed for WPI students to apply and view university projects. There is no way of accepting inbound ideas and problems from the students themselves to propose them to the school on an open platform. WPI has a robust project innovation method that incorporates a curricular aspect, but is rather limited due to its closedness to outside collaboration. A similar platform could be implemented that further opens eProjects to everyone as a way to submit or apply to projects proposed by anyone from outside entities or WPI students and faculty. Examining WPI's project-based learning methods will help when designing our final prototype proposal.

Figure 20: *Percentage of WPI Freshman and Sophomores that have done open collaboration*

Innovation & Entrepreneurship Center

The Innovation & Entrepreneurship Center (I&E Center) at WPI has countless resources for WPI students and the community to utilize and build an entrepreneurial mindset for the future. They are constantly involving the extensive WPI and Worcester community of students, alumni, faculty and staff into events and workshops through the entire year. Although these resources are beneficial and assist students with innovation and entrepreneurship, the I&E Center has some difficulty with advertising these resources to university students. As shown in Figure 21, 25% of WPI student survey respondents do not know if WPI has any innovation and entrepreneurship resources available for student use, and 30% of WPI student respondents do not believe WPI successfully advertise these resources to students and faculty. Advertising the resources and center are important for attracting students and faculty to utilize the network. In addition to the number of advertisements, the quality and type of advertising must attract users to the center. Although the I&E Center does some advertising, only 24% of WPI student survey respondents make use of any of these resources for project endeavors. Despite knowing about the resources, some students do not utilize these resources as some may not be attracted to use the center. The I&E Center does an excellent job with integrating innovation and entrepreneurship resources into the WPI community curricularly and extracurricularly. With additional attractive and impactful advertising, more members of the community will feel the need to utilize these

resources to build an entrepreneurial mindset. Similar resources could be utilized in an open innovation network that is open to the whole community, but has increased impactful advertisements that attract users from other universities, corporations and the Worcester community.

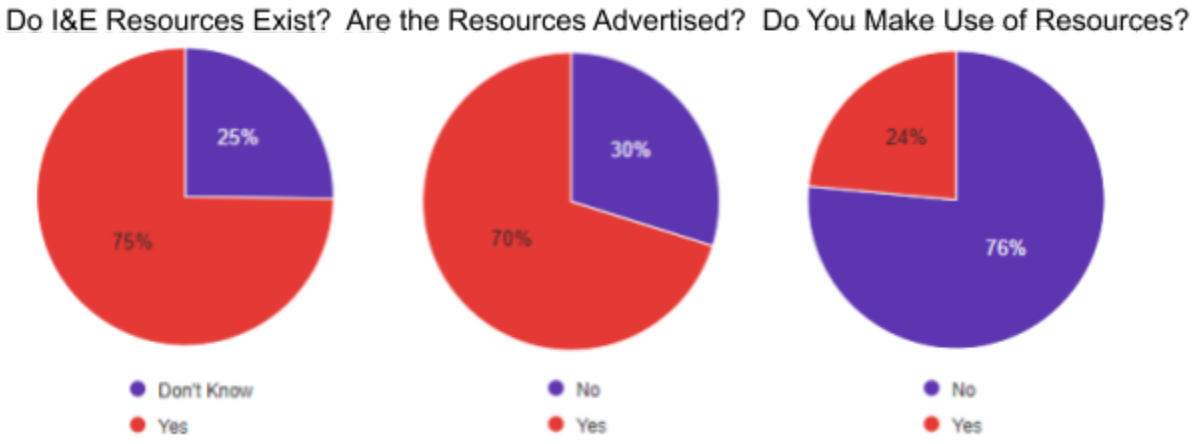

Figure 21: *Graphs of data for innovation and entrepreneurship resource usage at WPI*

MBTA Innovation Proposals

The MBTA's Innovation Proposals program allows for members of the greater boston area to submit their innovative ideas to improve the MBTA's services. As previously discussed (in section 4.1.1) this program has resulted in a few proposals that have evolved into fully fledged projects being pursued by the MBTA.This proposal has allowed for even more community outreach and responsiveness to the current needs and improvements that the users of the MBTA seek. However, while this style of open innovation has led to tremendous success for the MBTA, if this style of open innovation were to be implemented at WPI there are several complications that would need to be addressed to ensure its optimal operation.

Firstly it is not advertised that repeat development projects would be pursued from a successful proposal, this would limit the relation for future projects that could develop an innovative community in the long term when exposed to a new expanding network. Additionally, while this program is expanding to accept proposals from internal sources such as employees, the network's focus seems to be oriented towards seeking proposals from the public. However for an open innovation network to remain open at an educational institution such as WPI, a portal for

accepting innovative ideas must be advertised and offered to students, faculty, companies, community members and any other entity that would like to pursue an innovative idea with WPI. Additionally since this open innovation model is operating on the premise that all ideas end up with one entity and are oriented towards that , there seems to be limited expandability on the reception of these proposals. For a network to operate at WPI there would need to be a system where ideas from different fields and backgrounds could be connected with the right resources and people to ensure their success. For this type of program there would have to be a system implemented similar to that of Spring Theory to form the connection for a successful development effort.

Spring Theory Network

After analyzing the current methods that Spring Theory employs there were a few key takeaways that our group had. The model that Spring Theory follows finds its strengths in the fact that it can easily facilitate open innovation between corporate sponsors and academic teams. Spring Theory has worked with many different companies and universities to produce meaningful projects, sometimes working with several universities at once. It is evident through analyzing Spring Theory's methods that communication is truly key in producing successful projects. Their work is also evidence that there is desire and opportunity to complete open innovation endeavours with student-lead teams.

While Spring Theory demonstrates that there are projects to be designed and executed, there are a few improvements that could be made to their model if it were to be implemented at WPI or AUS. For instance, more impactful advertising could be done in order to maximize the amount of both academic and corporate sponsors that are introduced to the prototype. This could lead to more project proposals or requests from outside collaborators whose interest is piqued through the showcasing of an OI facilitation tool. Additionally, if one were to apply the same kind of innovation facilitation Spring Theory does to projects with government or community partners, then there would be even greater opportunity for successful projects. Overall, the examination of Spring Theory's model and other currently operating models and their benefits and drawbacks was helpful for designing our final prototype proposal. That prototype design is highlighted in the next section.

5.2.2 Final Prototype Design

Considering the strengths and weakness of each existing innovation model and the criteria our team set during the Ideation Phase, our team was able to design a prototype that we believe would be able to facilitate open innovation endeavours at both WPI and AUS. This final prototype design combined all of the strengths of the models discussed previously with the knowledge gained by our team during our literature review. The supplementary data collected during the Discovery Phase, namely the survey data and conversation with WPI faculty, was also used in order to tailor our prototype to apply well to a university environment. In this section, our team describes some of the potential prototype designs we considered. Additionally, our team examines our final chosen prototype format and assesses its ability to satisfy the criteria listed earlier on in the chapter.

Possible Ideas

There were several ideas that were considered by our team before we decided on the finalized form the prototype should take. The first prototype idea our team imagined would function similarly to a forum, where different faculty members or students could upload their project ideas for different external partners to see. This would also serve as an open communication space for ideas and entities who wish to engage in open innovation, however this prototype would seem to be challenging to protect IP and would mean that many companies would be hesitant to approach open innovation in this manner. Another prototype we considered was for a system of career fair or traveling university representatives where they would be able to form an in person relationship with another node in open innovation. However, this prototype would prove to be logistically challenging and somewhat redundant due to the ease and efficiency of electronic communication. A contrary idea to this would be to have a single office at WPI to handle all of the open innovation, this office would operate as a single point of contact for students, faculty and all external open innovation entities to inquire about projects and other collaboration efforts. Although this prototype would be limited by the number of personnel currently hired to work in the office, and would also seem somewhat inaccessible for community members who would like to approach the University about innovation proposals. Lastly we

discussed the potential of a Worcester open innovation portal which would be advertised to all Worcester residents for project proposals to be pursued by the City of Worcester and/or WPI. After further discussion, by itself this does not meet the requirements of being an entirely open innovation network. Following this idea generation phase we developed a model which encompasses the benefits of each of these models into one cohesive website portal prototype as discussed in the following section.

Prototype Overview

After considering several potential prototype designs and the strengths of all the models analyzed in the previous section, our team decided on a final prototype for our project. Our prototype would function as an organized network portal, complete with various features for project submission and discussion. This prototype would incorporate all of the themes of our open innovation framework from our findings and would satisfy each of the criteria of our Ideation Phase. The ways in which each criteria is satisfied are described in the following paragraphs.

Our network portal would satisfy the first criteria, interactive communication, in a variety of ways. Firstly, this network portal would act as a singular point of information for anyone to learn about open innovation endeavour opportunities at WPI or AUS. A directory of sorts will showcase different professors of various disciplines who are advising or conducting student-lead projects. By utilizing our portal, any organization will have a direct line of communication with these professors or other faculty members to discuss project opportunities originating at one of the educational institutes. Also, if an outside entity is submitting a project idea rather than speaking directly to a professor, quick feedback will be given by the individual or office responsible for the operation of the portal. This will limit the amount of time an outside collaborator has to wait to hear if a project will be begun or not. Communication is one of the biggest factors determining success in open innovation, and so our network portal prioritizes quick feedback between collaborators to expedite project execution.

The second set of criteria, categorized as intellectual property management, would also be satisfied by using our network portal design. In any open innovation endeavour, as indicated by our literature review and through our case study interviews, proper and careful IP

management is of the utmost importance. If our portal were to be adopted by WPI and AUS, then there would be a large emphasis on discussing any intellectual property rights that may be required for project completion. Those responsible for maintaining intellectual property rights could be a group like the Office of Technology Commercialization. Any entities using our portal, whether it be from an academia standpoint or from the standpoint of an outside collaborator, will be highly encouraged to discuss any IPs that may arise from the open innovation endeavour. Although any sort of IP rights will most likely have been discussed before beginning a project, it is crucial that each party discuss what deliverables may be a result of collaboration and who will have ownership of them. Our network portal will not pose any hindrances to the ability for different entities to collaborate with one another regarding intellectual properties.

After the Ideation Phase, the third set of criteria our team developed was organized under the heading “Impactful Advertising”. Essentially, these criteria related to our team’s need for our proposed network portal to be marketed in a way that interests outside entities and professors at each institution. In order to maximize the amount of outside organizations that take an interest in using the portal, there should be emphasis placed on showcasing it at every opportunity. For instance, WPI or AUS alumni could be reached out to and asked about promoting the network portal within their respective workplaces. At career fairs or other events with a corporate presence, the network portal could be shown off in order to gain more outside interest. Highlighting the network portal on the WPI and AUS homepages could also increase the amount of community involvement from local programs and smaller companies. Our team believes that our network portal would be an easily marketable innovation facilitation tool that would pique the interest of many different entities if advertised prominently. Information on who would be able to benefit from the network is highlighted in the next section.

The fourth and final set of criteria was organized under the header “Inclusive Operation”, and is perhaps the most important set of criteria our proposed network portal would satisfy. The network portal design our team is proposing would operate while prioritizing openness. The portal would be open to any outside organization that is interested in working on a project with WPI or AUS, with all given a voice to, at the very least, introduce their project idea. Instead of only taking projects or seeking sponsorship exclusively from large corporations, local governments and community organizations would also be encouraged to submit potential

endeavours to the portal. Additionally, SMEs or startups would be encouraged to use the portal. In order to allow for students to actively participate in the network portal and the projects included in it, it would be important to make sure that projects stay incorporated with the curriculum at each school. This way, students can participate in projects that benefit their education while also being able to attribute their name to an end project that may be used in industry or in the community. Making sure that the network portal is truly open to all who wish to benefit from it would be one of the portal's key features. In the next section, our team describes the actual logistics of the network portal, and how it would function in order to ensure that the criteria discussed above are met.

5.2.3 Logistics

After designing the final open innovation portal prototype, our team would need to create the physical portal and office to be implemented at WPI. Following these logistics, the network portal should allow for implementation at any academic institution. Before the construction of the network portal, our team would need to gain approval to create an overseeing Office of Open Innovation and the network portal from the WPI President or the Office of the Provost at our institution. Once we have received approval to create the office and network portal, the first step would involve deciding the format and platform of the portal itself.

Portal Design Software

To create the portal, we would use a software or website builder like Simbla which allows for dynamic website creation giving more room for a unique experience for each user. Another option would be to use the WPI Hub which offers a fast and simple website creator that is hosted on WPI servers. The decision to use either the WPI Hub or a dynamic website creator would depend on the time available to create the network portal. Both options will provide our team with the requirements to create the portal that provides users with easy access to the network and attracts students and faculty to use it. To attract users, the home page of the portal must be formatted for simple yet effective use.

