PROTOFOISIE:

PROTOTYPING THE USAGE OF THE FOISIE INNOVATION STUDIO

A MAJOR QUALIFYING PROJECT SUBMITTED TO THE FACULTY OF WORCESTER POLYTECHNIC INSTITUTE IN PARTIAL FULLFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF SCIENCE

ON APRIL 27, 2017

SUBMITTED BY:
MORGAN N. MITCHELL

ADVISED BY:
DEAN MICHAEL GINZBERG
DEAN ARTHUR HEINRICHER
DR. CURTIS ABEL

Abstract

The Foisie Innovation Studio (FIS) provides WPI the opportunity to take a different approach to project work. The purpose of this project was to better understand how the physical space in which a team works influences inter-group collaboration and team performance. The findings of this project provided insight and recommendations on a testing strategy to uncover the key physical space variables that improve team performance and inter-group collaboration.

Executive Summary

Worcester Polytechnic Institute was founded under the two principles of theory and practice. Throughout the past century and a half, WPI has taken pride in its academic project work through ongoing IQP, MQP, GPS, and other projects. Now, WPI has the opportunity to take project work to the next level both in and outside of the classroom through the creation of the Foisie Innovation Studio. The Foisie Innovation Studio will open in the Fall of 2018 as a space for students to collaborate, innovate, create, and more.

Project work at WPI has traditionally focused on intra-group collaboration but with the addition of the FIS, the possibility to encourage inter-group collaboration comes into fruition. The prospect of introducing the idea of inter-group collaboration is exciting because students will be able to expand their knowledge, help teach others, and make a bigger impact.

Therefore, this project was completed to determine whether or not the physical space in which a team does their work will make a difference in their overall satisfaction as well as in the successful outcome of their project. To test this, the *Three Chairs Challenge* was created. The *Three Chairs Challenge* prompts students to go through the design process in under 45 minutes given a specific customer and their needs for a chair. The Challenge was run in two different scenarios to see if two teams working in the same space would be more successful than two isolated teams due to inter-group collaboration. The first test scenario was comprised of two teams of four students each and was held in the ProtoFoisie space in the WPI Gordon Library. The students were all in one space and were given two different customers for the challenge. The second test scenario took another two teams of students (four people per team) and put them into isolated spaces to complete the challenge.

Overall, no quantitative difference was seen between the success of the teams based on the space in which they worked. However, the focus groups that were held after the experiment provided important insights that showed, that with more testing, inter-group collaboration would be likely to occur in open, adaptable spaces, that provide students with the opportunity to spread out, not have to worry about reserving spaces, and that have whiteboards/smartboards.

Acknowledgements

Thank you to the following people and organizations for making this project possible:

My advisor, Dean Michael Ginzberg, for taking a leap of faith in advising this project and for his insights in theory and practice along the way.

My co-advisor, Dean Arthur Heinricher, for his steady guidance and ongoing support.

My co-advisor, Dr. Curtis Abel, for his out-of-the-box thinking and passion for helping WPI students.

President Laurie Leshin, for recognizing the need of the student perspective in the Foisie Innovation Studio.

Donald Richardson, Jessica Colati, and Debbie Bockus, for being supportive of student learning and allowing me to use part of the library to build the ProtoFoisie.

Workplace Resource for helping design and acquire the furniture for the ProtoFoisie space.

Ken Fisher, Keller Roughton, Jeff Lussier, Fred DiMauro, and Jim Bedard, for their ongoing support of the ProtoFoisie space and their ongoing investment in the Foisie Innovaiton Studio.

WPI LaunchPad for sharing their insights, time, and passion for innovation and entrepreneurship.

Table of Contents

Table of Figures

Table of Tables

Introduction

The FIS was made and designed to serve the WPI student body by allowing a place for innovation, entrepreneurship, project collaboration and much more.

Although the premise of fostering innovation, entrepreneurship and collaboration seems fine and dandy, the practical application of how this will actually occur is another story. Therefore, prior to the opening of the Studio, it must be understood how each of these factors will have the opportunity to occur naturally by students and in settings and applications that already exist in the WPI ecosystem.

One of the keys to fostering the three factors mentioned previously is that of knowledge sharing. Knowledge sharing can be defined as "the exchange of knowledge between and among individuals, and within and among teams, organizational units, and organizations. This exchange may be focused or unfocused, but it usually doesn't have a clear a priori objective."[1] In order to expand knowledge sharing in the WPI community, it must first be understood how students currently share knowledge among each other and what may barre them from doing so.

The goal of this project is ultimately to determine whether or not the physical space in which a team does their work will make a difference in their overall satisfaction, as well as in the successful outcome of their project. In order to achieve this goal, experimentation will be conducted with WPI student teams.

[1] (Paulin & Suneson, 2012)

Literature Review

Innovation

Innovation is a very diverse activity that takes place in a plethora of locations such as a university, small garage, factory floor, or over dinner. However, it is important to note that there is a large difference between random brainstorming and a concentrated effort. The organized practice of innovation falls into four categories that are represented in the Innovation Matrix: basic research, sustaining innovation, disruptive innovation, and breakthrough innovation[2].

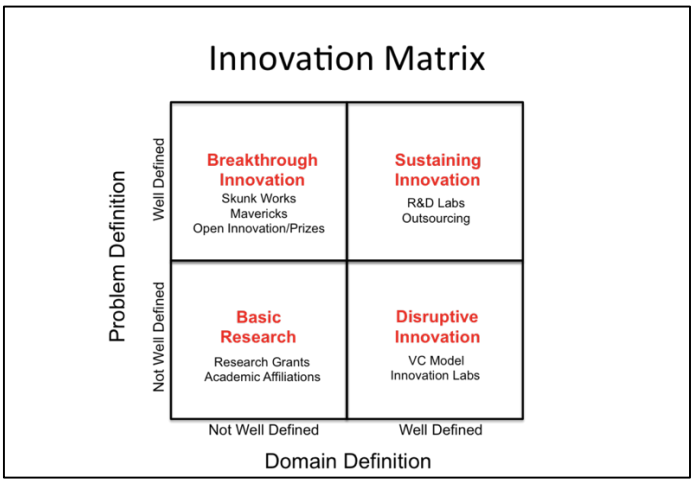


Figure I: Innovation Matrix

Basic Research

Basic research is the work that typically gets done in settings such as universities or research and development labs. The point of this type of innovation is to discover more about how things work. Examples of famous innovators that completed what may be considered basic research are Albert Einstein's theory of general relativity or Rosalind Franklin's discovery of the double helix structure of DNA.

[2] (Satell, 4 Types of Innovation, 2012)

Sustaining Innovation

Sustaining innovation, sometimes referred to as 'incremental innovation',[3] exists when there is a clearly defined problem and a decent understanding as how to solve it. An example of sustaining innovation was the introduction of the iPod by Apple in 2001. It was determined to be a device that could hold up to "1,000 songs in your pocket".[4] These determinations provided quantitative parameters for the designers and were based on the need of customers at the time. Needs, such as these, may not always be quick to solve, but it is typically clear what and who is needed in order to come up with a working solution.

Sustaining innovation is likely the most common in the corporate world and is often regarded as engineering instead of pure science. Much like Basic Research, however, a lot of Sustaining Innovation is completed by internal R&D labs, although some of it is outsourced to firms as well.

Ultimately, sustaining innovation is about fulfilling a customer need and in the modern day; these needs are often met with a technological solution. In his book, *Innovation*[5]*,* Curt Carlson introduces a model in which to present a value proposition. Carlson argues that every important innovation opportunity requires a value proposition. For when it's missing, "the result is confusion, poor communication between employees and management, a lack of focus on the customers' actual needs and wasted organizational resources." The goal of the value proposition is to show that you have created and will deliver a product that is "clearly greater than the competition's." Carlson models his approach, NABC, off of the four fundamental questions that "must always be answered when… new customer value [is created]." NABC is composed of the following questions:

- What is the important customer and market *need?*
- What is the unique *approach* for addressing this need?
- What are the specific *benefits per costs* that result from this approach?
- How are these benefits per costs superior to the *competition's and the alternatives?*

[3] (Estrin, 2008)

[4] (Apple Inc., 2011)

[5] (Carlson & Wilmot, 2006)

Disruptive Innovation

The concept of Disruptive Innovation (sometimes referred to as orthogonal innovation[6]) was introduced in Clayton Christensen's book *The Innovator's Dilemma* where it is described as "technologies [that] typically enable new markets to emerge."[7] In other words, these are typically new approaches to already existing goods and services.