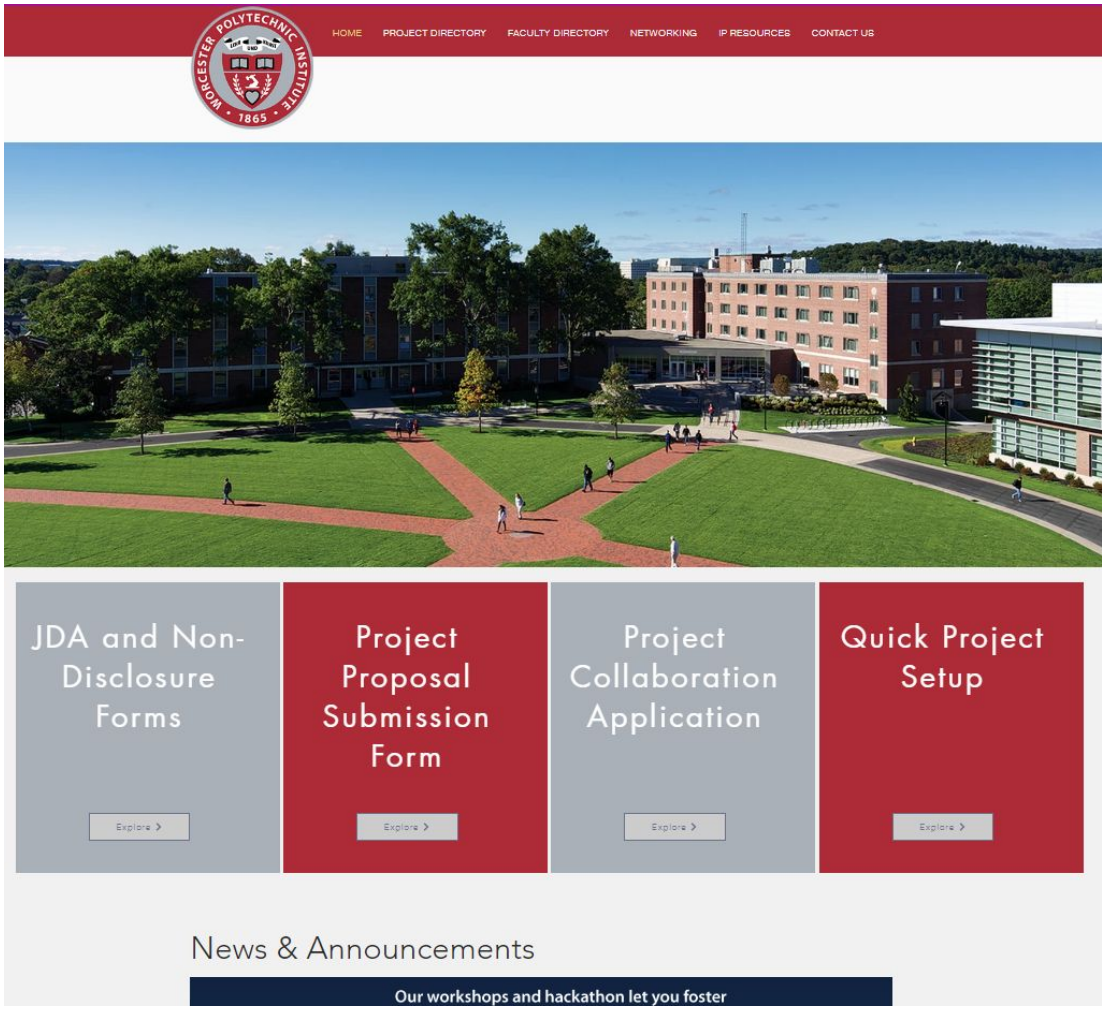

Figure 22: *Open Innovation Network Portal Home Page*

Home Page

On the home page, as shown in Figure 22, there will be multiple tabs that allow users to navigate the portal and access what they are searching for with ease. At the top will be the title of the portal as well as the title of the page the user is accessing, whether it is the home page or any directories. The first tab on the left would be the home page tab; this is to allow the user to return to the main home page of the portal. The next tab to the right would be the Project Directory tab where users can access a list of any proposed projects as well as which faculty, corporation or student has proposed it. After that would come the Faculty and Corporate Directory where users can access a list of any faculty and corporation that has registered their name into the network. In the Networking tab would exist a messaging or third-party chat room system like Slack where

users can interact with corporations and faculty and communicate about projects in the network or for general networking. The IP Resources tab would have access to any intellectual property resources such as Joint Development Agreement and Non-Disclosure Agreement forms, as well as a link to WPI's Office of Technology Commercialization. The final tab will be a Contact Us tab where the team's contact information will be found along with the office location and contact information. These tabs will be at the top of any portal page to navigate between all the pages In addition to the tabs mentioned, there will be three buttons that link to the Project Proposal Submission Form, the Project Collaboration Application, and a place for corporations to ask the network for a quick project set-up with a singular direct contact. On the rest of the page, there will be any news on projects in-progress, event dates and any announcements. Each page in the tabs will be described in the next sections

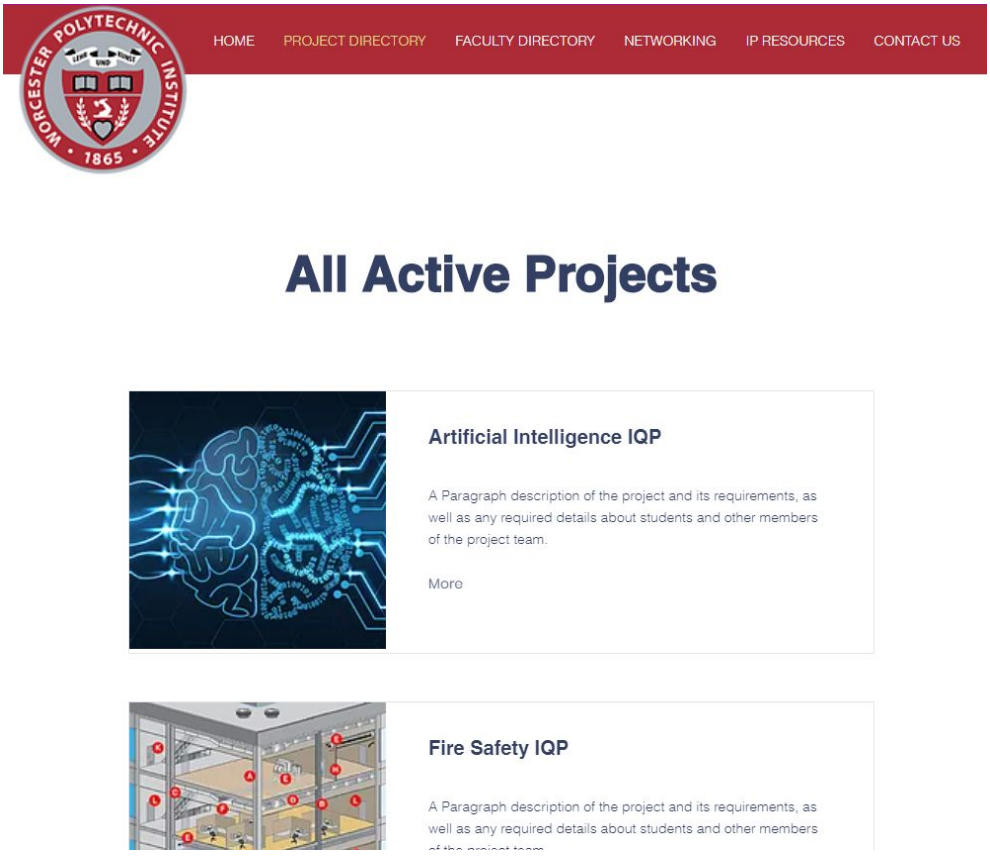

Figure 23: *Open Innovation Network Portal Project Directory Page*

Project Directory

In the “Project Directory” page, there will be a list of projects and problems that have been submitted by students, faculty and outside corporations. This list will be in a similar format as a Subreddit page where the title of the project, collaborating entity, and type of project will be listed as shown in Figure 23. Users will be able to click on each project and view more details, leave comments and questions for the project proposers to answer. Any interested user can contact the proposer and begin any collaborations at the discretion of the proposer. Any projects can be submitted and posted through the Project Submission Form through this page or the home page. All of the projects will be reviewed by the Office of Open Innovation before officially being posted onto the directory. The directory will be constantly updated as new project submissions are entered. There will also be a search bar at the top where users can search for specific projects or projects by specific faculty, students, or corporation.

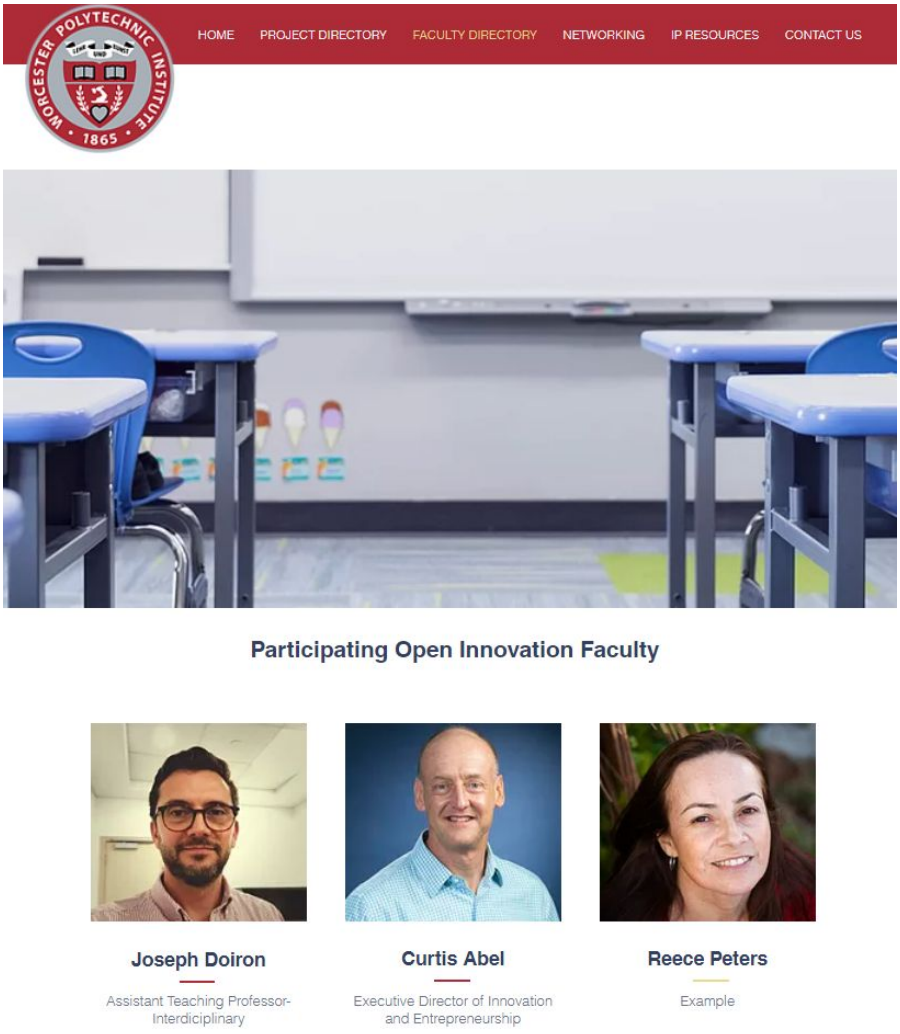

Figure 24: *Open Innovation Network Portal Faculty and Corporate Directory Page*

Faculty and Corporate Directory

In addition to the Project Directory, there will be a "Faculty and Corporate Directory" where users can search for specific faculty or corporations that are involved in the network (see Figure 24). The faculty can be searched for through any courses they are teaching, name or any other details they personally add. Similarly, corporations can be searched for through their company name, type or individual names added by the corporation. To add to the directory, there will be a button at the top where anyone can add themselves to the network and input any contact information to be contacted by other users for collaboration. The directory will be easy to navigate using a filter system to find faculty or corporations under a specific filter. Corporations can search for faculty or institution departments involved in projects to create connections and

begin collaborations, and faculty can search for specific corporations. The concept of a directory allows all of the entity information to remain in one place for easy access to networking and contact details.

Networking

To ensure seamless communication and collaboration, there will be a networking messaging service, where students, professors and companies can connect and form relationships. This will be accomplished through a 3rd party communication service such as Slack and Discord, or through an embedded browser messaging service which will allow for Inclusive Operations to continue. All members of this open innovation network will be able to communicate freely with others in either a public or private manner depending what each party would prefer. Furthermore different entities can approach the department through this messaging service if they do know which department or other entity to reach out to for their open innovation and with this the Open Innovation department can connect them with the right professors, clubs, students or outside entities, thus establishing a successful working relationship. This networking service will also serve to maintain sufficient communication between different nodes to satisfy our Interactive Communication criteria. This will also provide a record of all communication for use in IP discussions and other legal aspects of an open innovation partnership.

Figure 25: *Open Innovation Network Portal IP Resources Redirect Page: https://www.wpi.edu/offices/technology-commercialization*

IP Resources

For users to have access to intellectual property resources, the "IP Resources" tab will contain example resources for proper IP negotiation and any required forms for technology commercialization. As a secondary resource, this page will link WPI's Office of Technology Commercialization (see Figure 25) because of their ability to identify, evaluate, protect, market, and license IP assets already developed by WPI researchers and staff. Partnering with this office will prove to be a great resource for any faculty, student or member of the community to help them market their ideas or inventions. Since this office already exists, there is no need for a separate set of intellectual property and negotiation resources developed by the team.

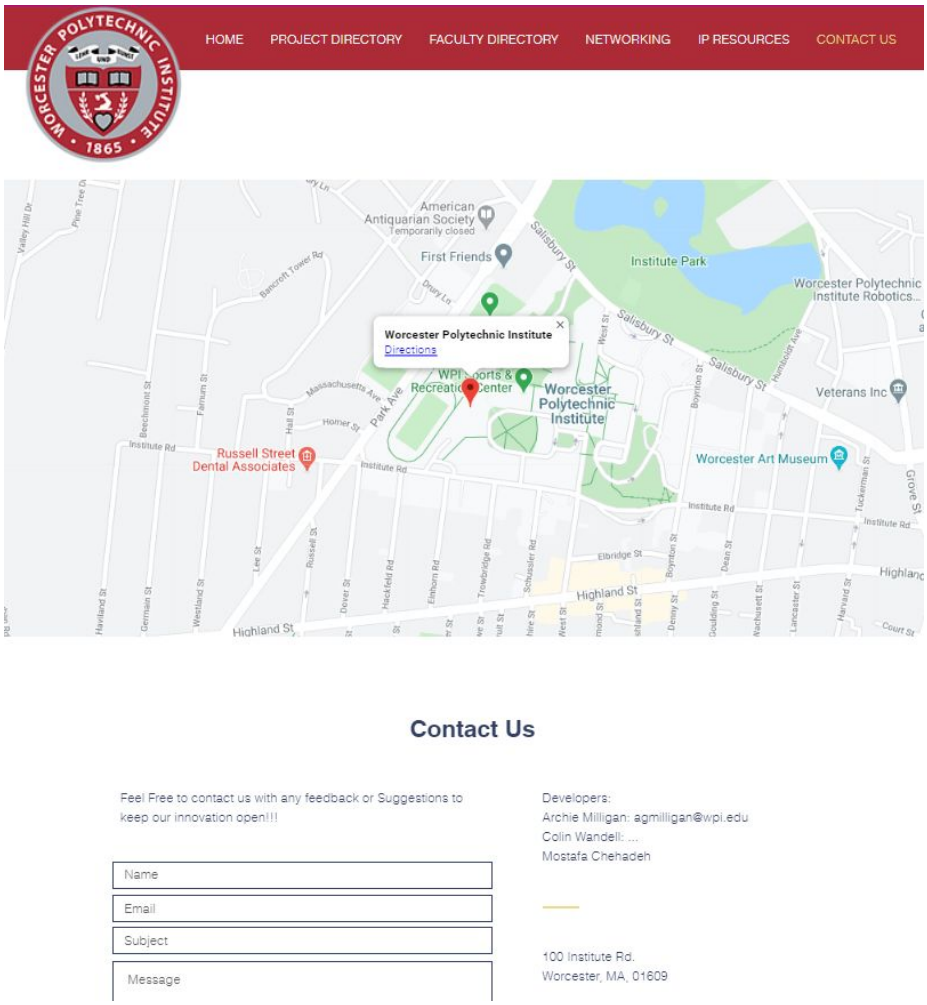

Figure 26: *Open Innovation Network Portal Contact Us Page*

Contact Us

In order to constantly evolve our network portal to operate as efficiently as possible, a "Contact Us" section will be an important feature for the portal to have as shown in Figure 26. Since our team is responsible for determining the different features and functions associated with the portal, our contact information will be displayed somewhere easily locatable within the portal. Outside collaborators and organizations, along with faculty and students of each institution, will be able to reach out directly to us with suggestions to improve the way in which the network portal operates. This will demonstrate the want of our team to make our network portal as user-friendly as possible, increasing the amount of open innovation and collaboration that can take place between students and outside entities.

Chapter 6: Feedback and Conclusions

In this chapter our team examines the different ways in which feedback could be solicited for our proposed prototype design during our Feedback Phase. Additionally, our team outlines the different recommendations we have for a successful implementation and efficient operation of the proposed portal in the future. Finally, our team concludes on the research done during this project and assesses the knowledge we have gained as a result. We also discuss some of the limitations possessed by our proposed prototype at the end of this chapter.

6.1 Feedback Phase

With the Discovery, Ideation, and Prototype Phases complete, the final phase is the Feedback Phase where we determine ways to solicit feedback from various sources. These are ways that would be considered "future actions" outlining the next steps after the physical implementation of the portal with approval from WPI. The Feedback Phase will be an ongoing phase that continues to happen for an extended period of time. The feedback from different perspectives will prove beneficial for the improvement of our network portal. We initially plan to receive feedback from the network portal's "Contact Us" page, where there is a feedback form for anyone to fill out. Participants can leave comments or concerns that will benefit and help improve the network. The form is simple requiring only the user's name, email, subject of the feedback or message, and the contents of the message. An additional way we hope to receive feedback from is by sending our final report and deliverable to our case study interviewees from the MBTA, Spring Theory, the City of Worcester, and Honeywell. Their input will provide our team with feedback and recommendations that are from an industry perspective with experience in facilitating and working on open innovation projects. Likewise, we plan to contact various campus offices and centers that oversee, manage, and organize the creation of new offices. Offices like the IT Services Office and the Office of the Provost will provide our team with the approval of the creation of the portal and office as well as assisting with the technical setup of the network portal. Finally, our team will ask our IQP classmates for ideas, recommendations,

and feedback after the completion of our presentation. Since they are students and our peers, they could provide our team with perspectives and ideas that our team has not yet considered. With the extended ongoing feedback from the various sources, our network portal will be constantly improved and updated. We have also provided ourselves with feedback in the form of recommendations for maintaining the network portal in the future.

6.2 Project Reflection

The research completed by our team during this project provided us with a greater understanding of many of the different elements of open innovation. After conducting conversational interviews with several organizations who partake in open innovation practices, it was clear to our team that there were many possible approaches to collaborating in an open nature. The MBTA displayed the value of openness through their Innovation Proposal Portal. By allowing anyone who had an idea revolving around the technologies they use to have a voice, the MBTA was shown problems with their services that they were not even aware existed. Spring Theory is a small company that facilitates open innovation and collaborative projects between student-lead teams and corporate sponsors. The work they have successfully done, like organizing projects to be completed with corporate sponsors at schools like Cornell and Northwestern, are evidence that academia can be a desirable partner in openly innovative projects. The City of Worcester's Office of Urban Innovation gave us an inside look at how government departments are making progress towards transparency in today's data-filled world. By highlighting Worcester's Elm Park bridge, completed by WPI civil and architectural engineering students in conjunction with the City of Worcester, our team was able to realize the ways in which the community could be a possible benefactor of OI projects done through our portal. Finally, our team spoke with Honeywell, enforcing the knowledge learned during our literature-based research and providing us with another standpoint on open innovation. While corporations are protective of intellectual property and carefully consider the external organizations they work with, Honeywell was able to highlight the benefits enjoyed from outsourcing R&D and sharing IPs.

There were constant themes among all of the transcriptions that our team analyzed after conducting interviews with the organizations described above. The qualitative coding that was done on all of the collected data allowed our team to construct our open innovation network framework. Themes such as communication and project selection (how a node of an open innovation network chooses *who* to work with and *what* to work on) were present in each of the models we examined and comprised the framework. Combining this framework with recommendations collected from our survey and the data obtained from the interview with Curtis Abel allowed our team to ideate the criteria that our prototype should solve. Among the criteria that needed to be solved were ones such as the need for impactful advertising of the prototype and the need of the prototype to remain open to all who wished to utilize its features. The finalized online portal design, complete with a directory of faculty who are leading projects and a page for submitting suggestions to improve the portal, satisfies all of the criteria ideated by our team. The limitations of the design and some of the recommendations our team has for the future of the portal's operation are described in the following sections.

6.3 Limitations

Although our team believes the online portal to be a good balance of the strengths we observed among the OI models we discovered, our final proposed design is not without some possible limitations. If the portal were to be implemented at either university, our team does not believe that there are inherent qualities of the portal that would cause it to fail completely. Most of the foreseeable issues with the proposed design revolve around it not being used to its fullest potential. One key issue that could affect the utilization of the proposed portal is a general lack of interest in innovation at each school. A lack of interest or decline in use of the portal could be a result of limited advertising or a failure to keep updating the portal over time as new suggestions for its improvement are submitted. As discussed in our prototype development chapter, one of the issues surrounding the network portal that would need to be prevented would be the shift towards exclusively profit-oriented projects. Projects submitted by external corporations with some kind of financial benefit towards one of the institutions should not be ignored, but those

projects should not be the ones exclusively completed by students. Some of the ways our team believes these limitations could be aided or counteracted are described in the next section.

6.4 Recommendations

Table 2: *Table of future recommendations for the implementation of the open innovation network portal*

Open Innovation Network Portal Future Recommendations
Evolving Layout
Collaboration Assessment
Maintain Openness

After concluding our Feedback Phase our group developed three recommendations (see Table 2) for future work with developing and maintaining open innovation networks at WPI. Firstly, our Open Innovation Portal must keep evolving its layout and content. This will be in response to suggestions and criticisms made by the community. To evolve, the portal must keep developing new features, and advertising strategies so that it gives the most streamlined experience to enter or continue participating in open innovation. Secondly, we recommend that a collaboration assessment be performed twice per year. This assessment could be performed after each semester to reflect on any projects that happened in the past two terms to allow for immediate reflection on the successes and shortcomings of each project. Each assessment should focus on communication between each node in the project, the reasoning behind the success/failure of the project, the benefit to each node in the project, and any future projects that can follow and build off of the work in this one. Lastly, and most importantly, this Open Innovation Portal must be constantly analyzed to maintain Openness. This will involve investigating how many active members there are participating in this open innovation, and what open innovation entities these members are from. The focus of this analysis should center around ensuring that the portal remains open to all and not shift towards catering exclusively to one type

of organization. If the portal is analyzed in this manner it will remain a great example of how to openly innovate with many different entities and provide a framework for developing future open innovation projects and networks.

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Appendices

Appendix A: IRB Consent Form

Informed Consent Agreement for Participation in a Research Study

Investigators: Mostafa Chehadeh, Archie Milligan, Colin Wandell

Contact Information:

Archie Milligan: Tel: +1 (802) 349-9903, Email: agmilligan@wpi.edu
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Title of Research Study: The Development of Open Innovation Networks at WPI and AUS

Sponsor: N/A

Introduction

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study:

The study being conducted will allow for data pertaining to the theoretical implementation of open innovation networks at WPI and AUS to be collected and subsequently analyzed.

Procedures to be followed:

You are being asked to partake in a semi-structured interview that will last for around an hour. The interview will be recorded and transcribed so that we can code the data. It is important that you feel comfortable and understand all of the procedures that will be followed after data collection and analysis from your interview question answers.

Risks to study participants:

Data analysis for this study will revolve around information collected from semi-structured interviews, surveys, and focus groups conducted electronically and remotely. As a result, there is minimal foreseeable risk to any of the human subjects involved. Anonymity will be protected during any publication of the collected data at the subjects' request.

Benefits to research participants and others:

There are no benefits to the subject as a result of the study.

Record keeping and confidentiality:

Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or it's designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you by name.

Compensation or treatment in the event of injury:

There is minimal foreseeable risk to the subjects of this study. You do not give up any of your legal rights by signing this statement.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:

Archie Milligan: +1 (802) 349-9903, agmilligan@wpi.edu
Colin Wandell: +1 (603) 913-7481, crwandell@wpi.edu
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IRB Manager: Ruth McKeogh, +1 (508) 831- 6699, irb@wpi.edu

Human Protection Administrator: Gabriel Johnson, +1 (508) 831-4989, gjohnson@wpi.edu

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ Date: _____

Study Participant Signature

_____

Study Participant Name (Please print)

_____ Date: _____

Signature of Person who explained this study

<u>Appendix B:</u> Qualtrics survey used to gather student body knowledge of OI

Welcome to our survey!
We are a group of students from WPI and the AUS working on an IQP (Interactive Qualifying Project) on the Development of Open Innovation Networks at each institution. We would like to analyze the student knowledge pool of open innovation to help us understand the logistics of implementing Open Innovation Networks. Please fill out the following survey to help us with our study.

1. **Which university do you attend?**
    a. WPI (Worcester Polytechnic Institute
    b. AUS (American University of Sharjah)
    c. Other (Please state where):
2. **What year are you in?**
    a. First Year (Freshman)
    b. Second Year (Sophomore)
    c. Third Year (Junior)
    d. Fourth Year (Senior)
    e. None (Not undergraduate student)
3. **Have you ever heard of the term "Open Innovation" with regards to research and development?**
    a. Yes, I know what Open Innovation is
    b. I have heard of it, but do not know what it is
    c. No, I have never heard of it

If Q3 is b or c:

4. **Have you worked on any collaborative projects with any other schools or companies?**
    a. Yes
    b. No

If Q4 is a:

Then you have participated in Open Innovation

Open Innovation (OI) is an alternative to the conventional method of innovation where the ideas and designs are required to remain within the company walls. Instead, OI opens these barriers and limitations by sharing and receiving information openly from other entities and organizations. Until now, OI is still a relatively broad concept that involves a variety of innovation practices and processes. For example, Google's "Google for Startups" program

utilizes open innovation practices where they share their search technology and data/statistics openly to help entrepreneurs make data-driven decisions.

5. **Are you interested in learning more about Open Innovation efforts and how it can be utilized in projects on and off campus?**
    a. Yes
    b. No

6. **Does your university have any innovation and entrepreneurship resources (Innovation and Entrepreneurship Center etc.) available for student use?**
    a. Yes
    b. No
    c. Don't Know

If Q6 is a:

7. **Do you make use of any innovative/entrepreneurial resources for project endeavors?**
    a. Yes
    b. No

If Q7 is a:

8. **How often do you utilize these resources?**
    a. Very Often
    b. Sometimes
    c. Rarely
    d. Never

If Q6 is b:

9. **Are there efforts in creating these resources?**
    a. Yes
    b. No
    c. Don't Know
10. **Has the university advertised (made clear of their existence) these resources to the students and faculty?**
    a. Yes, the university sends out information about these resources
    b. No, the resources exist but the university does not send out any information about them
    c. These resources do not exist yet

11. **Would you be interested in collaborating on innovation-based projects with entities outside of academic boundaries (i.e. corporate firms, students from other universities)?**

a. Yes
b. No

12. **Do you have any ideas on ways to implement Open Innovation efforts in projects at your university?**

Appendix C: Survey response data

Q7 - Which university do you attend?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Which university do you attend? - Selected Choice	1.00	3.00	1.49	0.51	0.26	279

#	Answer	%	Count
1	WPI (Worcester Polytechnic Institute)	51.61%	144
2	AUS (American University of Sharjah)	47.67%	133
3	Other (Please state where):	0.72%	2
	Total	100%	279

Q9 - What year are you in?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What year are you in?	1.00	5.00	2.62	1.13	1.27	279

#	Answer	%	Count
1	First Year (Freshman)	16.49%	46
2	Second Year (Sophomore)	34.77%	97
3	Third Year (Junior)	25.09%	70
4	Fourth Year (Senior)	17.92%	50
5	None (Not undergraduate student)	5.73%	16
	Total	100%	279

Q11 - Have you ever heard of the term “Open Innovation” with regards to research and development?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Have you ever heard of the term “Open Innovation” with regards to research and development?	1.00	3.00	2.59	0.61	0.37	270

#	Answer	%	Count
1	Yes, I know what Open Innovation is	6.30%	17
2	I have heard of it, but do not know what it is	28.89%	78
3	No, I have never heard of it	64.81%	175
	Total	100%	270

Q13 - Have you worked on any collaborative projects with any other schools or companies?

#	Answer	%	Count
1	Yes	28.06%	71
2	No	71.94%	182
	Total	100%	253

Q20 - Are you interested in learning more about Open Innovation efforts and how it can be utilized in projects on and off campus?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are you interested in learning more about Open Innovation efforts and how it can be utilized in projects on and off campus?	1.00	3.00	1.37	0.78	0.61	235

#	Answer	%	Count
1	Yes	81.28%	191
3	No	18.72%	44
	Total	100%	235

Q17 - Knowing a little about Open Innovation from the definition above, which of these aspects do you think could be most appealing (positive) for projects using Open Innovation? (You may choose several)

#	Answer	%	Count
1	It is non-traditional	8.70%	4
2	It promotes the inflow and outflow of knowledge	19.57%	9
3	It is a relatively new concept	4.35%	2
4	It can be flexible	15.22%	7
5	It can lack structure	2.17%	1
6	It can reduce costs of research and development	19.57%	9
7	It relies heavily on sufficient communication between companies	10.87%	5
8	As a result of the development of OI, universities interact with companies more	19.57%	9
	Total	100%	46

Q19 - Which of the following do you think could be the most unpleasant aspects of open innovation? (You may choose several)

#	Answer	%	Count
1	It is non-traditional	12.50%	4
2	It promotes the inflow and outflow of knowledge	0.00%	0
3	It is a relatively new concept	18.75%	6
4	It can be flexible	0.00%	0
5	It can lack structure	37.50%	12
6	It can reduce costs of research and development	3.13%	1
7	It relies heavily on sufficient communication between companies	28.13%	9
8	As a result of the development of OI, universities interact with companies more	0.00%	0
	Total	100%	32

Q16 - Does your university have any innovation and entrepreneurship resources (Innovation and Entrepreneurship Center etc.) available for student use?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Does your university have any innovation and entrepreneurship resources (Innovation and Entrepreneurship Center etc.) available for student use?	1.00	3.00	1.65	0.94	0.88	228

#	Answer	%	Count
1	Yes	67.11%	153
2	No	0.44%	1
3	Don't Know	32.46%	74
	Total	100%	228

Q18 - Do you make use of any innovative/entrepreneurial resources for project endeavors?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Do you make use of any innovative/entrepreneurial resources for project endeavors?	1.00	2.00	1.76	0.42	0.18	153

#	Answer	%	Count
1	Yes	23.53%	36
2	No	76.47%	117
	Total	100%	153

Q20 - How often do you utilize these resources?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	How often do you utilize these resources?	1.00	4.00	2.25	0.79	0.63	36

#	Answer	%	Count
1	Very Often	13.89%	5
2	Sometimes	55.56%	20
3	Rarely	22.22%	8
4	Never	8.33%	3
	Total	100%	36

Q22 - Are there efforts in creating these resources?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Are there efforts in creating these resources?	3.00	3.00	3.00	0.00	0.00	1

#	Answer	%	Count
1	Yes	0.00%	0
2	No	0.00%	0
3	Don't Know	100.00%	1
	Total	100%	1

Q24 - Has the university advertised (made clear of their existence) these resources to the students and faculty?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Has the university advertised (made clear of their existence) these resources to the students and faculty?	1.00	3.00	1.33	0.53	0.28	228

#	Answer	%	Count
1	Yes, the university sends out information about these resources	70.18%	160
2	No, the resources exist but the university does not send out any information about them	26.75%	61
3	These resources do not exist yet	3.07%	7
	Total	100%	228

Q26 - Do you have any ideas on ways to implement Open Innovation efforts in projects at your university?