Disruptive Innovation can be difficult to value in the present because "disruptive innovation can reliably be seen only after the fact."[8] It is for reasons like this that many venture capitalists expect many of their investments to fail.

It is important to note, however, that disruptive innovation tends to be one of the most controversial types of innovation. In 2014, an article titled *The Disruption Machine: What the Gospel of Innovation Gets Wrong,* was published by The New Yorker. This article argued that Clayton Christensen's "sources are often dubious and his logic questionable" in regards to Disruptive Innovation. The author, Jill Lepore argues that much of Christenson's writing and research are based on "single sources" that best fit what he wants his theories to say. Lepore argues that "disruptive innovation is a theory about why businesses fail. It's not more than that. It doesn't explain change. It's not a law of nature… It makes a very poor prophet." Regardless of her disagreement with Christensen on Disruptive Innovation, Lepore does believe that incremental improvements are a more plausible method of innovation and are the method in which we will truly progress into the future.[9]

Breakthrough Innovation

Breakthrough Innovation is also sometimes known as "revolutionary science"[10] because it introduces a paradigm shift. In Breakthrough Innovation, the problem is well defined but the solution to the problem is unclear. A common example of breakthrough innovation was the introduction of transistors.

---

[6] (Estrin, 2008)

[7] (Christensen, 2013)

[8] (Lepore, 2014)

[9] (Lepore, 2014)

[10] (Kuhn, 1962)

Many fields have trouble moving forward because they need a new approach. It is for this reason that it is often newcomers that make the major breakthroughs. The problem with this however, is that society can't just wait for the next genius to come along, as it isn't efficient or realistic. Because of this, some companies are attempting to hit the problem head on by promoting open innovation. Open innovation is when companies encourage employees to use paid work time to work on their own projects or openly share ideas with their colleges allowing for more internal innovation to occur.

Structuring Innovation

Although the substrate in which our ideas are developed is highly determinate, we do have the ability to shape our surroundings. With this being said, there are many essential needs when creating an innovative culture such as diverse influences, creative enrichment, and constant renewal.[11]

Jane Jacobs, a well-known urban-studies activist and author, found that diversity is the key to economic viability[12]. The same is true for business. The reason that this translates well to business is that ones that get too ingrained within their own industry have a tendency to shun outside ideas or objectives alienating themselves to change, progress and innovation. This concept of diversity rings true to creative enrichment as well because a creative environment/lifestyle tends to attract highly talented people. An example of this creative enrichment can be seen in San Francisco, CA. The Bay Area is not only a city with state-of-the-art research labs and machinery, it is also a community that offers a thriving art and music scene. These diversified options offer an attractive lifestyle to sought after talent.

The concept of constant renewal is also very important in regards to innovation. If workplaces or relationships become too stagnant, they are more likely to fail. An interesting example that proves this concept was a project that researched the social network of Broadway shows. The findings were that while some familiarity is good, too much inbreeding of casts actually caused their show ratings to fall.[13] Because of this, it is important to keep teams fresh and reshuffle workflow occasionally.

---

[11] (Satell, Structure, Agency and Open Innovation, 2011)

[12] (Jacobs, 1970)

[13] (Satell, Building Creative Collaboration, 2011)

Intra-Group Collaboration

Students have been shown to perform better in a cooperative environment. This is due to the positive interdependence, individual accountability and increased motivation[14]. It is for reasons like this, that the desire for team work in academic environments has increased as this type of research continues. If an academic environment aims to encourage good social interactions, the groups will engage in more frequent sharing of best practical work examples[15]. Providing groups with the space and environments that encourage this will enhance knowledge exchanges and transactions.

In order to create these environments, students must get to know one another socially, before the project work begins, to enhance their team dynamics (which has been shown to be beneficial to the end product as well). Positive social interaction in groups is positively related to group trust and a supportive environment for knowledge sharing[16]. In terms of task interdependence, organizations can uses task designs that require high mutual dependence to increase interactive connections. However, it is important to note that an increase in intra-group cooperation is positively related to inter-group conflict in most settings[1718].

[14] (Mastin & Yoon, 2013)

[15] (Jiang, Flores, Leelawong, & Manz, 2014)

[16] (Lee & Wu , 2015)

[17](Böhm & Rockenbach, 2016)

[18] (Mantilla & Juan, 2015)

Background

Worcester Polytechnic Institute

Founded in 1865, Worcester Polytechnic Institute has always encouraged students to utilize what they have learned in the classroom and to complete real world projects and experiences. As the second oldest polytechnic institute in the country, WPI sought to bring together the concepts of theory and practice, which was best exemplified in the philosophies of its founders: John Boynton and Ichabod Washburn. John Boynton had little formal education and wanted to create an institution that would allow everyday mechanics and manufacturers the ability receive a higher education. Ichabod Washburn wanted to create an institution that would teach its students through practical apprenticeship-type work experiences. Together, the two founders set the foundation for WPI, and on May 10, 1865 the "Free School for Industrial Science" in Worcester was established[19].

Theory and practice were upheld throughout the first hundred years at WPI, with students attending traditional classes in Boynton Hall and then participating in hands-on projects in Washburn hall. During the late 1960s, WPI began to develop the WPI Plan, which would further the University's commitment to hands-on learning experiences. This plan would address the changing times and would be made up of four components: a four term academic calendar, a non-punitive grading policy, a flexible curriculum, and three mandatory academic projects[20].

[19] (Worcester Polytechnic Institute, 1999)

[20] (Worcester Polytechnic Institute, 2011)

Foisie Innovation Studio

To support WPI's project-based learning, the university has begun construction of the Foisie Innovation Studio, which is slated to be completed by the Fall of 2018. This studio will serve as a hub for student projects and will be composed of various robotics labs, maker spaces, and high-tech classrooms. This facility will give students the necessary resources to continue to work on both academic and individual projects. The studio will feature the Global Impact Lab, which will allow students to communicate their project work and research to global communities. The Innovation and Entrepreneurship Center will serve as a resource for students to pursue their own business venture outside of their normal academic project work.

In the fall of 2015, architects from Gensler were hired by Worcester Polytechnic Institute to design and imagine the potential of the Foisie Innovation Studio (FIS). Although this building brings numerous opportunities to the community, it must be properly utilized in order for the proposed outcomes to be achieved. During the 2015-16' academic year, an Interactive Qualifying Project (IQP) group explored the WPI students' needs for the Studio. Numerous recommendations were made by the project team from programming opportunities to internal layout recommendations.

The aforementioned IQP group stated that it is "important to ensure the students' voices [are] heard because the Foisie Innovation Studio… [is a] building by the students, for the students"[21] . Throughout months of research and visits to a plethora of colleges and community spaces, it became very apparent to the team that the community within the FIS may be difficult to create but is ultimately critical to its success.

[21] (Detora, et al., 2016)

Methodology

Experimentation

Introduction

The preliminary experiment in this project, *The 3 Chairs Challenge,* tested if inter-group knowledge sharing among the teams will increase or decrease based on the space that they are given to work in as well as if another team is in the same space. The experiment was based off of a Stanford Design School design challenge known as the *5 Chairs Exercise*[22] and IDEO's Human-Centered Design Process[23]. The *5 Chairs Exercise* was chosen as a foundation to this experiment because it has been utilized in academic settings and has been successful in helping groups of students understand design models, prototype design in different mediums, communicate in cross-functional teams, and learn about iteration. The aforementioned lessons taught through this design challenge are representative of characteristics that will be prominent in the Foisie Innovation Studio thus enabling a strong representation of how students may act during a project.

It is also important to note that since this experiment was conducted in order to best understand how a physical space impacts the work of the teams, two types of team spaces were utilized. One space had no physical barriers between the two teams and had white boards in the surrounding space for their use (hereby known as space x). The other variable space had two library tech suites, thus isolating each time from one another and from anyone else (hereby known as space y).