Do you have any ideas on ways to implement Open Innovation efforts in projects at your university?
Portals For Open Collaboration
More and frequent seminars
No
None
Internships but that already exists.
No
Put out posters informing students on campus
No idea
no
no
public database of the data collected in projects
Start a OI center or club

Add more surveys
You might already know this, but Curtis Abel is the man to talk to
Not really
I think IQP is probably a good start, but i certainly think more could be done in this area. Linking up with companies to make class projects that have a real impact could be something really interesting
No
More MQP opportunities that connect with other schools/companies would be cool
Similar to IQP, have projects focus on organizations or individuals outside of WPI.
For the record, I'm a professor here, but I saw your request and thought I'd put in my answers. Feel free to discard them.
No
N/A
More heavily advertised specific opportunities for students to enter the OI scene on campus.
Create competitions with good prices and advertising.
Have I&E offer OI project opportunities with companies
Professors encouraging more based on class projects

Try not to get on the student's bad side by closing space

Office hours, advertisement

No haha

Work with other majors/ classes

Monthly seminars, conferences, industry talks would be fantastic.

If there was a system to be on boarded onto interesting projects.

No

Not really

When classes are doing final projects, one assignment can be to learn what other teams are doing.

I feel our school is very involved in OI especially with our project based curriculum

I don't know enough about them

not really

I would think this would work well in research projects.

Not sure

Q28 - Would you be interested in collaborating on innovation-based projects with entities outside of academic boundaries (i.e. corporate firms, students from other universities)?

#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Would you be interested in collaborating on innovation-based projects with entities outside of academic boundaries (i.e. corporate firms, students from other universities)?	1.00	2.00	1.42	0.49	0.24	203

#	Answer	%	Count
1	Yes	58.13%	118
2	No	41.87%	85
	Total	100%	203

Q21 - Any feedback on the survey?

Any feedback on the survey?
Good
None
Interesting and eye opening
Well formatted and engaging, too bad I’m busy to join the interesting collaboration
Nothing
I would like to learn more
The questions were very clear and concise.
Good luck on your project!
-
Great Survey
it was very well organized and straightforward :)
Wordy
Nice

Very pretty me like

Very responsive!

Yay Archie! Good luck on iqp!

If I don't know if my university has innovation resources, how am I supposed to know how they are advertised?

Two thumbs up 👍👍

calm

No

I’m very interested in the concept of open innovation. Thank you for sharing this information.

Love it

Nice Job

Very quick.

looks good!

<u>Appendix D:</u> Interview question outlines ordered by organization (bolded questions deemed high-priority questions)

MBTA Interview Questions

1. **Can you talk a bit more about the MBTA Innovation Proposals endeavors and what your role is?**
2. What are some of the essential positions involved in the management of the Innovation Proposals?
    a. What do they do?
3. What kinds of companies/individuals usually send in submissions?
4. **Have you had challenges trying to get innovations submitted by students and other people?**
5. What kinds of things determine whether or not an Innovation Proposal goes to implementation?
6. How do you analyze incoming proposals?
7. How is the work distributed between the MBTA and external innovators?
8. **How are communication and disagreements between the MBTA and external innovators handled?**
9. **What are some other technical challenges you have encountered in collaboration?**
10. Are there any projects that have been done with multiple entities/submitters?
11. How much are the submitters involved in the adoption of the proposal?
12. What are some improvements that you would like to see with the Innovation Proposals process? What would make the process easier/more effective?
13. **How do you coordinate Joint Development Agreements (JDAs) between the MBTA and whoever submitted an Innovation Proposal?**
14. **How do you determine who gets what IP rights?**
15. What efforts are made to advertise the Innovation Proposal to potential co-collaborators?
16. How are technologies developed through Open Innovation marketed differently?
17. **How is the MBTA Open Innovation program advertised to the public?**
18. What strategies have been the most successful at reaching potential co-collaborators?
19. Does the MBTA actively consider academia for Innovation Proposals? Are there any attempts to market to students for innovation ideas?
20. **Is there anything I didn't ask that you think I should've asked?**

Spring Theory Interview Questions

1. **What is Spring Theory's role in the collaboration efforts?**
2. **What are some challenges faced when starting up a program to create open innovation networks?**
3. **What are some of the challenges you guys face when facilitating collaboration?**
4. Do you only facilitate collaborations between university and company?
5. What strategies have been the most successful at reaching potential co-collaborators?
6. **How do you handle communication and disagreements between the collaborating entities?**
7. **What types of faculty members typically get involved in the collaborations?**
    a. **What departments/majors?**
8. How do you find people/entities to connect with?
9. **How do you advertise your collaboration efforts?**
10. Are there projects that have involved more than one entity?
11. **Do you guys handle any IP right distribution and do you get the rights to any innovations?**
12. Do you guys get the rights to any innovations that are created through the collaborations?
13. **Is there anything I didn't ask that you think I should've asked?**

Honeywell Interview Questions

1. Tell us a bit about yourself, what is your role?
2. Is open innovation routine practice or is this a one-off endeavor. Do you collaborate mainly with companies, academia or government labs?
3. What are some challenges you have encountered in collaboration?
4. What are, in your experience, the benefits of collaborating openly opposed to only in-house?
5. How do you resolve technical or business related disputes that arise during execution of the project?
6. What is the communication protocol between the partners? How do you separate confidential information from non-confidential when communicating with your partners?
7. How is IP ownership and IP rights distributed between parties (ie. background IP and Jointly developed IP)
8. How do IP rights and processes vary between companies of different nations in your experience?

9. When working with academia, how do you manage to keep confidential the IP created and at the same time allow students/faculty to publish thesis and papers?
10. How do you construct the JDA? Do you have templates accepted between you and the other parties?)
11. Employee innovation - what are their thoughts/inspiration?
12. Explain the project, ask for feedback
13. **From a corporate perspective, what kind of projects grab your attention that academia can participate in? Is there outreach to academia in your experience?**
14. Is there anything that I should have asked that I did not ask?

City of Worcester Interview Questions

1. Could you briefly tell us a bit about yourself, including your role/job description?
2. Has the Office of Urban Innovation collaborated with any of the colleges in Worcester?
3. What are some of the ways your office collaborates with other cities or companies outside the City of Worcester?
4. Have you ever considered using Open Innovation in collaboration efforts?
5. Explain to us your LEAN Management Principles
    a. What are some of the City's most challenging operational and customer service issues?
6. What is the Open Data Portal and what are some of the Challenges associated with?
7. What are some essential aspects of Joint Development Agreements that you use for Open Innovation?
8. Explain the project, ask for feedback
9. Is there anything that I have not asked yet that I should have asked?

<u>Appendix E:</u> Interview transcription codes ordered by theme

Advertising:

MBTA - § 2 references coded [1.57% Coverage]

Reference 1 - 1.18% Coverage

It's on our website for private sectors. You know, we must have gotten I don't know how many. Let me just check. From now I think, from when it started, we have had Ah, I would say close to 200 proposals maybe? Well, yeah, that we have. So there is there is not a need for us. I don't see like, you know, an all out external campaign

Reference 2 - 0.39% Coverage

What we do need to do is talk to startups and talk more to educational institutions or more to innovation labs.

Challenges:

City of Worcester - § 4 references coded [3.80% Coverage]

References 1-2 - 2.87% Coverage

City of Worcester: “So for example, the portal, a lot of them think that they can just put data into this portal in a very fancy graphic way, etc, etc. And when we tell them well no, that's not why we're looking for, we're looking for raw data, right, and what the raw data looks like. And some of them, they never, they don't even know what that means. Why because they're not. They're not they don't deal with the back end of the data, they just deal with the front end of it. And so and so there's a lot of educating them on what that means. What is what is an API, some of them don't know what an API is, and what the importance of an API is for people like you and institutions and research institutions and whatnot, or even developers. And so we have to spend a lot of time in creating what methodology we want that data to be created, and what they're trying to communicate”

References 3-4 - 0.94% Coverage

City of Worcester: they all say that we have the systems that they do, they're like you have what it takes, like you have it all. Matter of fact, some of those technologies that we have, they don't even have. And so but there's there is, the issue that we have is that we don't communicate it enough.

Spring Theory - § 20 references coded [12.40% Coverage]

References 1-2 - 0.36% Coverage

I would say our biggest challenge, some of our biggest challenges is like, well, somewhat recently was COVID.

References 3-4 - 1.20% Coverage

You know, because these projects a, you know, companies do pay us to set them up with the opportunities and you know, access our network. So, you know, funding is low, you know, for certain companies, even big ones, sometimes, you know, we'll put on like a spending freeze. So that, you know, that kind of takes them out of the pool of, you know, what we need to do

References 5-6 - 0.78% Coverage

But sometimes, you know, maybe, maybe the course wasn't the right fit, or something else to where the project is still valuable, but maybe, you know, missed the mark in an area, not saying that that's something that happens all the time.

References 7-8 - 0.88% Coverage

if string theory was just a consultancy, so to speak, you know, we would be doing all the work ourselves, it's like, you control more things that, you know, you oversee, but with these, you know, having the university having the school, there's a lot more variables.

Reference 9 - 0.82% Coverage

And you know, the client is like, Hi, I feel like, you know, haven't been speaking with the class enough, like, you know, I feel like, I want to give them information. But again, I'm not going to be the one reaching out and running the whole project.

Reference 10 - 1.59% Coverage

So if there are, you know, issues like that, you know, yes, I would step in, you know, reach out to the professor, whoever's running the project, to see, you know, where we can kind of get on even ground. Because, yeah, we don't really want the client to be worrying about, you know, things like that, you know, we want their time spent on, you know, providing data, providing feedback, you know, watching presentations, and not, you know, not looking over the administrative pieces.

References 11-12 - 0.52% Coverage

So we don't necessarily market exactly. The way that we get the word out is you know, through email, I was gonna say email marketing, but really email sales.

References 13-14 - 2.48% Coverage

But usually, I would say also, with smaller companies, they might not be as set up to do this. Like we as Spring Theory, we've had a couple of university partners who needed a project, and we're like, wait, why don't we give them one from us. But the smaller you are usually the less supporting materials you have in terms of data and everything else, and less time. And, you know, while these projects are, you know, very useful to the companies that we work with, I would say, you know, the smaller companies, you know, they're usually looking for results faster. They're trying to, you know, kind of pivot with what they're doing right now. So sometimes working on like, a three, three and a half months project might not really fit into their plans.

References 15-16 - 0.69% Coverage

All of them seem to have a different process than us, but I've seen ones where it's like, hey, let's take a project from the professor and put it online, and then have someone try to like, you know, work on it.

References 17-18 - 0.82% Coverage

And like, those types of situations I feel like are more set up to fail because, you know, there's less communication. It's, you know, someone just looking at what the brief is online and not really, you know, working it through speaking it through.

References 19-20 - 2.26% Coverage

But I've definitely come across people that I, you know, I, you know, I don't think they don't believe in working with students as much or they don't believe that it can benefit them. And then there's also the companies that I'd say fall in between where they think that the students could benefit them, but because of the industry that they're in, it's kind of hard, you know, if the project that you're going to, you know, propose to a university, like you know, people on your team are head scratching their heads about it all the time, and they live and breathe it every day. That's where it might be hard for you know, students to come in and provide more than what's already there.

MBTA - § 10 references coded [3.76% Coverage]

References 1-2 - 0.66% Coverage

However, of course, the launch was overshadowed by COVID. So we launched it in March, and COVID also launched itself in March. So it was eclipsed by that we intend it has been ongoing.

References 3-4 - 0.78% Coverage

Interestingly enough, we go through the same transit agencies go through the same struggle. Innovation is sometimes one of you know, it's the thing with innovation is that we also have to balance it with procurement law.

References 5-6 - 1.02% Coverage

Hopefully, when priorities realign, and some sort of normalcy comes back, where everything is not just a matter of emergency, because of COVID, hopefully, we intend to have to assume some sort of, like, the frequently some cadence in in the meetings with them and conversations with them.

References 7-8 - 0.31% Coverage

So yes, there have, there was a time where proposals were not were few and far between.

References 9-10 - 0.99% Coverage

So, you know, so, when we are sharing with amongst transit agencies, the other thing is, is the challenging thing is to how to make it relevant, right? How to make it a priority, because it has to be so that it is able to run as a value with a core value within our organization.

Honeywell - § 8 references coded [7.99% Coverage]

Reference 1 - 1.25% Coverage

So when we're talking about doing collaborations, now, we're talking about open innovation. And that's where the various issues come in place. Because it's easy to say, yeah, let's hug and kiss and let's do development work together. But there are a lot of the devils in the details. And there's a lot of issues that come up with it. And that's why I think this project is very interesting, because it will examine some of these issues and maybe provide some solutions at the end of the day.

References 2-3 - 0.89% Coverage

And one of the issues with IP, when you're doing open innovation is like, what's going to happen if I learn something in this project, can I use it in another project, because if I can't, then basically, my hands are tight, and I cannot, I don't want to be tied my hands to be tied, I want my hands to be free to, to use whatever I learned elsewhere.

References 4-5 - 2.86% Coverage

But in practical terms, it's very difficult because like a university or an academic institution may have like a lot of students working on a project. And you cannot keep reading theses all the time. And, you know, trying to be like an auditor. So that's, that's an issue. So we do put agreements in place that says you cannot disclose certain things. But usually when you're working with academic institutions, the academic institutions insist that they have the right to publish part of the information at least in the work right. And then the other things like become, when you have open innovation, you're required to have some exclusivity, that these are some of the issues. You have exclusivity where you want to work with one party, and you make sure that that party, your partner only works with you and they don't work with anybody else. And this goes both ways, right? Because you don't want to work with anybody else. Because then it's very easy to lose secrets and intellectual property, it's very easy to learn something from one company and then on to another company. So this is usually some kind of an issue

References 6-8 - 2.98% Coverage

The disadvantage, of course, like I was discussing before, is all these things about IP sailing and IP Likud's and things like that. So you have to balance the pros with the cons and say, Is this worth going out and doing it with an academic institution, or with another company, because at the end of the day, we're gonna have to share the IP. The other thing, another disadvantage of working with another institution is the quality assurance. You know, like when we develop things internally, we have certain processes, and we make sure that we don't, if there is somebody outside questionable, we throw them out, we don't use them, because at the end of the day, we want to make sure that we develop successful technology. But in that we don't know like, when you go out to another entity to another institution or another company, how good they are in terms of throwing up bad results or you know, not taking into account bad results, or how good they are in a recording any issues that they see along the way, you know, so sometimes you need to kind of this is one of the unknowns and one of the disadvantages of working with another company or another institution.

Collaboration Goals:

City of Worcester - § 5 references coded [6.98% Coverage]

Reference 1 - 1.06% Coverage

Yeah, so right now our primary focus is, so because it's so new, we need to build a data governance structure on how the data is coming in, how frequently, etc, etc. So we need to build that, as part of building that. We're also looking at building a data warehouse, for the purposes of reporting, communication, etc.

Reference 2 - 0.81% Coverage

So there's things that we start to put out there based on public's kind of input or, or things that we hear in council meetings that the public is interested in, or what have you, we try to get that data set and put it in the open data portal

Reference 3 - 1.53% Coverage

I wish we could do more. I would love a better partnership where we could sit with WPI on a monthly basis and just run down and list of ideas or things that you as a young person that's as a student you're in dorm rooms but you're you're enjoying the city life right going out to drinks going out to dinner, etc. Hey, I wish was Worcester here had this, I wish I could provide x y&z Let's sit down, let's think about it. And let's figure out a way to do it.

Reference 4 - 1.45% Coverage

Maybe through the work with WPI, we put our data on the open data portal and you goes goes out there and create an application that you can people can call Alexa and say, Hey, Alexa, when is the next restricted parking, whatever, maybe where do I park if I live in this neighborhood, and Alexa can tell you that information. So those are the types of things that I think WPI could really help us in driving open innovation for our city.

Reference 5 - 2.14% Coverage

But I would love to expand our relationship with WPI. Because of your innovation, and now that you're building an innovation world kind of building there, the thing is, the building is going to be beautiful. And you have a hole not only do you have a smart city, we're a smart city smart world building, you're gonna you have an innovation, your voice, your voice, auditorium, whatever it's called, Foise innovation studio you have there, I mean, you have quite a facilities in the in the infrastructure to be able to support the efforts that are happening in a city. So I would love the opportunity continue to expand on that relationship.

Spring Theory - § 1 reference coded [2.55% Coverage]

Reference 1 - 2.55% Coverage

But at the same time, I think that part of the thought process of having these collaborations is that, you know, we are trying to provide useful strategies, innovation, insights, you know, to these companies. And I think that it's important for the universities at a program level to understand that, like, that's kind of, you know, the situation, not necessarily like putting pressure on students there, but just saying that, you know, they're coming to us, because they want to get our good ideas, and, you know, see how we work through things. So, making it, you know, kind of making sure it's always a mutual, like collaboration, and not just the company feeling like, Oh, well, you know, we're helping students develop, but we're not really getting anything out of it.

MBTA - § 5 references coded [6.98% Coverage]

Reference 1 - 1.03% Coverage

So new service or service that we want to try out and see what the uptick is, it's another part of my job. The other part was to really look into and study what innovation and what the proposal can do, given the constraints and the current situation that the T was in, or is in at this time.

Reference 2 - 0.24% Coverage

And so we wanted to highlight that sort of achievement within the T.

Reference 3 - 0.96% Coverage

you we wanted to fill that gap within the policy, which was, for me very essential, because innovation should be organic, and is really organic within the institution. And we needed to kind of champion that. So in the first quarter of this year, we officially launched it.

Reference 4 - 3.54% Coverage

We've, I've received innovation proposals from employees. But we intend to relaunch it in in the first quarter of next year as part I mean, as part of our endeavor to do just encourage and boost the morale of our employees. The other thing that the innovation proposal, so these are the endeavor, these are the things that we have been doing and the innovation proposal has been trying to do that. So my role is really to one start conversations, encourage innovation, start conversations within the community. Reach out to universities, by Harvard, we reached out to this is a perfect example. This is what I want to happen like students are talking to us that we welcome innovation, ideas, whatever they want to do, whether they want to partner with us whether they want to learn from us whether you You know, they want to study the T and and and you know, whether it's a matter of mechanism or machine learning or whatever it is, you know that the T is do we move welcome any interest in the T.

Reference 5 - 1.20% Coverage

we want to launch a story, sort of like an open mic for, for innovation next year, how we're going to do that. We have some ideas, but the target audience would be broader. So So I hope that comes to fruition. I it's just an idea that has been, that has not been formalized at all, but there have been ideas, there are ideas such as that.

Honeywell - § 2 references coded [1.65% Coverage]

Reference 1 - 1.02% Coverage

But the main thing that I'm basically my job here is to see if I can get collaboration work, done joint development projects, with either other companies or universities academia. So this is the main part of my job. So to answer your question, how I'm involved in open innovation, this is a big part of my job here is to try to establish joint development projects, with customers and with academia.

Reference 2 - 0.63% Coverage

Customer, what we're trying to do is we're trying to become partners with these customers, right, we're trying to be more than just suppliers, and vendors, you know, we're trying to be like a partner. So we developed technology together with them.

Communication:

City of Worcester- § 4 references coded [5.11% Coverage]

Reference 1 - 0.26% Coverage

Making sure that we're open in terms of our communication, and data as well.

Reference 2 - 1.08% Coverage

So when you get a job They typically ask for a reference and, and the old fashioned way of doing is you get a phone call, and someone calls you to, or you give them a phone number. So they can call somebody and call for references. And then that person calls, and they're jotting down on the checklist, all the references.

Reference 3 - 2.83% Coverage

What side of things is there specific department that has one individual, I'm Dr. Laurie Ross, who focuses on research analysis and and data and she hosts classes that connects with us. And we go and present to them. So she is my contact person. So anything related to any of that, I'm always going to her. And she's kind of like the de facto person to us. The same thing happens with with Worcester State. There's one urban planning kind of the director of urban planning. He He's the one that kind of works with us on on all anything related to analytics, data analytics and reporting on there. And so I think that's what we need. I think maybe with WPI, it's one direct person that I can work with. And I can connect and throw ideas to and they can throw ideas to me and we can constantly be in communication to to really develop that partnership.

Reference 4 - 0.94% Coverage

But you what's interesting is that I've had a lot of conversations with the city of Boston's innovation office, City of Cambridge innovation office, City of San Diego's innovation office, Philadelphia innovation office, in a lot of these communities that I've had conversations with

Spring Theory- § 8 references coded [10.73% Coverage]

Reference 1 - 0.15% Coverage

I'll have like an introductory call with them

Reference 2 - 0.52% Coverage

We check in with both sides, make sure things are going well, and, you know, if any course corrections need to happen, you know, we'll go ahead and do that.

Reference 3 - 0.22% Coverage

we're supposed to do, get the project set up, make sure we check in.

Reference 4 - 1.20% Coverage

So typically, when I'm checking in with clients, you know, I'll send them emails, we send them surveys, you know, just to, you know, get them to answer some quicker questions without meeting for a back and forth. I also scheduled time, you know, at least once during the semester just to, you know, check in with the company over the phone, or over a zoom meeting.

Reference 5 - 3.22% Coverage

So, yeah, again, you know, for quick questions, maybe a group leader will be, you know, checking in with the project leader from the company over email, a lot of times, there are, you know, weekly check ins or bi weekly check ins, so that, you know, they're keeping in touch, but yeah, communication is a huge piece, especially when you have, you know, students who are not, you know, within the company, you know, they are getting information from the company and doing their own research. But, you know, I think that the most successful projects are ones where there is a good cadence of communication, because then the client can see how the team is progressing. And if there are any areas where it's like, oh, well, we don't really want to go down that avenue, or, you know, we've thought about this before, you know, they can kind of let them know that so that, you know, the recommendations that they're going to get are more geared towards what the client is looking for.

Reference 6 - 1.77% Coverage

But you know, if it's not reaching the right people, like the decision makers at companies, and it's not reaching them at the right time, like, you know, if they're on Spotify, or something, taking a weekend run, I don't think that's going to be the time in place to try to, you know, try to reach them. So usually, we just go, you know, directly reach out, you know, in for a specific opportunity, or maybe just in general, saying, you know, this is what Spring Theory does. Do you have any needs and projects, and we can work together?

Reference 7 - 2.83% Coverage

But, you know, there needs to be as you're working through things, because I think that's the biggest thing for companies is that they, you know, kind of want to know what they're going to get at the end. So along the way, you know, even if not every piece of the project is ready, they'd like to at least see what's going on. So that if they, you know, want to course correct, they can. I think those are the biggest things that really just happen during the project. And, you know, this isn't necessarily challenged, because this is kind of built into our process, but to make sure that we do have a successful fit, you know, we want to make sure that, you know, when the professor and the client are speaking initially, like, you know, they're working through all like the roadblocks and they're understanding, you know, how this project is going to be run.

Reference 8 - 0.82% Coverage

And like, those types of situations I feel like are more set up to fail because, you know, there's less communication. It's, you know, someone just looking at what the brief is online and not really, you know, working it through speaking it through.

MBTA - § 2 references coded [4.16% Coverage]

Reference 1 - 0.42% Coverage

We've also started conversations with big agencies and what they're doing and obviously sharing lessons for innovation

Reference 2 - 3.74% Coverage

So I think it depends on on the, on the project, like for research proposal, there was all there's always a constant communication within the T and and a research proposal from both sir right. There's also some collaboration, we also have a project where, you know, we wanted to, you know, we were where the proposal was about a product a product for increased accessibility or enhanced accessibility. I would say that the communication there is always towards what we want and so, the communication is some sort of, so for that particular project, for example, We wanted like a urine detection software or I'm not sure if software is the correct word, but software is definitely a component to the product. So in that way, our communication was really based on, here's the thing, here's the things that we want to achieve 1234567 we think that this technology is necessary 1234567. But if you can deliver the things here, through the technology here are whatever technology you have, show it to us. And that's the become the tenor of that conversation.

Innovation Methods:

City of Worcester - § 4 references coded [5.15% Coverage]

Reference 1 - 0.86% Coverage

So it's we're spending a lot of time on educating and so we have datasets right now that we've put out there based on stuff that the public's want, like, for example, incident data, we have employee earnings information in there, we have COVID data available.

Reference 2 - 1.77% Coverage

And so so it's right now we're spending a lot of time educating staff on what what what it means and what the use of it is. Because a lot of them, they think that the general public will use a portal. And for me, the way I see it is the general public may not understand what a portal is either people like yourselves. And like I said, institutions, researchers, developers, they probably more in tune with what a data portal is, and what it looks like. Because that's most of the interest because they can pull analytics from it.

Reference 3 - 1.19% Coverage

Lean Six Sigma is it's a specific way of managing, right, and it's a way of looking at problems, situations, root cause, etc. So we decided about two years ago to kind of take that route. So we started providing trainings and our staff, we want to shift the culture of how we do business, right, so that we're continuously improving our day to day services.

Reference 4 - 1.33% Coverage

If we start to train our staff in LEAN our staff starts to think this way, they start to see a situation this way they start to identify, okay, there's an issue here, I now can provide an idea or a way to provide a better process, and what does the process look like so that we're not only data driven, but we're also looking Process driven, which right now is not like that we're very much reactive,

Spring Theory - § 3 references coded [3.11% Coverage]

Reference 1 - 0.82% Coverage

And you know, the client is like, Hi, I feel like, you know, haven't been speaking with the class enough, like, you know, I feel like, I want to give them information. But again, I'm not going to be the one reaching out and running the whole project.

Reference 2 - 1.59% Coverage

So if there are, you know, issues like that, you know, yes, I would step in, you know, reach out to the professor, whoever's running the project, to see, you know, where we can kind of get on even ground. Because, yeah, we don't really want the client to be worrying about, you know, things like that, you know, we want their time spent on, you know, providing data, providing feedback, you know, watching presentations, and not, you know, not looking over the administrative pieces.

Reference 3 - 0.69% Coverage

All of them seem to have a different process than us, but I've seen ones where it's like, hey, let's take a project from the professor and put it online, and then have someone try to like, you know, work on it.

MBTA - § 4 references coded [8.29% Coverage]

Reference 1 - 3.09% Coverage

So what is, you know, kind of like, a lot of people go through filing a proposal, thinking that it's going to fast track where their proposal without first asking whether it's really, is it really innovative? Do I mean, does it really fall within, you know, normal regular procurement, which, which usually is, I would say, 70% of that is usually just falls under procurement, normal procurements. But in the there have been proposals that are that have helped generate ideas within the T, help us realize the many assets that we have that we have not, and how we have not Maxim, maximized them and gave us ideas on how to potentially derive more benefit from them. we've engaged in many, many conversations with proposers on how we think we can partner with them, or they think that they can partner with them, there have been ongoing firewall of discussions with them.

Reference 2 - 2.03% Coverage

So in my experience, I can speak to the far this that a proposal has gotten, and we handle those proposals with the engagement of all stakeholders within the team, so meaning to say we actively engage in investigating the the the proposal, there is a period where we are able to the proposal, the proposer is able to ask us more questions, so that they are able to, to do respond to our needs more, and that we are also able to ask them further detail or like a detailed proposal. So I would say that these are my on at least the part of this that that I have experienced.

Reference 3 - 1.47% Coverage

So it really depends on and in that particular situation, we also open it up through through through a system called stir, which is basically, I don't know if you're familiar with it, but it's a platform for startups. to to to, to suggest that one technology, and then we give them time to develop it. But it depends on the product and the technology that we're looking for, or the product that we're looking for.

Reference 4 - 1.70% Coverage

Because, you know, innovation proposal is not something we don't, this is not an open bid where we're saying, you know, hey, you know, we need x, give us why it's not, it's not that simple. This isn't, this is an unsolicited platform. So we're not looking for that, but you're giving us you know, in a sense, I mean, you know, you know, informally we're, you know, informally it's not like we're out there looking for Hey, everybody, we want x It's not like that it's unsolicited.