Required Materials

The following materials are necessary for the completion of the 3 Chairs Challenge:

- Tape
- String
- Pipe Cleaners

[22] (Young, 2014)

[23] (Lanoue, 2015)

- Popsicle sticks
- Construction paper
- Tin foil
- Recycled cardboard
- Straws
- Scissors
- Character Profile Cards

Figure II: Materials for Experiment

Metrics

In order for a team to be deemed ‘successful’, they must receive a score of at least 15 from the possible point values given below:

Given Points (17 points possible)

- Meet all three of the original design needs of the user (2 points for each design need up to 6 points)
- Complete at least five preliminary designs (1 point for each design up to 5 points)
- Prototype at least three chairs (1 point for each one up to 3 points)
- Implementation of the ‘added need’ in the prototypes (1 point up to 3 points)

Bonus Points (4 points possible)

- Fully implement an additional user specific function to the design (1 point for each function up to 2 additional points)

- Use all given materials in the prototype process (2 points total)

Procedure

I. Setup

a. Students will break into their two teams of four to which they are assigned by a random computer generator

b. The student teams will be placed either space x or space y (two teams in each scenario)

i. The first team in space x will be known as Team A

ii. The second team in space x will be known as Team B

iii. The first team in space y will be known as Team C

iv. The second team in space y will be known as Team D

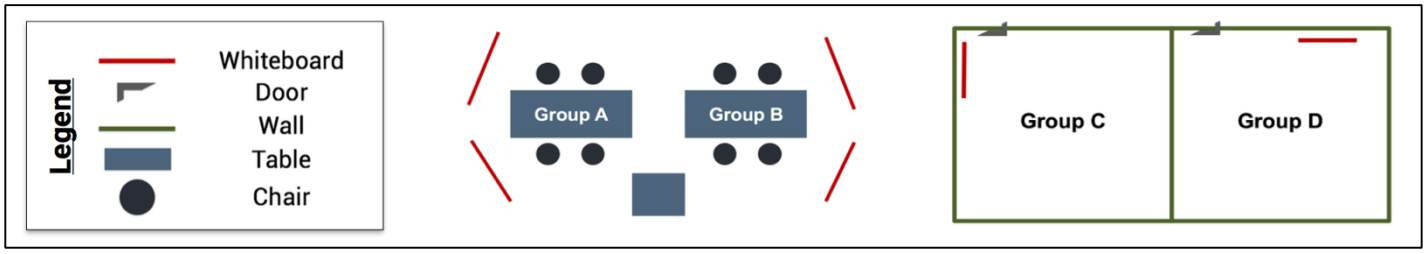


Figure III: Experiment Space Layouts

II. Customer Understanding

a. Each group will be handed one Character Profile Card (to be hereby known as the group's customer)[24]

i. Team A and Team C will both be given information about Customer 1

ii. Team B and Team D will both be given information about Customer 2

b. Students will be given five minutes to discuss the customers within their groups in order to gain an understanding of their needs

III. Design

a. The teams will have ten minutes to come up with five designs for the chairs based on the needs of their customer

i. Teams may sketch them out on paper or white boards

IV. Change Order

[24] The character profile cards can be found in Appendix I

a. The teams will be handed a Change Order Card which details an added need from their customer[25]
b. Teams will be given two additional minutes to implement this into their designs

V. Prototype
   a. The teams will have ten minutes to use a variety of provided materials in order to create at least three physical versions of their sketched designs
      i. Students will be told they can use whichever of the provided materials they desire

VI. Evaluation
   a. The teams will be given a chance to show the moderator how each of the needs are met in their designs and prototypes
   b. The experiment moderator will use the scoring metrics outlined previously in order to determine if a team was 'successful' or not

[25] The character change orders can be found in Appendix II

Data Collection Methods

Observation Methods

In the *Practice of Adaptive Leadership*, Heifetz, Grashow, and Linsky describe observations as one of the three key activities in adaptive leadership. Observations provide an opportunity to get on the "balcony" without making interpretations, to allow for better understanding of an adaptive challenge at hand. Observations will also aide in understanding the audience, which Shell and Moussa[26] describe as a critical aspect of leading change, as it will not only help the observer better understand the stakeholders' perspective, but also how to communicate with them through a channel they are attuned to[27].

By observing the groups during the challenges, a better understanding of the students perspectives, values, and student communication channels can be obtained. Passively observing first in the process also allows for the opportunity to prepare specific questions to better understand the particular group and their perspectives. This practice of better understanding the audience is known as mindful leadership and is very beneficial for observers to understand and utilize. In *Finding the Space to Lead,* Marturano encourages observers to stay in the moment and listen attentively. Mindful communication methodology also encourages the observer to listen deeply and be open to what is happening in the moment, instead of making interpretations immediately or drifting away from the present.[28] Removing distractions, such as cell phones, also allows people to be mentally present in the moment.

The Eberly Center for Teaching and Education at Carnegie Mellon University offers a resource for educators called, *How Can I Monitor Groups.*[29] It provides helpful, practical tips for observing group interactions. The guide recommends that a moderator, circulate between groups during activities to observe group interactions. This observation should include not only observing the words spoken, but also body language and distractions (e.g. people using cell phones). It is also recommended to listen for feedback within work groups, such as whether or not constructive feedback is being given within the group, if all members of the group

[26] (Shell & Moussa, 2007)

[27] (Grashow, Linsky, & Heifetz, 2009)

[28] (Marturano, 2014)

[29] (Eberly Center - CMU, 2015)

participate, and note the quality of the participation (i.e. are all members equally contributing and/or are some comments of higher quality?).

Observing Communication in Teams was developed by Dr. Lori Breslow at MIT's Sloan School of Management as a guide to help observe teamwork and group dynamics. The guide was originally developed for the course "Management Communication for Undergrads", and provides a list of questions to help the observer pinpoint different behaviors of the group and individuals of the group. Some of the questions presented are as follows[30]:

- Who are the most frequent participators?
- Who are the least frequent participators?
- How is turn taking negotiated?
- Who talks to whom? Who responds to whom?
- How are interruptions handled?
- Is simultaneous speech (i.e., two or more people talking at once) tolerated?
- How are topics shifted?
- Is silence O.K.?
- Finally, observe how the team makes decisions. By consensus? Voting? Does everyone participate in decision making? If not, is that a source of dissatisfaction for some team members?

A similar resource to MIT's *Observing Communication in Teams* is used at Union University to assist faculty for observing group work. The resource is known as the *Group Observation Sheet*[31] and was originally created by J. Eitington for use in his book, *The Winning Trainer*[32]. Like the MIT guide, the *Group Observation Sheet* poses several questions to help observe group work during an activity. The sheet has three sections, Getting Started, Group Behavior and Decision Making. In the Getting Started section, it is recommended that the observer look to see if the task at hand was understood, and if not, if the group worked to clarify it. Next, the observer notes what steps the group took to solve the problem at hand. The section on Group Behavior recommends looking for energy level, a group leader, and if it appeared there

[30] (Massachusetts Institute of Technology, 2016)

[31] (Union University)

[32] (Eitington, 2011)

was a level of trust (i.e. are people openly sharing or some holding back). Finally, in similarity to *Observing Communication in Teams*, the final section covers how decisions were made whether it be by voting, bulldozing, or some other method.

Focus Group Methods

At the completion of the assigned task, focus groups will take place in order to gather direct feedback from the participants. Focus groups can be defined as a discussion in which the primary goal is to gain information about a topic and is led by a moderator. Best applications of focus groups are for understanding opinions of a given project / program and areas for improvement. In order to ensure open dialog during focus groups, it is important to make the environment of sharing comfortable[33].

The main goal of these focus group is to understand if students feel satisfied working in their teams and how that correlates to their success of completing the challenge. The focus groups allow meaningful conversation with students and provide the opportunity to tailor the questions or tone of discussion to understanding how the value and perceive the idea of innovation

Another important topic to note when leading focus groups are communication channels. In order to get the most from these student focus groups, it was important to speak with the students in person, as opposed to sending out an online survey. By speaking with the students in person an understanding of their communication channels can be developed. On top of this, questions and conversations should be tailored to best suit their preferred channels of communication. The first step in understanding the student's communication channels is to listen to the audience itself[34]. By giving students the forum to speak freely and comfortably, they are able to set an honest and transparent tone to the focus groups. In the case of these focus groups, it will be best for students to moderate them as they already 'speak their language' which, in turn, provides common ground during discussions.

Using Focus Groups by Ball State University outlines major advantages and disadvantages of using focus groups. Some advantages of focus groups are they are a low cost way to get feedback, are quick to implement/get results, are flexible, and offer an avenue for people to discuss in a group (an interview may be too high-pressure for some individuals). Focus groups also allow for in-person communication of ideas. On the other hand, disadvantages of focus groups include the potential difficulty of creating a focus group, the size of the focus group

[33] (Ball State University, n.d.)