Honeywell - § 1 reference coded [5.95% Coverage]

Reference 1 - 5.95% Coverage

the head of the CTO of the company, when he looks at what, where which area we're gonna go to, to develop, you see, let me take a step back, basically, a CTO when he has like a whole array of projects in front of him that he wants to do r&d on, you know, and the way he chooses these projects are basically are based on how much money these projects will make later on, if they get commercialized. You know, they have like, they have metrics, they calculate NPV and other metrics, like financial metrics, potential, because you know, you don't know in the beginning, you try to estimate like, what is the market base in the marketplace for that, and how much it will cost, how much investment we have to put into the development work. But so they collect all these financial metrics, they calculate like some, they calculate, like an NPV and some other metrics, and then they decide they said, this project, it's, it's going to make us more money at the end of the day. So that's what they choose to go to. Now, once you make that decision that you want to work in this particular technology area, then you make the decision that we discussed before you go internal, or you go open innovation. And when you go in, if you if you feel like that this is like super critical, it needs to move really fast. You cannot share IP with anybody else. Because this is like really a very, very cutting edge idea, then you keep it inside, you know, and you do the work inside. But if you feel like that, this is a nice to have, and it's, it's okay. And also the resource. The resource requirements are now on our part. So basically, it will be painless, we will go throw this to a

university, let them work on it, we'll give them a million dollars or something like as a grant, and maybe we'll have some oversight as to what they do. And let them let them do this work. No, that's that's kind of easy. But then again, you know, like I said, before, all these factors come into play, and you say, do I want to do it outside or I want to do it inside. And so the decision is made at a high level by the CTO or by the CEO of the company. And then once the decision is made at that level, then you go to the you, you drive it, you give it to people like me, and I go out there and I try to find the partners. Basically, that's how it works in practice.

Intellectual Property:

City of Worcester - § 1 reference coded [4.91% Coverage]

Reference 1 - 4.91% Coverage

Right now I'm in a contract negotiations with this vendor. Because of their agreements there, they want certain stipulations. And we want certain stipulations, certain liabilities, that we need to take consideration. So there, there is a lot of that, right, and especially in the cybersecurity end of things, how well our information is protected, and how well your information is protected within the system. So there's a lot of discussion on that, on that. And especially when it deals with, you know, technology driven stuff. Now when it's when it's infrastructure, like the bridge, that's not that doesn't involve a lot of negotiation, it's kind of mostly discussing with the institutions working that partnership, I'll and then you know, putting the funding allocations for that project. If it's a vendor, if it's if we're looking at we're hiring a vendor, then it's a little different, we have to, we have to go out to bid and we have to bid it out. Because under the city's regulations, municipal regulations, you have to bid out certain projects that are over $10,000. And so you have to go out to bid and bid it out. The same thing with any technology products, if I was to buy a technology product for the city, and it's over $10,000, I have to put it out to bid and have equal opportunity for multiple vendors to bid into that into that that proposal. But if it's a partnership with an institution, I can easily develop that partnership and kind of work that way

Spring Theory - § 3 references coded [4.28% Coverage]

Reference 1 - 0.60% Coverage

We also help out with any paperwork, you know, a lot of projects may need an NDA to be signed, some of them that are maybe a little bit more complicated, might have IP involved in it.

Reference 2 - 2.63% Coverage

So I mean, depending on, you know, what needs to be done. You know, a lot of times, we'll go ahead and administer those agreements. Now, if the company needs to change something about the agreement, they'll, you know, use their counsel, sometimes, like, you know, we sign an agreement with the company, just, you know, as a basic understanding, you know, so if they have any red lines, you know, we'll go ahead and take care of that. And then on the school side, you know, if they need to change anything, that they would have their counsel, so we're kind of like, you know, getting the right people in the room, providing our guidance as we go along. But at the end of the day, sometimes it has to be, you know, their legal or, you know, or the company's legal just so everyone feels comfortable.

Reference 3 - 1.05% Coverage

Most times no, I mean, we will create case studies, sometimes around projects, or, you know, maybe the company will and they'll mention us. But we're not always, you know, like, when they do their final reports, like you won't see Spring Theory on the, you know, on the PowerPoint, or a masthead, or something like that.

MBTA - § 4 references coded [6.61% Coverage]

Reference 1 - 2.10% Coverage

So so this is what happens when a proposal is, when a proposal is agreeable to the T, it, it doesn't necessarily mean it's outside of procurement law, that we still have to it's an innovative idea, it goes to the proposal. And it goes through procurement law. And we follow procurement law, meaning transparency, we show everybody that this person or this entity proposed to us acts, you know, we publish everything. So I can only speak to my experience, to the extent that a proposal has reached we have my one year and a half, we haven't had a proposal that has been fully implemented yet.

Reference 2 - 2.26% Coverage

We handle this proposals with in accordance with procurement laws. But also with a very open mind towards new things being introduced into transit. I think as you already know, three piece, there is not a, you know, there's no, like, designated statute for three B's within Massachusetts. So there's that piece as well, that needs to be considered. So there's other constraints as well, like, you know, how how, how certain projects need to be done through competitive bidding. So all these things, so we we take proposals to the extent that we can under you know, you know, with extreme consideration of what we have and what we can do,

Reference 3 - 0.46% Coverage

There are also products where, or the proposal where we're also limited by confidentiality laws that we cannot disclose to them.

Reference 4 - 1.79% Coverage

So it depends. So fora particular project, we might have to have confidentiality agreements or non disclosure agreements to have been signed. And it It happens all the time. And not just with a T it happens with with because, you know, we also have information that we need to protect, and the proposers as well needs to have information or ideas that they need to protect. So it really depends on the product or the idea. And, and, and the kind of engagement that that is involved in a particular project.

Honeywell - § 8 references coded [22.94% Coverage]

Reference 1 - 1.37% Coverage

I mean, one of the biggest things here in the Middle East, also in other parts of the world, is that they realize that what keeps the West ahead in terms of economics versus the rest of the world, is the IP ownership of IP is very big, right? So that's a very important thing for them. And they welcome this kind of collaboration from their side, they want they believe that the more they learn how to do IP, how to do research and how to develop their r&d, the sooner they will reach the same level as what we see in the US and Europe,

Reference 2 - 2.14% Coverage

One of the major things that I believe comes with open innovation and sharing IP is that it's the area is that it's the, it's the contamination of IP, like, because once you learn something jointly with another person, whatever you learned, you need to, you may want to apply it in another technology in another area, because there is a lot of similarities. So you have basically, in our industry, you basically, it's a chemical, you know, based industry, you have a reactor, and you have catalyst inside the reactor, so you produce a certain product. Now, there are many different technologies, which use the same basis, just the

reactor and fixed bed reactor in a product and a separation section, catalyst. And so whatever you learn from one technology, you can apply it in another. There are a lot of overlaps in terms of technology.

Reference 3 - 5.87% Coverage

Because one of the ways to take care of this is during the agreement phase, when you actually come up with a joint development agreement, you put this kind of term into the agreement, and you say I want to have that right to use this technology, that the learnings of this project, I want to use them in other technologies. That's one way to do it. And hopefully the other party will agree to it. Um, but another way to do it is to actually do firewalling. So you take like seven individuals, and you say, you're going to work on this project, with this other entity with the either an academic entity or company. And whatever you learn, you don't discuss it with anybody else in the company, you maintain, basically fire they call it a firewall, there is another term, it's called typhoid Mary, nondisclosure agreement, which basically, it names specific individuals. It's not the whole company that needs to maintain secrecy to this low specific individuals. So you can either take care of it by firewalling people and say, you know, you work in isolation from the rest of the company in developing this technology. Or you agreed to the, to the other people not to from with your partner, to allow to allow the partner to allow you to use this technology elsewhere. That's one thing. So it's how do you share IP and contamination issues like, the other issue is like, the one that has to do with disclosure, for example, if you work with a university, they usually work with like PhD students or graduate students who do research. These people, they want to usually publish a thesis at the end of their, of their study. Now that thesis becomes public domain, anybody can take the thesis. And now it's very important that whatever they put in the thesis, it stays outside of, you know, it doesn't disclose any, you know, important information, which you can, it can basically reduce your competitive advantage rate by, so you're basically getting the competition, free of charge, things that you've learned, right, so and so it becomes kind of a practical thing, I can take your like, let's say if you prepare a thesis, and you want to publish it, me as the corporate side, I can take the thesis and read it and say, I can try to edit it that and say, don't talk about this, and don't talk about that.

Reference 4 - 3.00% Coverage

. But usually, this is not very serious. And this kind of terms come into the joint development agreement, and you agree to disturbing the joint development agreement, and everybody's happy at the end. But it's a part of a negotiation, give and take. But these are the main issues, basically, to sum up, one is the IP contamination, so that I can apply it somewhere else without being sued for patent infringement. The other one is non disclosure of the information so that you don't leak the information that we work together in, in a project to get done, put it out in the public domain. And the third is, you know, you need to get some terms inside the agreement that binds the other party to only work with you and not work with others on the same team. That is in general, I mean, I send you a copy of a joint development agreement in a draft. Actually, if you go through that, then you can read every article, you know, you will see exactly what the issues are and why. Because otherwise, if that were not an issue, they wouldn't be in the agreement. So everything that's in the agreement, actually tries to address certain issues that usually comes with open innovation.

Reference 5 - 4.18% Coverage

But I know that different countries have different ways that they protect IP, some of them are more rigorous than others. And so they gather if there is a difference. I'm not so I'm not sure such an expert, but I believe that, like, for example, Saudi Arabia, may actually interpret certain things about IP ownership in a different way, than, than, an American or an array or an English company. That's the way we get around this is to basically, we agree as part of the JDA, we agree on what law, this agreement is done under, right. And when we're dealing with international companies, so you have an American company on one side, and you have a Saudi or another that another country's company from the other side, the way to do it is to have like an image of another country, a third country using the law of the third. So usually we use English law as the kind of intermediate or we use Singapore law or you know, depends on some

countries, they they agree on certain things like in India, they use English law as the as the law, you know, because it's kind of they consider it to be they think that if you go with American law, and you go to an American court, you may get the favorable treatment being an American company. So we try to use like third country as the intermediate. So but there are in there to answer your question. Yes, there are differences in interpretation. There is WIPO. It's the World Intellectual Property Organization. They have like guidelines of how in most countries abide to those guidelines, but the local law prevails, and sometimes different courts interpret the law the WIPO rules in a different way.

Reference 6 - 2.43% Coverage

Yeah, I mean, one of the things that is important in open innovation is the joint development agreement, right that I mentioned this before. And it will be worth You know, when you're talking to people, it will be worth to ask them like, what kind of elements go into the joint development agreement, what kind of things that you want to agree on ahead of time. So they, of course, you have to agree on scope, like you need to agree. You have to agree the there is a term called the field field. Basically, it's a, it's a legal term, which basically you describe what you're planning to research on. And this is very important, the field is very important, because when you limit the field, then you're free to do r&d on things outside the field, you're not bound by this agreement. Right? You can do other things. Like I mentioned before exclusivity, like, you want to have exclusivity with your partner, if you define, but only it's within the field.

Reference 7 - 2.56% Coverage

So, as part of the JDA, what you need to include in the JDA, of course, you need to develop the scope, who and who does what, like, you're going to do this part of the work, I'm going to do this part of the work. And you also specify how often you have to meet and how you're going to exchange information and all these things. That's, that's like, basically these things that we say that the among engineers when we talk to each other, but then there is a legal component to the agreement, which I sent you before that draft from the, you know, draft JDA, which gives all these legal terms and this legal terms are very important to understand what what components going inside the agreement and what things need to be agreed and discussed with the other party, right. And that is a whole bunch of them. That is like exclusivity, there are warranties. That's it, that's another thing that's like liabilities, you know, when you sign an agreement, you basically have to limit liabilities for your company.

Reference 8 - 1.39% Coverage

These kind of things, so that I don't remember all of them off the top of my head, but there is a whole bunch of items that need to be discussed and agreed between parties. So that's something that I think when you interview different individuals, when you do your interviews and talk to different people, it's kind of it's a good question to ask, like, what, what are the kind of the elements that go into your JDA, into your joint development agreement? What kind of things are you trying to, to come into an agreement before the project starts?

IP Legality:

City of Worcester - § 2 references coded [1.48% Coverage]

Reference 1 - 1.11% Coverage

And we want certain stipulations, certain liabilities, that we need to take consideration. So there, there is a lot of that, right, and especially in the cybersecurity end of things, how well our information is protected, and how well your information is protected within the system. So there's a lot of discussion on that, on that.

Reference 2 - 0.37% Coverage

But if it's a partnership with an institution, I can easily develop that partnership and kind of work that way

Spring Theory - § 1 reference coded [1.19% Coverage]

Reference 1 - 1.19% Coverage

And then on the school side, you know, if they need to change anything, that they would have their counsel, so we're kind of like, you know, getting the right people in the room, providing our guidance as we go along. But at the end of the day, sometimes it has to be, you know, their legal or, you know, or the company's legal just so everyone feels comfortable.

MBTA - § 3 references coded [2.89% Coverage]

Reference 1 - 0.69% Coverage

And it goes through procurement law. And we follow procurement law, meaning transparency, we show everybody that this person or this entity proposed to us acts, you know, we publish everything.

Reference 2 - 0.46% Coverage

There are also products where, or the proposal where we're also limited by confidentiality laws that we cannot disclose to them.

Reference 3 - 1.74% Coverage

So fora particular project, we might have to have confidentiality agreements or non disclosure agreements to have been signed. And it It happens all the time. And not just with a T it happens with with because, you know, we also have information that we need to protect, and the proposers as well needs to have information or ideas that they need to protect. So it really depends on the product or the idea. And, and, and the kind of engagement that that is involved in a particular project.

Honeywell - § 7 references coded [11.94% Coverage]

Reference 1 - 0.91% Coverage

One of the major things that I believe comes with open innovation and sharing IP is that it's the area is that it's the, it's the contamination of IP, like, because once you learn something jointly with another person, whatever you learned, you need to, you may want to apply it in another technology in another area, because there is a lot of similarities.

Reference 2 - 5.87% Coverage

Because one of the ways to take care of this is during the agreement phase, when you actually come up with a joint development agreement, you put this kind of term into the agreement, and you say I want to have that right to use this technology, that the learnings of this project, I want to use them in other technologies. That's one way to do it. And hopefully the other party will agree to it. Um, but another way to

do it is to actually do firewalling. So you take like seven individuals, and you say, you're going to work on this project, with this other entity with the either an academic entity or company. And whatever you learn, you don't discuss it with anybody else in the company, you maintain, basically fire they call it a firewall, there is another term, it's called typhoid Mary, nondisclosure agreement, which basically, it names specific individuals. It's not the whole company that needs to maintain secrecy to this low specific individuals. So you can either take care of it by firewalling people and say, you know, you work in isolation from the rest of the company in developing this technology. Or you agreed to the, to the other people not to from with your partner, to allow to allow the partner to allow you to use this technology elsewhere. That's one thing. So it's how do you share IP and contamination issues like, the other issue is like, the one that has to do with disclosure, for example, if you work with a university, they usually work with like PhD students or graduate students who do research. These people, they want to usually publish a thesis at the end of their, of their study. Now that thesis becomes public domain, anybody can take the thesis. And now it's very important that whatever they put in the thesis, it stays outside of, you know, it doesn't disclose any, you know, important information, which you can, it can basically reduce your competitive advantage rate by, so you're basically getting the competition, free of charge, things that you've learned, right, so and so it becomes kind of a practical thing, I can take your like, let's say if you prepare a thesis, and you want to publish it, me as the corporate side, I can take the thesis and read it and say, I can try to edit it that and say, don't talk about this, and don't talk about that.