[34] (Marturano, 2014)

(a small group may not indicate the general population's views), and the fact that some people are less likely to share in a group (especially if they feel uncomfortable). Furthermore, the quality of the results from a focus group are relative to how stronger the moderator is, and their ability to summarize results.[35]

Preparation

The preparation for a focus group is critical to its outcome. The desired questions should be prepared beforehand to ensure that they cover both the specifics of the topic at hand and are open-ended enough to encourage conversation. While a focus group's main method of communication is verbal, Ball State University recommends preparing activities that invite different types of learners to participate – for example, taking individual time to brainstorm.[36]

The size of the focus group should be carefully planned up front, as well as the location in which it will be held, and whether or not incentives will be provided to encourage participation. Ball State University suggests that a focus group should ideally contain between eight and fifteen people. Incentives, such as providing refreshments, should be considered as a means to attract participants to the focus group. Next, a location should be pre-selected to ensure the space is comfortable and arranged to allow for discussion (e.g. a circle of chairs)[37]. Preparing a method to document the focus group should also be decided, be it note-taking by hand or recorded. However, limitations to recorded focus groups, beyond the legal waivers, is that participants may not feel as comfortable speaking up if they are recorded.[38]

During the Focus Group

It is recommended that a focus group begin with a quick introduction to explain the topic and provide guidelines (e.g. confidentiality requirements - as required). During the focus group, active listening by the moderator is essential. Beginning with an open-ended question will be helpful, as it will encourage all participants to become involved. It is also important that the moderator be able to help the participants dig a little deeper, and steer the conversation as

[35] (Ball State University, n.d.)

[36] (Ball State University, n.d.)

[37] (Doorley & Witthoft, 2012)

[38] (Ball State University, n.d.)

required.[39] This concept of steering the conversation is brought up in *The Art of Woo* as the ability to listen to your audience and tune into their channel. It will be important for the moderator to be mindful, as Shell and Moussa suggest, and put their own emotions and judgments aside to monitor and react to the focus group, adjusting pitch and/or questions as required.[40]

In order to ensure that all needed data is collected during the focus groups, an 'introduction script' will be read by the moderators in order to ensure consistency of providing an overview of the topic (a), ground rules for the discussion (b), and the first question (c)[41]. In a typical focus group setting, there is normally a welcome and participant introduction. However, in this case of this project, the focus group will take place directly after the completion of the design challenge meaning that the participants are already acquainted to the moderator and tasks at hand. The following script will be used by the moderator of the focus group:

(a) The goal of this MQP is to better understand how WPI students work in teams and how the environments in which they work alter them.

(b) Please note that there are no wrong answers but rather differing points of view. Please feel free to share your point of view even if it differs from what others have said. Keep in mind that we're just as interested in negative comments as positive comments, and at times the negative comments are the most helpful. With this being said however, please do not speak over another person. With your permission, I would like to audio record this discussion because I don't want to miss any of your comments. You may be assured of complete confidentiality, we won't use any names in our reports. The findings of this project will help the WPI administration understand what students need in the new Foisie Innovation Studio.

(c) To begin, I would like to know if you found it difficult to come up with so many iterations of the chair and if it was, why do you believe that it was?

[39] (Ball State University, n.d.)

[40] (Shell & Moussa, 2007)

[41] (Krueger, 2002)

After the first question is asked, additional questions will be used by the moderator of the group in order to continue conversation and steer discussions. These questions will be a collection from MIT's *Observing Communication in Teams*, The University of Minnesota's *Designing and Conducting Focus Group Interviews*, and others developed specifically for this project. It is important to note however, that due to the open flow of conversation that focus groups attempt to obtain other questions may be introduced at the moderator's discretion. Some examples of guiding questions are as follows:

- If you could do this project again, what would you change?
- Was receiving the change order after the design phase hindering to your team?
- What were the most productive contributions? What made them so?
- What was the most difficult part of the prototyping process?
    - ie, time, materials, transferring ideas, etc…
- How do you feel that your team managed the time you were given?
- How did the space in which you were in influence how your team worked?
- If you could complete this challenge in any type of environment, what would it be?

When the allotted amount of time is over, the moderator will ask the group: "Have we missed anything?" Following the answers (or follow ups) to this question, the moderator will follow the final script:

> Thank you for your time and feedback today. If you have any additional questions, comments or concerns regarding this project please contact protofoisie@wpi.edu. Have a great rest of your day.

Results

Scenario X

Overview

Scenario X took place starting at 6:00pm on Thursday, March 23, 2017 and went until 7:10pm. Both team A and team B worked simultaneously in the open ProtoFoisie space on the Ground Floor of the WPI Gordon Library.

Figure IV: Scenario X Setup in ProtoFoisie Space

The two teams consisted of a total of eight WPI undergraduate students (four per team). The students were randomly split into teams by the use of a random number generator.

Figure V: Scenario X with Groups

The participants had the following demographics:

Participant	Team	Class Year	Major	Gender
1	B	2019	Mechanical Engineering	Female
2	B	2018	Mechanical Engineering	Female
3	A	2018	Environmental Engineering	Female
4	A	2017	Biology/Biotechnology	Female
5	A	2019	Biomedical Engineering and Mechanical Engineering	Male
6	B	2017	Biology/Biotechnology and Biochemistry	Male
7	B	2019	Chemical Engineering	Female
8	A	2019	Chemical Engineering	Female

Table 1: Scenario X Participant Demographics

Observations

Ideation

Team A

Team A acted more introverted in their team dynamics. Although they discussed details as a team, they were very quiet and all shared their individual ideas. Much of their discussion involved materials that could potentially be used in the chairs (metal, steel, plastic, etc.) rather than the functionality of the chair. Their conversation ended about halfway through the allotted time.

Figure VI: Ideation, Team A

Team B

Team B discussed their customers' needs in a very loud and animated fashion. Although they covered the basic design requirements of their customer, they also started coming up with 'out of the box' ideas right away. The team used a lot of "yes and..." terminology to build on each other's ideas. Their discussion was continuous throughout the entirety of the allotted time.

Figure VII: Ideation, Team B

Design

Team A

Team A sat through the entirety of the design process. Although given white boards, they opted to use the provided paper and markers instead. At first, they worked on one design at a time with one person sketching. As time began to run out, the team realized that they would need to work on multiple designs at once and other team members started sketching as well. Each team member drew their own design, with the person that was initially sketching completing two. The designs were very detailed and included description labels.

Figure VIII: Design, Team A

Team B

Team B worked together on all of the designs simultaneously to make sure that all of the design factors were included. The team immediately stood up and did four out of their five design sketches on the whiteboards. One person did it on paper because they did not feel that there was enough white board space for them as well. They continuously gave each other feedback and continued to be loud and animated in their actions.

Figure IX: Design, Team B

Change Request

Team A

Team A added a folding table to all of their designs. In order to meet the specific customers' needs (in this case, an astronaut) they added the functionality of having a magnet in the table so that objects would stay attached to the surface. The team discussed how they believe that functionality is more important in the design than the look of it. They also commented about how the other team's design challenge looks "easier" because they are just making an "office chair" after looking over at Team B's designs on the white boards.

Figure X: Change Order, Team A

Team B

Team B added folding tables to their design as well. Since the chair is for around the office, they opted for the table to fold multiple directions in order to accommodate food and/or a laptop. The team realized that they were much louder and more animated in their actions and commented among themselves that "[Team A is] working normally and we look crazy over here."

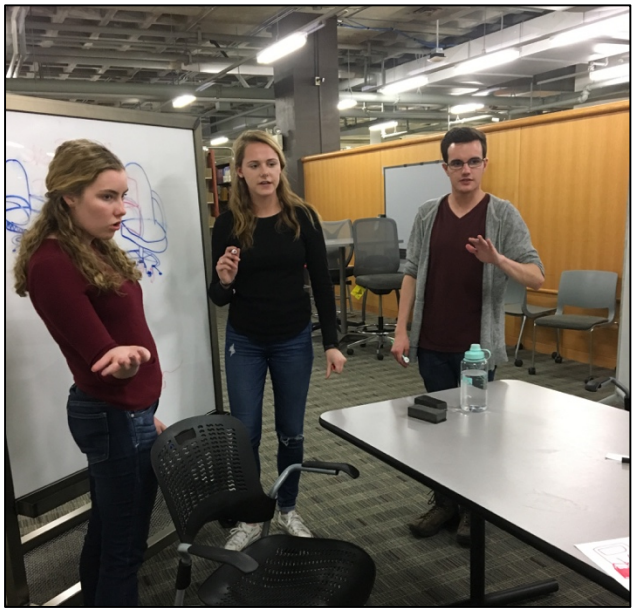


Figure XI: Change Order, Team B

Prototype

Team A

Team A took time to get their supplies. Although they immediately went up to the table, they didn't compete with Team B to grab things first. They were more conservative in the amount of supplies that they took back to the table with them and were meticulous when picking out the specific materials (i.e. picked out all of the black and white pipe cleaners without taking any other colors). All team members worked on different parts of the chairs. For example, one person constructed the bases, one did the chair backs, one did the tray tables, etc... Because of this, many of their prototypes ended up looking very similar in the end.