Reference 3 - 1.29% Coverage

But these are the main issues, basically, to sum up, one is the IP contamination, so that I can apply it somewhere else without being sued for patent infringement. The other one is non disclosure of the information so that you don't leak the information that we work together in, in a project to get done, put it out in the public domain. And the third is, you know, you need to get some terms inside the agreement that binds the other party to only work with you and not work with others on the same team.

Reference 4 - 0.31% Coverage

So everything that's in the agreement, actually tries to address certain issues that usually comes with open innovation.

Reference 5 - 0.77% Coverage

Yes, there are differences in interpretation. There is WIPO. It's the World Intellectual Property Organization. They have like guidelines of how in most countries abide to those guidelines, but the local law prevails, and sometimes different courts interpret the law the WIPO rules in a different way.

Reference 6 - 2.56% Coverage

So, as part of the JDA, what you need to include in the JDA, of course, you need to develop the scope, who and who does what, like, you're going to do this part of the work, I'm going to do this part of the work. And you also specify how often you have to meet and how you're going to exchange information and all these things. That's, that's like, basically these things that we say that the among engineers when we talk to each other, but then there is a legal component to the agreement, which I sent you before that draft from the, you know, draft JDA, which gives all these legal terms and this legal terms are very important to understand what what components going inside the agreement and what things need to be agreed and discussed with the other party, right. And that is a whole bunch of them. That is like exclusivity, there are warranties. That's it, that's another thing that's like liabilities, you know, when you sign an agreement, you basically have to limit liabilities for your company.

Reference 7 - 0.23% Coverage

What kind of things are you trying to, to come into an agreement before the project starts?

Node Identification:

Spring Theory - § 4 references coded [7.19% Coverage]

Reference 1 - 1.91% Coverage

We work with some universities on more of a professor level, like they're teaching a course, you know, they're allowed to, you know, have clients in their course and they're allowed to find them themselves, no matter whether it's, you know, they, you know, contact an alumni or they work with us. Some other programs like a capstone type program, those are usually more overseen by a program director or like, maybe an Associate Dean. So in those cases, you know, we might work with them. So it really just depends on you know, the type of opportunity to whom we might speak with.

Reference 2 - 2.10% Coverage

So kind of just like you found me, you know, we worked, you know, many different lead gen sources, you know, including like LinkedIn. And we'll look for, you know, depending on the course, maybe look for different position titles, different types of industries, even, you know, geographic location, if we think you know, that, you know, some schools, you know, you you say the school doesn't matter where you are in the country, you know, they know that school, but sometimes it's more of a regional type thing. So maybe it's best to, you know, reach out to somebody in the East Coast for an East Coast type school or West Coast for West.

Reference 3 - 1.96% Coverage

we work with companies that probably have about 100 or more, you know, because like IBM, that's, that that's a super company, I mean, that, you know, 10s of thousands, if not more employees. So I would say that they're massive, but yeah, we've definitely worked with companies that you know, are smaller. But I think the ones that, you know, you're talking about 10, 20, 30, usually, you know, not that our pricing is, you know, like, you know, insane or anything, it's, you know, usually just, you know, about several thousand dollars, you know, just so that we can meet our costs and everything.

Reference 4 - 1.23% Coverage

And I think two is finding the right companies, because I you know, I've spoken with hundreds of companies over the time, and, you know, there's a lot of them that see the value in these types of projects. And, you know, for many different reasons, not just the work product, but in developing students and everything else. So those obviously, are good people to work with.

MBTA - § 3 references coded [7.78% Coverage]

Reference 1 - 4.14% Coverage

But for example, and I would then my job is to bring this to the attention of departments or offices that would have an interest in this. And usually it's like, you know, bus operations would have an interest in this CTD would have an interest in this customer experience would have an interest in this and all of those sorts. And, and I we have these groups come together and whether and and and, and and ask them whether whether a certain proposal is a priority for them? Or is it new to them? And more often than not, we receive questions like, Oh, can this technology do this? Because we actually need this. And and and that starts this conversation. And it has not been you, you know, it has also happened where we receive a proposal. And because of the questions that have been posed, we realize, Oh, this is the technology that this while the proposal is not the technology we want, we realize that because of this conversation, we need this. And we're going to look at look for this. And you know, so what I always say

innovation proposals do not necessarily do not necessarily result into a new product. But it always almost always resolved into a new idea.

Reference 2 - 0.66% Coverage

when I took on this job has been to talk to employees, trying to find out what they need, how they welcome innovation, what they think of innovation, and how they see this moving forward.

Reference 3 - 2.98% Coverage

But I think that, generally, from my experience, there's two types of proposals that really catch our attention. One is, is a problem we never thought was a problem. And they just pointed it out to us. And do presenting us with a solution that was right under analysis. That was easy to do. And there's somehow some sort of proof of concept whether or not at scale yet or already at scale. And these two, these two proposals, almost always get to the top of the pile. Because, one, it's easy to implement to it just, it just is not financially burdensome. You know what I mean, almost almost always, ideas like this are impactful, but not necessarily fiscally cumbersome. So those are the types of proposals that usually get to the top of the pile and usually get deserve and a high level. I mean, a discussion with high level officials.

Honeywell - § 3 references coded [9.46% Coverage]

Reference 1 - 4.16% Coverage

The projects that we normally work with in academia is usually projects, which are like cutting edge, you know, like, because academia is usually, when you do research, you know, you have like, various stages of research, like you have very exploratory research, very basic stuff that you're doing now on a bench scale. And then you have things that you do to improve like existing technologies and you have things like, between exploratory and, and development. So, usually, the projects that we are involved with in academia, it's like very early stages of research. And that's because academia, they kind of work a fine line between theory and application, you know, so then, so by definition, their work that they do is usually very cutting edge, very new stuff that doesn't exist outside. Because what the academia has, it has like a lot of brains, it has people with understanding of the theory, what the, the corporates have, they have more know how in how you scale up how to take, like, a concept that you develop in a lab, and actually build the and plant around it, right. So that, that the knowledge doesn't exist in academia, because academia, it's only, you know, they doing things like at the very early stages. So this is what we try to do concentrate, we go around to like, for example, reading articles, and, and publications that come out of academia from different universities, we see what kind of technologies they they're working on. And if we see like an area where basically, we think that this is commercially viable, and it will, it will create, you know, it will be a successful technology commercially.

Reference 2 - 3.96% Coverage

Now, the difference between working in, in house research, it's always preferable, right? For us, like if I, if I have the know how, if I have the enough expertise in house, to work on a project, to me, it's much preferable. Because it's much faster, I don't need to have a you don't have a fence in between you and the university. Because when you deliver, either with another company or with another university, there is always like a fence that you have to jump over, you know, and they're two different institutions with different policies, different work ethics, different, you know, there is a lot of differences that you need to kind of patch together. So for me, you know, like, as a, as a corporate, as a corporation, the easiest thing to do is work to develop things in house. The reason we go you know, to open innovation, instead of living and working things in house is a we don't have the resources to do it. Because maybe outside we have a limited number of scientists, which are all tied up in different projects, and I just don't, if I don't go outside, this project will have to remain in the cell for for some time. And by that time, I may lose competitive advantage, if I'm like late coming into the market. So and the other thing, like I mentioned before is I don't

have the knowledge, the brainpower, the knowledge. And sometimes in academia, you find professors who are highly specialized in a very narrow area of research and corporate corporate Institute institution may not have you, they may not have that particular specialty.

Reference 3 - 1.34% Coverage

And people were basically lining up to talk to him, because he was kind of a rock star, you know, anyways, these kind of people sometimes are difficult to in a company who may or may not have this kind of authority in working for you, you may do you may not, you know, and if you don't, then it's easier to go and go to him to in like a in an academic environment and say, let's work together, let's do this project together. You know, and that's why you want to talk to you know, you want to engage with these people, right.

Open Collaboration Examples:

City of Worcester - § 5 references coded [9.38% Coverage]

Reference 1 - 1.15% Coverage

And so just the past couple of weeks we've been working on with the departments are trying to get more data sets into the open data portal. To ensure that we're open government, we're issuing an executive order soon with an open data policy that really determines how we, as a government, we're going to operate and the kind of this environment.

Reference 2 - 2.20% Coverage

so I've had meetings already with your director of relate or community relations, government affairs, at WPI, the manager, city manager, have met with your president and talked about what could that look like? We've talked about possibly doing a fellowship program as part of the innovation office. So maybe one of you could probably be doing that fellowship program, and work for the city, you know, whether it's in a master's program or an undergrad in a summer, or we've had, we've worked with IQP over at WPI, where IQP has come in and provided some technical support, they actually developed an app called the stigma free app for the city of Worcester.

Reference 3 - 0.75% Coverage

We do a lot of work with Clark university, Clark university is a research partner for youth violence initiative. We've worked with Worcester State on on our suspension, data analysis. So we work with institution all the time.

Reference 4 - 2.44% Coverage

I did that I did that once with WPI. So the Elm Park bridge, I don't know if you've been to Elm Park, there's a there's a red wooden bridge there. That red wooden bridge was a project by WPI. We worked with the architecture, architecture and civil engineering teams. And, and they designed the bridge, we spent a lot of time that was actually one of my first project when I came on here in the city about six, seven years ago. And, and so we work with them on on the design, and in the infrastructure engineering of the, of that bridge. And that's so that's something that, yes, it's a one time project, but they you got to, you know, that bridge has been there already six, seven years, probably gonna be there for another 50 years,

Reference 5 - 2.83% Coverage

What side of things is there specific department that has one individual, I'm Dr. Laurie Ross, who focuses on research analysis and and data and she hosts classes that connects with us. And we go and present

to them. So she is my contact person. So anything related to any of that, I'm always going to her. And she's kind of like the de facto person to us. The same thing happens with with Worcester State. There's one urban planning kind of the director of urban planning. He He's the one that kind of works with us on on all anything related to analytics, data analytics and reporting on there. And so I think that's what we need. I think maybe with WPI, it's one direct person that I can work with. And I can connect and throw ideas to and they can throw ideas to me and we can constantly be in communication to to really develop that partnership.

Spring Theory - § 2 references coded [5.32% Coverage]

Reference 1 - 2.36% Coverage

All over the country, is where we have projects like Cornell is a partner of ours. For data science, we work with Columbia in their business school. Like I mentioned, we worked with Northwestern, we worked out here with USC. So really, yeah, all across the country. We have had some projects that reach internationally, I think we've worked with like Stanford, I think they have a collaboration like process with Tsinghua University in China. So I think we've set up a project there, most of our projects are going to be with domestic universities, but a lot of domestic universities also offer like global marketing or global research to where the students are based here. But the focus of the class is international.

Reference 2 - 2.96% Coverage

Yeah we have. Not that I can say recently, but I know even before, like, I've been at Spring, Theory three and a half years now. And, you know, we've been a company for about 11. I do know that we've had a couple of times where like, my boss, and our founder has, you know, set up projects that were kind of like, somewhat like a competition between like two or three different schools. So yeah, we've seen that before. It just makes for more coordination. You know, sometimes, you know, maybe the schools that you might think of might not have, you know, all the same courses to be able to do that type of project. So most times, it would be, you know, the client working with one school because it's also more helpful on their resources, because if they have three or four different schools, they might need to pull more people from their team to be able to meet the needs of each university partner.

MBTA - § 4 references coded [11.00% Coverage]

Reference 1 - 2.45% Coverage

in October started the innovation policy proposal, proposal policy called the IPP. And since then, it has received a lot of proposals. To date, it has had three success, only three successful proposals that have been carried on as projects. One is actually a research project with MIT. One is a an enhancement to, it's actually a tool for procurement and another one is actually like a technology. It's called. I forget what it's called, but it's actually a ribbon that you but we put on the commuter rail, step board and it melts ice. So at that time that it was proposed, it was fairly new, not the only one in the market. I don't I think, if not the only one in the market at that point.

Reference 2 - 3.65% Coverage

You know, I don't know if you've heard, we, the T actually has a system, which is now you know, you know, two of our bus supervisors or inspectors, they actually helped develop a an app that helps drivers. First of all, drivers with the same route, know exactly where the, the previous bus is, and how far they are apart from each other. So this helps in the dispatch. And and this is, so this has been developed also together in partnership with the, with CTD customer technology department of the MBTA. And that is now if I'm not mistaken, other transit agencies have contacted us and would want to have a chair that technology as well. So we've had innovations led by employees. Similar to that we also in 2015, we had this employee because of the storm. We have this employee who basically put to like electric snow

shovels together and create the monster I forget what it's called, but it's actually patented, and it was bought by john deere, john deere. So all of these things created, we want them to answer that, that,

Reference 3 - 2.60% Coverage

And so last year, we engaged and started contacting innovation labs within the Boston area. And kind of, Hey, you know, we've reached out to them and say, you know, this thing is alive, when this thing is not a dormant document, we are thinking of improving it, can you help us improve it? Luckily, we've been able to have very fruitful discussions with the Harvard Innovation Lab, be you and I'm looking forward to touching base with other universities as well. We've also reached out to the private sector, you know, just telling them that, you know, so, the challenging thing about innovation is how to make it a priority in any transit agency, I'm sure you've talked to other transit agencies as well have you guys stuck to it.

Reference 4 - 2.30% Coverage

. So BU had invited us last year, I'm, you know, I have no sense of time now, because of COVID. But I think early this year, they invited us, they had an Innovation Challenge for their students. And, and we participated in it. We also did some coaching for their students. It's not really coaching, but kind of like, giving them advice. I mean, it wasn't a prolonged engagement, it was fairly new, because we had just started this whole conversation with them. But yeah, so they were students who, after that thought approached us and they said, you have this idea and Baba and and? Yeah, I mean, we would appreciate, I would really appreciate that.

Honeywell - § 1 reference coded [1.74% Coverage]

Reference 1 - 1.74% Coverage

Then we approached the university, and we say, let's, let's work together, do you have, do you have another partner, if they don't have another partner, or they working in isolation, then we can come in, and we can supply our own know how to scale things up. And we also give a reality check to academic projects, because academic projects, sometimes they don't, they're not bound by economics, the corporate side, we're bound by economics. And so we give a reality check and say, don't go down this path, because it's economical, go down try something else, which reduces the cost of the process, because we know that at the end of the day, you can develop things which are great.

Problem Identification:

City of Worcester - § 4 references coded [5.56% Coverage]

Reference 1 - 1.24% Coverage

The reason why we started the office was basically there was a lot of new technologies, new ways to improve efficiencies. And the city was looking at a way to become smarter, via smart city. And so because of all those components, it was kind of a no brainer to start an office to focus primarily on those things. And so part of that focus has been on big data, open data.