Ultimately, they got all of their prototypes completed in time but used the entirety of the time. Their work table was pretty clean and organized overall, (in comparison to Team B) allowing them to keep a better view of their progress as a whole. They ended up sitting the entirety of the challenge with the exception of getting up to get the prototype supplies from the communal table.

Figure XII: Prototype, Team A

Team B

Team B rushed up to the supplies table to grab their supplies first. They weren't specific in what they grabbed but focused mainly on grabbing cardboard and tape. The team was unorganized in communicating what they were each working on but mostly seemed to focus on building one design each. Their space quickly became cluttered and although they had stood for

most of the rest of the process, they mixed standing and sitting for the prototyping portion. They realized too late that they only completed two out of three prototypes in the allotted amount of time.

Figure XIII: Prototype, Team B

Quantitative Result

Metric	Group A	Group B
Meet all three of the original design needs of user (2 points for each design need up to 6 points)	6	6
Complete at least five preliminary designs (1 point for each design up to 5 points)	5	5
Prototype at least three chairs (1 point for each one up to 3 points)	3	2
Implementation of the 'added need' in the prototypes (1 point up to 3 points)	3	2
Bonus: Fully add and implement an additional user specific function to the design (1 point for each function up to 2 additional points)	1	-
Bonus: Use all given materials in the prototype process (2 points total)	-	-
	18	**15**

Table 2: Scenario X Quantitative Metrics

Team A completed the activity with a score of 18 deeming them successful in the challenge. Team B was also deemed successful although their score was the lowest throughout the experiments (15 points). Team B lost a point for only prototyping two of the three chairs and lost an additional point since the 'added need' couldn't be put on a third prototype. Team A received an additional point for adding one extra function (attached headphones) to their designs. Ultimately, there was not a major quantitative difference between the two teams regardless of their style of work (as described above).

Focus Group Results[42]

During the focus groups, the teams talked about the design process, what they did well, and what they would do differently if the activity was completed again. Both teams agreed that the most difficult part of the process was the time constraint in the prototyping phase. Both teams felt that if they had more time, they could have better met the customer's needs. As Team B reflected what they would change, they noted that they liked some of the ideas (specifically the base of the chairs) that Team A had implemented and would try using something like that if the challenge was completed again. Team B mentioned that they liked using the whiteboards so everyone could visualize what was going on while also having the ability to erase and add-on. On the flip side, Team B said that they liked having a paper trail that they could continue working on later which whiteboards didn't allow for. The teams agreed that implementing technology such as a smartboard would be a great option for students to use. Team B also noted that they wish Team A had used the whiteboards when designing their chairs so that they could have seen what they were doing and potentially gained inspiration from it. Team A didn't mention anything about getting ideas from Team B. They did, however, mention that they decided to use paper because they didn't feel comfortable drawing on the whiteboards.

In regards to the space, Team B noted that they enjoyed the open atmosphere. Although they got distracted at times, it was typically while building on each other's ideas for the design. They noted that they enjoyed the freedom to stand, sit, and continuously move around (sitting the entirety of lectures is one of the major things that make them so difficult for the students). If they were to change something about the setup, they said that they would prefer tall tables. Team A on the other hand said that the reason they liked the open space was because they didn't feel claustrophobic. They noted that it gave them 'space to think'.

When asked what the ideal space to complete an activity such as this was, the students said that an apartment or fraternity house would be too distracting but they also wouldn't choose a classroom because they are used to just sitting down in them. Ideally, they would prefer to be up and moving in an open space with whiteboards that is able to adapt to their needs. Another important factor to the students is table space. A student noted that one of the biggest factors in where they complete their work is what has the largest tables for them to spread out on and

[42] A full transcription of the focus group session can be found in Appendix III

classroom desks are far too small for that. Some of the quieter students said that they prefer having a quiet space even for group work and that although some background noise is alright, places like the Campus Center can be overbearing.

Scenario Y

Overview

Scenario Y took place starting at 7:30pm on Thursday, March 23, 2017 and went until 8:50pm. Team C completed the experiment in the WPI Gordon Library Anderson Labs A. Team C completed the experiment in the WPI Gordon Library Anderson Labs B. The two teams consisted of a total of eight WPI undergraduate students (four per team). The students were sorted into teams by the use of a random number generator. The participants had the following demographics:

Participant	Team	Class Year	Major	Gender
1	D	2017	Mechanical Engineering	Female
2	C	2018	Biomedical Engineering	Female
3	D	2018	Mathematical Sciences	Male
4	C	2017	Biomedical Engineering	Female
5	D	2020	Robotics Engineering	Female
6	C	2017	Environmental Engineering	Female
7	D	2017	Computer Science and Physics	Male
8	C	2017	Actuarial Mathematics	Male

Table 3: Scenario Y Participant Demographics

Observations

Ideation

Team C

Team C started their ideation process in close physical proximity to one another around the end of a computer table in Anderson lab A. They mostly talked about non-traditional ideas and add-ons for chairs after they discussed the basic customer guidelines. Although the ideas that they came up with were mostly 'out of the box' they also came up with many off topic ideas and discussions that did not relate to the topic at hand.

Figure XIV: Ideation, Team C

Team D

Team D sat in a semi-circle in rolling chairs in order to face each other. One person read the description out loud and they started to discuss guidelines for what their customer may want. They discussed materials, features, and 'out of the box' ideas that went beyond a standard office chair (ie bar stools and exercise balls). When there was about 30 seconds left out of the given two minutes, the team started walking to the whiteboard in the room to begin sketching their ideas before they were told that the design phase was the next step.

Figure XV: Ideation, Team D

Design

Team C

The team seemed to enjoy each other's company and sketched out labeled designs for different chairs on paper. Although their customer requirements were technically met through their designs, many of them were impractical for true use. For example, their customer was an astronaut in outer space and one of the chairs that they came up with was a wooden Adirondack chair. Three of the team members (of the same class year) were laughing together while the fourth was a little more isolated and didn't get distracted from the project at hand like the three others did.

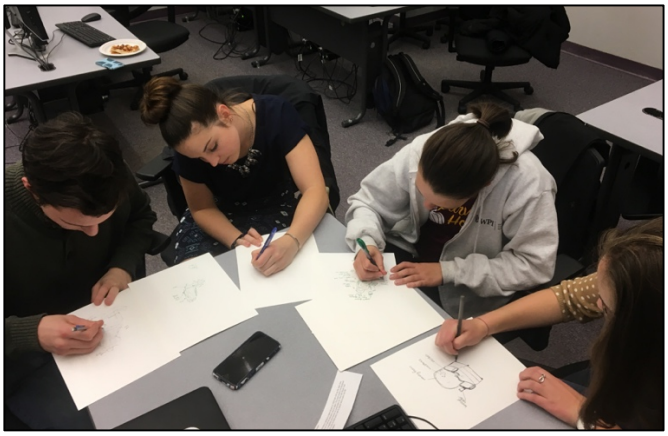


Figure XVI: Design, Team C

Team D

Team D used most of the white board that was in Anderson Labs B to sketch out their designs, label the different components, and write a list of customer add-ons that they planned on

presenting to the customer after they had narrowed the designs down further. The team drew out and edited the designs together with two members writing on the board in different colored markers and two team members sitting while giving feedback. The team came up with the most differentiated designs out of the entirety of the experiment as they included a stool and exercise ball design that included all needed factors.

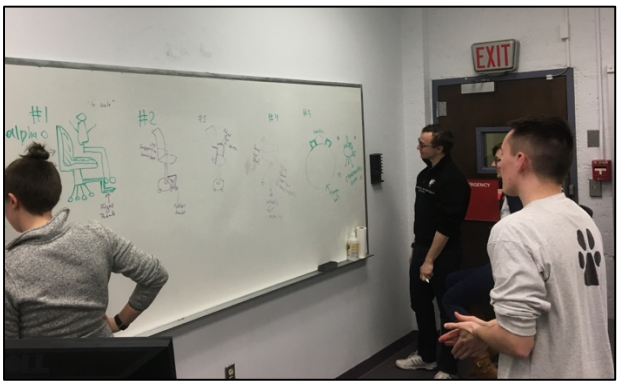


Figure XVII: Design, Team D

Change Request

Team C

Team C added folding trays to all of their designs. They had already added cup holders, head phones, and other accessories to their chair designs for user comfort so they simply added the trays where they could. They only used about a quarter of their allotted time for the change requests and spent the rest of their time adding more to their designs and talking about subjects not related to the challenge at hand.

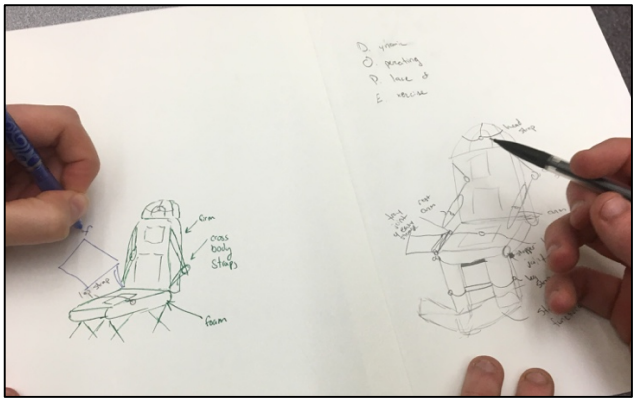


Figure XVIII: Change Request, Team C

Team D

Team D responded to the change request by analyzing each of their designs to see how a table addition would best fit in. They had the most difficult time adding a table to the exercise ball design seeing as it was round and was meant to be rolled around. However, they managed to figure out a removable add-on.

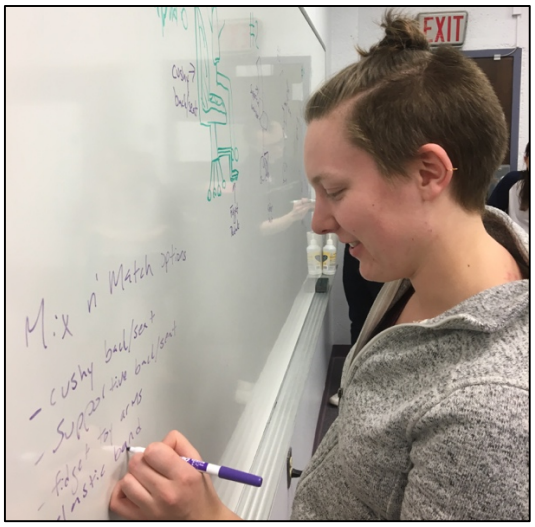


Figure XIX: Change Request, Team D

Prototype

Team C

The team took all of the given materials and sat on the floor in an oval shape. Two people worked to build their own initial designs while the other two people worked to build the remaining one. Although the designs did have some variation, the prototypes were all built in very similar fashions, mainly out of cardboard, string, and tape. The group worked on the prototypes for the entire given time and rushed at the end to make the final attachments before the time ran out. Throughout the time they talked about general day to day life. This team was the only one that decided to use all given materials in their prototypes.

Figure XX: Prototype, Team C

Team D

The team worked in pairs to build the prototypes. The pairs sat on the floor across from one another to complete the construction. One pair constructed the stool and the exercise ball while the other built the more 'standard' chair. Unfortunately, the group that was working on the chair was too meticulous in the details and ran out of time to attach the change request (table add-on) in the last moments. The designs and prototypes were all very different from one another and showcased the group's 'out of the box' thinking style. The group used the entirety of their allotted time and the conversation stayed focused on the task at hand.

Figure XXI: Prototype, Team D

Quantitative Results

Metric	Group C	Group D
Meet all three of the original design needs of user (2 points for each design need up to 6 points)	6	6
Complete at least five preliminary designs (1 point for each design up to 5 points)	5	5
Prototype at least three chairs (1 point for each one up to 3 points)	3	3
Implementation of the 'added need' in the prototypes (1 point up to 3 points)	3	2
Bonus: Fully add and implement an additional user specific function to the design (1 point for each function up to 2 additional points)	2	-
Bonus: Use all given materials in the prototype process (2 points total)	2	-
	21	**16**

Table 4: Scenario Y Quantitative Metrics

Team C completed the activity with a score of 21 deeming them successful in the challenge. Team D was also deemed successful although their score was lower than Team C (16 points). Team D lost a point since they ran out of time to attach the 'added need' to one of the prototypes. Team D received two additional points for adding-on two extra functions to their designs and two more for using all provided materials. Ultimately, there was not a major quantitative difference between the two teams regardless of their style of work (as described previously).

Focus Group Results

During the focus groups, all members discussed what they felt they did best, what they would do differently next time, and how they would improve workspace on campus. Team C noted that they started with several different design concepts since each person in their team came up with one. Team D on the other hand started with one design and branched off of it. They would try to come up with unique ideas and differentiated the designs based on those ideas. Neither group felt thrown off by the change order as they expected something to change based off of other project work they had completed.

When discussing the most difficult part of the process, Team D said that time was their biggest constraint. Team C said this this was almost a problem for them as their design process started with them all focusing on their own designs, but when they realized they were running out of time, they were able to completed one more. Team D also said that they had difficulty transferring some of their ideas from paper to prototype. For example, wheels on their design seemed logical but they found them difficult to prototype with the given materials.

Building off of the what they found difficult, the teams said that if they were to do this challenge again they would have moved faster through the prototyping phase. Both teams talked about how an assembly line style would have been beneficial, rather than individuals trying to build the prototype by themselves. On top of timing flaws, the groups both discussed that they would have preferred having more whiteboard space in their work areas. Team C didn't use the whiteboard because the 'paper was right in front' of them and they didn't even notice the small whiteboard in the room (attached to the wall behind the door). Regardless, they said they would have preferred to have used a whiteboard in the design phase. Team D went straight to the white board in the room because it was large and the location of it was convenient (front of the room on the wall). They hoped that there was an additional whiteboard in the room and were disappointed when there was not.

The next point discussed was about working in the same room versus different rooms. The teams both felt that they would have worked differently if they had been in a mutual space. The students felt that they would have worked faster and had less of an issue with the time constraints. It was also noted that they could have learned from the other teams if they had completed the challenge in the same place. The main concern that the students had about working in the same space is that they wouldn't want to disturb other people with their noise.

The students noted that while some of them prefer a quiet space for work, many enjoy a lively atmosphere because headphones let them change the noise if needed.

When asked about their ideal work environment, the students commented that tech suites were their main choice. The students started off by saying they liked the spaces because they were closed off from others and the time constraint of the reservation made them need to work more quickly. However, after digging deeper (aka saying that there were hypothetically no more tech suites on campus), it was revealed that what students really wanted was a space that could adapt to them and their needs. The main fear that students have is that they won't be able to find space on campus to do group work. The library is often full and being able to reserve tech suite gives students piece of mind that they will have a space to work. A way in which this could be solved is for the culture to promote a space that is constantly moving. Therefore, this would mean that there would need to be regulations about people 'camping out' or leaving objects to reserve their space when they leave. Also, the fact that there will be more project group space on campus was relieving to students as they noted that this was a major stress factor related to group work.

One member of Team D noted that her favorite space on campus to complete work was the robotics labs. There are constantly people working on similar projects and there is desk space next to the computers to complete work. Any necessary tools are also in that space so students don't have to leave. Another key aspect to the labs is that groups help each other out when they run into problems. Since their project work is similar they can often answer each other's questions. Ultimately, the space provides a good medium for group work and induvial work.

As the students relieved their stubbornness towards wanting more tech suites, they began to discuss how having vertical space to write is very important to them. They felt more awake and productive standing up and moving around. By having multiple colors or markers, students felt that they could be more creative, organized, and communicate better visually within teams. Students wanted to be able to draw on white boards and windows alike. The surfaces need to wipe clean well rather than being poorly adhered to the walls. When asked about resetting the space, the students noted that they didn't mind if people left a little bit of their work behind but it didn't necessarily relate to the work that they were about to complete so it more often than not would just annoy them if students didn't erase the area when they were done.

Lastly, students talked about adaptability versus rigidity, especially in the sense of tables in a given space. Although students wanted tables that could allow for different sized groups, they noted that their preferred work space depended more on whether there was an outlet nearby rather than the size or shape of the table.

Conclusion

Ultimately, all teams were quantitatively successful in the challenge. This implies however, there is no distinction that the space in which the student teams worked impacted the outcome.