Reference 2 - 1.12% Coverage

What is what is an API, some of them don't know what an API is, and what the importance of an API is for people like you and institutions and research institutions and whatnot, or even developers. And so we have to spend a lot of time in creating what methodology we want that data to be created, and what they're trying to communicate

Reference 3 - 2.54% Coverage

And to do so, we need to use a system or structure and how we look at problems, how we look at issues within departments, so that we could identify, okay, what's the workflow look like? Where are the gaps, where the inefficiencies and how we build more efficiencies? Again, the the ultimate goal is to saving not only saving taxpayer dollars is also saving time, right? So if we if our average time to fill a pothole takes 48 to 72 hours, could we do that in 12 hours? Could we do in 10 hours? I don't know. And we don't know that until we start digging in? And knowing what the data tells us when a ticket is open, when a ticket is close? how frequent are those tickets happening? Where are they coming from? Why are they coming from that area so often, etc.

Reference 4 - 0.67% Coverage

There's not a network of there's not a network of people in our city that talks innovation that talks Smart City, and that says this is who we are, this is what we have, and communicate it frequently.

Spring Theory - § 2 references coded [4.22% Coverage]

Reference 1 - 1.36% Coverage

So, you know, we initially start out with educating the client on, you know, what the opportunity is, usually I'll have like an introductory call with them, then if they want to move forward through the process, you know, we speak with the professor of the course, you know, really dive into the project, understand, you know, where any roadblocks might be, and you know, what the expectations are for everyone.

Reference 2 - 2.86% Coverage

So I would say that, you know, a big thing for companies. I think a big thing for the university, too. Is that understanding that these companies, you know, whether they're, you know, working with Spring Theory and they're, you know, paying for services or you know, whether they're you working with the university may be going to make a donation. If you know, the money aspect of it, I feel like isn't as big of a, you know, a question for the companies assuming that you're not going to say, Hey, you know, you're going to work on, you know, three month project, it's going to be 100 grand or something like, obviously, but I think for them is really feeling that their time is going to be spent, is going to be useful, and that the students aren't just trying to receive a grade for their their work, you know, you know, obviously, that is what they're trying to do.

MBTA - § 4 references coded [8.10% Coverage]

Reference 1 - 4.14% Coverage

But for example, and I would then my job is to bring this to the attention of departments or offices that would have an interest in this. And usually it's like, you know, bus operations would have an interest in this CTD would have an interest in this customer experience would have an interest in this and all of those sorts. And, and I we have these groups come together and whether and and and, and and ask them whether whether a certain proposal is a priority for them? Or is it new to them? And more often than not, we receive questions like, Oh, can this technology do this? Because we actually need this. And and and that starts this conversation. And it has not been you, you know, it has also happened where we receive a proposal. And because of the questions that have been posed, we realize, Oh, this is the technology that this while the proposal is not the technology we want, we realize that because of this conversation, we need this. And we're going to look at look for this. And you know, so what I always say innovation proposals do not necessarily do not necessarily result into a new product. But it always almost always resolved into a new idea.

Reference 2 - 2.55% Coverage

So that has also much of the effort is also trying to change the culture within the organization within management that, hey, this is something that we need to look into, because there are proposals out there and we're not just talking about new products, it can be totally like new financing mechanisms, creative financing mechanisms, maybe three P's it can be I don't know build drags, you know, Build Operate and transfer or whatever it is some permutation of that, and all of these things need to for us, need for us to you, we need to put some resource in trying to kind of understand the product, or the idea and, and determine how best we can we can we can take advantage of that idea that has been given to us.

Reference 3 - 0.66% Coverage

A lot of the conversation is really towards understanding how the culture is changed, right? Like how the work approaches change, and also just recognizing what is relevant for the team.

Reference 4 - 0.76% Coverage

so I've been asked this question how what gives? What makes a proposal? What proposal attracts the city? What sort of proposal and density? And I think that the answer there is not. There's no, there's a formula.

Honeywell - § 2 references coded [3.22% Coverage]

Reference 1 - 1.37% Coverage

I mean, one of the biggest things here in the Middle East, also in other parts of the world, is that they realize that what keeps the West ahead in terms of economics versus the rest of the world, is the IP ownership of IP is very big, right? So that's a very important thing for them. And they welcome this kind of collaboration from their side, they want they believe that the more they learn how to do IP, how to do research and how to develop their r&d, the sooner they will reach the same level as what we see in the US and Europe,

Reference 2 - 1.85% Coverage

let's say you have a car, I'm just using a very simple example. If you if you're trying to research on the car, and you say, I'm gonna try to develop the glitz, develop technology on a tire, you can you basically specify that the field is only the tire of the car. And you don't, you may even specify the size of the car, you're talking about, like a regular passenger car, you're not talking about tracks. So you try to develop to specify the field so that you can you're free to work on things outside the field. Like if it's an electric car, you can work on the engine or whatever. But you don't, you know, you're not working on the on the tire only, you know, so this is something very, very important that to be specified.

Project Advice:

City of Worcester - § 2 references coded [7.49% Coverage]

Reference 1 - 4.96% Coverage

I think probably there probably needs to be a centralized way. For me, because right out, right, WPI has so many components, right? I can do, I can do some work with the civil engineering office, I can do some work with the architectural office, I could do some work with IQP, I could do some work with the government office. I just need, like, who is my central communication, and maybe is the president's office

and I communicate with them directly. And then they, you know, they leveraged a relationship with, you know, your professors or whatnot. But I think that relationship needs to be harnessed to fostered a little better, so that we could really have a day to day or monthly or quarterly conversations as to how do we start engaging one another in these projects, and also give, I bet you this tons and tons of you with tons of ideas, like, we want those ideas, let's put them out to the table, let's put them on a whiteboard and figure out which ones work and which ones doesn't. And let's just test them out. I'm open to doing that. And I think this is an opportunity that the city now have that has an office to do that can do it before it was kind of, you know, what do we do that? Who who manages that information, who manages those projects? But now we do now, we can do that I can do that on our end, and meet with, you know, a team of folks at WPI and figure out what what technical innovations are? Our Do we need right now? What some can be in the long term, etc.

Reference 2 - 2.53% Coverage

And I think, in partnership with WPI is how does the VPI become an advocate of Worcester and starts to communicate to other communities and other institutions in their networks to say, Hey, what's up does have this infrastructure. And they are smart city. Because it's important, not only for us now, but also in the future in terms of our growth, our economic growth and our development as a city, which also impacts the growth of the WPI as well. And helps to for them to recruit students. So imagine a student coming in and say, Whoa, ha, was there. I mean, that'd be as a top notch school. But also Worcester is a smart city that has a huge relationship with the institutions to develop, and even new applications and new technology. I want to go there.

MBTA- § 1 reference coded [2.73% Coverage]

Reference 1 - 2.73% Coverage

If you could help us with the innovation proposal in what way whatever, whatever shape or form any feedback or because we welcome that from students really want to develop a more robust relationship with innovation labs, and, and, and hopefully, we could have an innovation lab of our own where we could, and I'm just, this is just my dream, this is not my dream yet. This is just the registry. I we hope that to be able to invite students and that they are able to somehow get some, I don't know whether it's an apprenticeship or whatever summer internship, I don't know. out of it, and and because the T is the community strengthened. So there should be and this is part of that, that engagement and forming the T of the transit to the community transit that we are.

Reflection:

City of Worcester - § 4 references coded [8.40% Coverage]

Reference 1 - 2.21% Coverage

where we hear an issue from a neighborhood, and we just go send a crew to go fix it. And we just do that we hear an issue, go fix it hear an issue, go fix it. But we never really sit back and say, why is that issue been happening anyways? Why is it happening so often? Or why is it keep coming from this particular neighborhood? So I think lean allows the city to look at processes in a different way, but also encourages staff to feel empowered to share ideas and think of ways to improve their day to day, on a much kind of much fluid way, much quicker. way. So that so that's why we're focusing on providing Lean management to our city and to our residents.

Reference 2 - 2.27% Coverage

that as a student, you get an opportunity to be involved in it and see, and see people enjoy it for the rest of, you know, I take my kid, I just, I did mom, I just had a kid about three months ago. So I got to take my kid with a stroller and walk through it. And you know, through that bridge, and I was a part of, you know, even though I work for the city, it's you know, it's rewarding, but you as a student, 10 years, 20 years down the road, you can bring your kid down to that park and say, Hey, you know, I've built this, and I was part of this design work or whatnot, you know, it's pretty rewarding, which is pretty cool. And so that's something that WPI worked with us on.

Reference 3 - 3.19% Coverage

so once all those systems interconnect and they communicate with one another, we can best be we can best serve the community in terms of the services and the access that they need on a day to day to get in and out of the city. That makes us a smarter city, that makes us work smarter on the back end all these technologies talking to one another than then having to them work in silos. And so right now that's where they are they all working in silos. They're not interconnected. So we try to build this architecture, internal architecture that allows them to connect to talk to one another. And what allows for us with better analytics, better understandings, so when we need to make decisions on particular neighborhoods, on infrastructure, on resources, etc, we can best determined through the data, we can best determine what the need is in that area because all of these things are talking to one another and informing us in a more comprehensive way.

Reference 4 - 0.73% Coverage

We're actually now in conversations of potentially doing an op ed in the newspaper where it talks about smart city, because we have this stuff, we just don't random, we don't communicate and we need to do a better job.

Spring Theory - § 1 reference coded [1.58% Coverage]

Reference 1 - 1.58% Coverage

And, you know, the professor is, you know, a really good professor, and, you know, we've given him some really good companies. And, you know, we have had times where, you know, the project itself, it may, it could have been better the results. And I think that really comes down to just the structure of the project, like I was alluding to before is that, you know, there needs to be a good amount of cadence, not, you know, like an internship where you're hand holding every day.

MBTA - § 3 references coded [4.76% Coverage]

Reference 1 - 2.04% Coverage

So at that time, I joined the T, one of the things that I noticed was that the proposal was really more outward looking, meaning it was directed more towards private sector and academia. It did not include employee led innovation. And at that time, I thought that it really so I, we interviewed a lot of people within the T, and safe to say innovation has never stopped at the T. I mean, we have had employees who, you know, using their own balance and the assets that we currently have maximizing them, morphing them into many other uses that that he has taken advantage of.

Reference 2 - 1.98% Coverage

So a lot of it has been as a lot of it also is sustaining the engagement and the traction that we've already received over the past four years, but, you know, admittedly, we really need to strengthen it. It also has to

morph together with the post COVID world, right? It also has to do more with the realities of our, the reach of our resources, and I think now more than ever, it's become innovation has proven itself as essential. So I think that's, that's where the next phase of, you know, redefining how important that is to us, because it really is.

Reference 3 - 0.74% Coverage

At the moment, I feel like the the conversation that needs more development is towards really the startups and educational institutions. But as far as private sector is concerned. I think we're good with that.

Honeywell - § 1 reference coded [1.48% Coverage]

Reference 1 - 1.48% Coverage

But if they don't make financial sense, then it's not a success. It may actually lend it may teach you how to how things work, you know how to how to make, why things work, like in a scientific way, but it's not going to translate into developing a technology that can be commercialized. So then, so sometimes, and sometimes the industry and the academia, they have diverging points of view. But there are certain times when they both match together and they say, Okay, now we have something here, which we feel like it can become commercially viable. Let's Let's work together.

Success:

City of Worcester- § 1 reference coded [2.27% Coverage]

Reference 1 - 2.27% Coverage

that as a student, you get an opportunity to be involved in it and see, and see people enjoy it for the rest of, you know, I take my kid, I just, I did mom, I just had a kid about three months ago. So I got to take my kid with a stroller and walk through it. And you know, through that bridge, and I was a part of, you know, even though I work for the city, it's you know, it's rewarding, but you as a student, 10 years, 20 years down the road, you can bring your kid down to that park and say, Hey, you know, I've built this, and I was part of this design work or whatnot, you know, it's pretty rewarding, which is pretty cool. And so that's something that WPI worked with us on.

Spring Theory - § 1 reference coded [4.30% Coverage]

Reference 1 - 4.30% Coverage

I would think that there's probably yet two things, the first thing would be, you know, the success of the project, meaning the company felt like they got something out of it. Now companies don't, you know, they understand that they're not signing up to get a billion dollar idea. But a lot of them, you know, idea generation, you know, confirming directions that they've had previously, like, those are all big things for them. So I'd say definitely the work product. And then the time spent, because there's definitely really successful projects, but then maybe the client at the end is like, Oh, you know, that was a lot of our time. So we can't be doing this, you know, every, you know, every semester. And I, I think, too, that that's the, that's something that we've learned is that, you know, we've gotten better at retention of clients. But we realize that, you know, if they did one project in the spring, they're probably not going to do one in the fall, you know, maybe a year from now, or maybe a year and a half from now. They'll want to so that's why we do try to focus on not just, you know, that same department at a company, but maybe once we've worked

with that department, see if there's leads in other areas of that company who haven't done a project, so they might want to do one sooner.

MBTA - § 1 reference coded [3.65% Coverage]

Reference 1 - 3.65% Coverage

You know, I don't know if you've heard, we, the T actually has a system, which is now you know, you know, two of our bus supervisors or inspectors, they actually helped develop a an app that helps drivers. First of all, drivers with the same route, know exactly where the, the previous bus is, and how far they are apart from each other. So this helps in the dispatch. And and this is, so this has been developed also together in partnership with the, with CTD customer technology department of the MBTA. And that is now if I'm not mistaken, other transit agencies have contacted us and would want to have a chair that technology as well. So we've had innovations led by employees. Similar to that we also in 2015, we had this employee because of the storm. We have this employee who basically put to like electric snow shovels together and create the monster I forget what it's called, but it's actually patented, and it was bought by john deere, john deere. So all of these things created, we want them to answer that, that,

Appendix F: Ideation brainstorming session results

Brainstorming - "What should our prototype do/consist of?"
What problems do other networks have that ours can help with?

Criteria

INTRO

- Willingness from project partners/sponsors to work with/critique students
- Accept projects from smaller firms, startups (look outside large corporate connections)
- Accept projects from government entities, willingness of WPI to coordinate with other schools as well

Interactive Communication

- Consistent knowledge base
- Constant/Consistent Communication
- One office (point of contact) to manage the portal/facilitation tool
- Directory of sorts for finding specific professors to reach out to

Intellectual Property Management

- Strong negotiation for IP
- Integration with WPI Patent Lawyers/Department

Impactful Advertising

- Advertisement to external partners and generally, to the public
- Advertise to professors harder to encourage them to throw their projects into the portal
- Orient towards to different majors
- Act as a two-way street: advertise some of the research being done here so that companies can see that and reach out to us (be it grad students or professors)

Inclusive Operation

- Prioritizing/highly considering projects that benefit and involve the Worcester community
- Incorporate curriculum-based project collaboration
- Student involvement - office members etc. as a form of employment
- Online vs In-person office
- Online learning and project efforts