Metric	Group A	Group B	Group C	Group D
Meet all three of the original design needs of user (2 points for each design need up to 6 points)	6	6	6	6
Complete at least five preliminary designs (1 point for each design up to 5 points)	5	5	5	5
Prototype at least three chairs (1 point for each one up to 3 points)	3	2	3	3
Implementation of the 'added need' in the prototypes (1 point up to 3 points)	3	2	3	2
Bonus: Fully add and implement an additional user specific function to the design (1 point for each function up to 2 additional points)	1	-	2	-
Bonus: Use all given materials in the prototype process (2 points total)	-	-	2	-
	18	**15**	**21**	**16**

Table 5: All Group Quantitative Metrics

There are a variety of reasons as to why this may have occurred. This was only one iteration of the experiment. In order to reach a significant conclusion, many more iterations must be performed. By doing the experiment multiple times, bias factors such as team dynamics, age, gender, time of day, and others will be nullified. Not only could this specific experiment be completed more times, but it could be done with other variables that may encourage or even require more inter-group collaboration.

Even though no quantitative conclusions can be drawn at this point in time, some important takeaways were found through the focus groups:

- Students benefitted from visualization

Whiteboards were generally preferred to paper due to erasability and viewability; however, students wanted a way to save their work. Therefore, they suggested that user-friendly smartboards would be a good option for the space.

- The space needs to adapt to the students, not students adapting to the space.

Adaptability of the space is key to allow for different sized teams, different types of work, and different work styles/preferences.

- When working in the same space, students looked around to see what the other team was doing.

The student's took inspiration and ideas from what the other team was doing. It also helped them manage time better as compared to the isolated groups. However, if students are in the same space but working on completely different things, students didn't feel the need to see what others were working on.

- Students in the open space didn't feel competitive against one another because they knew what the other team was working on.

Some students in the open space debated whether or not to ask the other team questions. They didn't however due to it not being explicitly stated that it was 'allowed'. One team in the closed off space scenario felt competitive and the other team didn't only because they noticed that they had 'customer 2' which lead them to assume that they had different clients.

- Students like 'tech suites' (reservable spaces) because they worry about finding collaborative space to complete work in when they need it.

Having a culture that promotes constant flow rather than 'camping out' and claiming spaces is essential. Also, having adaptable spaces will allow for furniture to be moved around so that a team of four can just have space for four rather than taking up set up space for more individuals.

Based on the feedback gathered, it is promising that with further iterations of this experiment, or ones that are similar in nature, it will be found that working in an open space will encourage inter-group collaboration. These findings can be further implemented into the spacial layout and culture of the Foisie Innovation Studio, thus allowing WPI's project work to be taken to the next level.

Bibliography

Apple Inc. (2011). *iPod + iTunes Timeline*. Retrieved September 30, 2016, from Apple Inc.: https://www.apple.com/pr/products/ipodhistory/

Böhm , R., & Rockenbach, B. (2016, February 6). The Inter-Group Comparison – Intra-Group Cooperation Hypothesis: Comparisons between Groups Increase Efficiency in Public Goods Provision. *PLoS ONE*.

Ball State University. (n.d.). *Using Focus Groups*. Retrieved September 28, 2016, from http://cms.bsu.edu/-/media/www/departmentalcontent/effectiveness/pdfs/wkbk/wbkm12012%20%20ch%209.pdf?la=en.

Breslow, D. L. (2000). Observing Communication in Teams. Cambridge, MA, USA.

Carlson, C. R., & Wilmot, W. W. (2006). *Innovation.* New York: Random House Inc.

Chang, J. W., Chow, R. M., & Woolley, A. W. (2016, December 5). Effects of inter-group status on the pursuit of intra-group status. *Organizational Behavior and Human Decision Processes, 139*, 1-17.

Christensen, C. (2013). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail.* Cambridge, MA: Harvard Business Review Press.

Detora, C., Errichetti, M., Melnikov, I., Mitchell, M., Mitrano, P., & Powers, D. (2016). *Student Input on the Design of the Foisie Innovation Studio.* Interactive Qualifying Project, Worcester Polytechnic Institute, Worcester.

Doorley, S., & Witthoft, S. (2012). *Make Space.* Hoboken, NJ, USA: John Wiley & Sons, Inc.

Eberly Center - CMU. (2015). *How Can I Monitor Groups?* Retrieved October 1, 2016, from Carnegie Mellon University: https://www.cmu.edu/teaching/designteach/teach/instructionalstrategies/groupprojects/monitor.html

Eitington, J. E. (2011). *The Winning Trainer* (Fourth ed.). Routledge.

Estrin, J. (2008, October 29). Three Types of Innovation.

Grashow, A., Heifetz, R., & Linsky, M. (2009). *The Practice of Adaptive Leadership: Tools and Tactics for Changing your Organization and the World.* Boston, MA: Harvard Business Press.

IDEO. (2003, November). IDEO Method Cards. William Stout.

Jacobs, J. (1970). *The Economy of Cities* (Vol. First). Vintage.

Jiang, X., Flores, H. R., Leelawong, R., & Manz, C. C. (2014, December 12). The effect of team empowerment on team performance. *International Journal of Conflict Management, 27*(1), 62-87.

Krueger, R. A. (2002, October). Designing and Conducting Focus Group Interviews.

Kuhn, T. S. (1962). *The Structure of Scientific Revolutions* (Vol. First). Cambridge, MA: University of Chicago Press.

Lanoue, S. (2015, July 9). *IDEO's 6 Step Human-Centered Design Process: How to Make Things People Want.* Retrieved from User Testing Blog: https://www.usertesting.com/blog/2015/07/09/how-ideo-uses-customer-insights-to-design-innovative-products-users-love/

Lee, Y.-C., & Wu , W.-L. (2015, March 4). How to make a knowledge-sharing group: a group social capital perspective. *Personnel Review, 45*(3), 523-538.

Lepore, J. (2014, June 23). The Disruption Machine: What the Gospel of Innovation Gets Wrong. *Annals of Enterprise*. New York.

Mantilla, C., & Juan, C. (2015, February 17). Between-group competition, intra-group cooperation and relative performance. *frontiers in Behavioral Neuroscience*.

Marturano, J. (2014). *Finding the Space to Lead.* New York, New York: Bloomsbury Press.

Massachusetts Institute of Technology. (2016). *IAP*. Retrieved October 10, 2016, from Massachusetts Institute of Technology: http://web.mit.edu/iap/about/index.html

Mastin, T., & Yoon, K. (2013, September 24). Benefits of Group Knowledge Sharing for Student Teams. *College Teaching*, 153-154.

Palmer, I., Dunford, R., & Akln, G. (n.d.). *Managing Organizational Change: A Multiple Perspectives Approach* (Second ed.). New York, New York: McGraw-Hill Education.

Paulin, D., & Suneson, K. (2012). Knowledge Transfer, Knowledge Sharing and Knowledge Barriers – Three Blurry Terms in KM. *The Electronic Journal of Knowledge Management, 10*(1), 81-91.

Privitera, D. (2015, October 2015). Founding Member of IDEO Cambridge. (C. Detora, P. Mitrano, I. Melnikov, M. Mitchell, D. Powers, & M. Errichetti, Interviewers)

Satell, G. (2011, January 30). *Building Creative Collaboration*. Retrieved September 23, 2016, from DigitalTonto: http://www.digitaltonto.com/2011/building-creative-collaboration/

Satell, G. (2011, April 3). *Structure, Agency and Open Innovation*. Retrieved September 24, 2016, from DigitalTonto: http://www.digitaltonto.com/2011/structure-agency-and-open-innovation/

Satell, G. (2012, May 16). *4 Types of Innovation*. Retrieved September 25, 2016, from DigitalTonto: http://www.digitaltonto.com/2012/4-types-of-innovation-and-how-to-approach-them/

Shell, R., & Moussa, M. (2007). *The Art of Woo: Using Strategic Persuasion to Sell your Ideas.* New York, New York: Penguin Books.

The WPI Journal. (1971, October). Intersession 1972. (H. R. Kay, Ed.) *The WPI Journal, 75*(1), pp. 1, 8-10.

Tufts University. (2016). *Experimental College*. Retrieved October 9, 2016, from Tufts University: http://www.excollege.tufts.edu

Union University. (n.d.). Group Observation Sheet.

University of Delaware. (2016). *Winter Session*. Retrieved October 9, 2016, from University of Delaware: http://www1.udel.edu/winter/

Worcester Polytechnic Institute. (1999, March 5). Glossary. *A Planning Program for Worcester Polytechnic Institute: The Future of Two Towers - Part Four: A Plan*. Worcester, MA, USA.

Worcester Polytechnic Institute. (2011, December 19). The Story of the WPI Plan. Worcester, MA, USA.

Worcester Polytechnic Institute. (2016, August 31). WPI Celebrates Successful Alden Trust Challenge by Breaking Ground for Foisie Innovation Studio and Messenger Residence Hall.

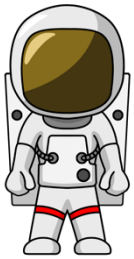
Young, D. (2014, April 28). *5 Chairs Exercise.* Retrieved from The K12 Lab Wiki - Stanford Design School: https://dschool-old.stanford.edu/groups/k12/wiki/17761/5_Chairs_Exercise.html

Appendices

I: Character Profiles

As mentioned in the experiment outline, each team will receive a character profile card. These cards will give a bit of background on the customer and outline what their three specific needs are. The two character profiles that will be used are as follows:

Customer 1: The Astronaut



Astronaut is going on a space mission in which she will use the same chair for lift off and for relaxation once in space. The chair needs to be functional for a weightless environment, be comfortable for when she Skype's her family back on Earth, and is safe for launch and re-entry into the atmosphere.

Customer 2: The Marathoner

Marathoner spends almost all of his free time being active. Therefore, when he is working at his desk job throughout the day, he gets fidgety and restless. On top of this, since he is always pushing himself to the next level he is often sore. His ideal chair would allow him to move his legs around, be soothing for when he is sore, and be able to move around to whatever part of the office he has a meeting in.

II: Customer Change Orders

During the experiment, the teams will be given an additional customer requirement between the design and prototype rounds. The change orders are as follows:

The Astronaut

The Astronaut wants to make her space time experience as enjoyable as her time at home on Earth so she would like to request a way for her to eat her TV Space Dinners while sitting in her chair. She doesn't want to have to hold her meal the entire time. Who can blame her?

The Marathoner

The Marathoner really likes to work through lunch time so he can get out of the office earlier in the day to go for a run. He would like to request that his chair also has the ability to allow him to eat his lunches while sitting in it regardless of if he has a table in front of him or not.

III: Focus Group Transcription - Scenario X

Moderator: Thank you for being such awesome participants and diving right in I really appreciate it. The first thing I want to ask both teams is did you find it difficult to design so many iterations of your chair and why?

Team A: I think for us, we got very excited very easily so our original design for step one was in our heads and we had a hard time branching off of that.

Moderator: So you came up with one initial design with a bunch of different things with that, do you guys have anything to add-on to that?

Team B: Originally we started with one pretty basic design and we added slightly different things to each. Change the material, change the stool, change the recline function and that was pretty much ours.

Moderator: So for both teams, what was it like receiving the project change order?

Team B: For us it wasn't that bad because our design dealt mostly with the legs and the change order was for the arms so it was pretty easy to do. We really didn't think about it too much. For us it was like oh! Make it a desk.

Moderator: And you added the same change to all your designs?

Team B: Yeah. Everything was the same for the change order.

Moderator: And what did you do with the change order group A?

Team A: We got a little worried at first when we thought of the physics of it. We thought of the food staying on the tray and how it would affect it. Then we thought about making it magnetic and it was actually an easy addition.

Moderator: So you had to think about the environment the person is in, which is kind of hard because we're used to gravity here. Alright, so what did you find was the most difficult part of the prototyping process, maybe having to use different materials, time constraints, transferring ideas from paper to prototypes, having enough materials, etc. We'll start with Team B over here.

Team B: I thought the most challenging part was the time constraint as well as getting the design from your head to physical being as well as the scale that it was on.

Moderator: Do you feel that if you had more time, you would've done a third or would you have focused on just the two?

Team B: We had a third in progress.

Moderator: Alright so it was the time constraint, and what about team A over here?

Team A: I think the hardest part was the time just because we found one thing that worked as you saw with the cardboard base and we tried to use that for all the designs. Maybe if we had more time we could have been more creative with different materials.
Moderator: Working as a group in the prototyping phase did you find that you had different ideas to prototype it. Like did someone else on your team come up with an idea where you said Oh I hadn't even thought of that? Can you give me an example of that?
Team A: I started making the trays out of pipe cleaners while the rest of us were working on the chairs, kind of a divide and conquer kind of thing. I thought to come up with the back with a wood source or a straw source and I thought we were pretty good at communicating that there.
Team B: Our group did something a bit differently. I mentioned an idea, like the car pedals, and we built off the idea, like what if it was a bike and we just kept building from there.
Moderator: Now given the whole situation and I were to ask you to repeat this all again, what would you do differently either as a team or an individual?
B: Definitely steal their idea for a base for the chair and come up with something sturdy. We all worked individually to make different chairs but it would make sense to have an assembly line, where one person makes chairs, someone makes the base thing out of the popsicle sticks and pipe cleaners and we could've assembled it at the end like you guys did with the trays.
B: We would've also made it smaller because ours were way too big.
M: Well thank you Team B. Team A what would you do differently?
A: We probably could've thought of something easier to prototype. We just went with the three easiest ones to build for our final, so I guess having the foresight of having to build something would've made that a bit easier.
M: Anybody else from your team? You would do it exactly the same all over again?
A: I would probably rush more through the prototyping because we took our time and were rushed a little bit at the end there.
M: Ok, perfect. So now this comes up with what you actually started touching on. You were obviously working next to each other and had different customers you were serving, but at the end of the day clearly you were building chairs and eventually had to build some sort of table. Was there any point during the process, I heard one team say your team got the easier one we should've had that one or the other team said you had that astronaut that was more fun or Mikayla you said Oh we should've done the base like theirs. Was there any point where having

the other team in the space change the way your team worked or acted? Team A is shaking their heads no ok Team B?
Team B: We're really loud so I wasn't focused. Like our personalities are really loud so I couldn't really hear them.
B: In the beginning I looked over to see if they were drawing on the white board and they weren't so I couldn't but I wanted to see the papers.
Moderator: Interesting, so how do you think that would've changed the process? Would you have used their inspiration from the white boards?
B: Yeah, it would've been cool to see what they were doing because I wasn't really sure if they were making the office chair kind of thing.
A: If anything, I got kind of distracted because I was very curious about what kind of chair they had. It was clear we were both making chairs and that took away some time of me thinking on this.
M: So what did you think about working in a very open flexible space like this? So you guys got up a lot and used the white boards and started walking. You guys were a little bit more quiet. How did this space influence what you guys did?
B: I liked having the white boards around and being able to get up and move. I hate sitting down as it is. So that definitely helped.
M: Did you feel like that fostered your creativity vs if you were told to sit down and stay put?
B: Yeah definitely. That's why lectures are so hard.
M: Fair enough. How about you guys? Did the space influence anything you did?
A: No I think we're kind of very quiet relaxed people. So I think sitting down was our best option.
A: I think having a piece of paper on the table where we could all see what was drawn was helpful where on the white board we were all kind of removed.
A: It felt pretty organized where I could see what they were all doing. It was nice I think to have an open space, like I'm kind of claustrophobic, I like having the space to think and not feel like someone is too close or anything like that.
M: So is there any particular reasons you guys decided not to use the white boards?
A: Just easier to draw on paper. We're really bad at drawing on white boards.
M: What about you guys, did you feel the white boards helped your design process?

B: I like the white boards because I'm a really bad drawer and being able to erase was very helpful.
M: So Team A since you used paper, did you each kind of come up with a design to contribute to the five?
A: Yeah, we talked it over and said oh what can we change and asked for help.
A: I think the first design we made ourselves and we all asked for modifications from there and went with the one that was the most simple.
M: Cool, and how about you guys, did you all do them individually or were they a team effort?
B: When we were thinking of the designs it was definitely a team effort but when we were drawing them, we kind of picked one and went at it. We each had our own white board and went HAM.
B: We still helped each other
M: IF you were to pick any kind of space to do an activity in, would you pick a space like this, a classroom, tech suite, your apartment, what kind of room would help you do an activity like this the best?
B: I wouldn't do my apartment or fraternity house because there would be too many distractions, but I wouldn't do a classroom because I'm used to just sitting down. I want to be up and moving around like a library filled with whiteboards like this is really nice because you have the flexibility to get up and do stuff.
B: Going off that, I know you're not doing this for a library setting. Me I know I'm very loud, and I may bother people around me. I'm very aware of the surroundings.
M: And your group was definitely more extraverted, and more loud.
B: I find one of the biggest decisions on where I do my projects are table space. This was much easier than a desk in a classroom.
M: What about you group A? If you could do it in any space, what would you do it in?
A: I guess a study suite since it's a similar set-up.
A: Table space agree with previous.
M: He mentioned you were more quiet. Would you rather have a tech-suite where its more quiet and free of distractions or did you mind having other people around you.
A: I'm a very quiet contained person so I think having a little bit more quiet would have been more helpful and worked for my preference.

A: Sometimes I like having a slight background noise, nothing over bearing. I didn't find them over bearing but maybe other people would. I can't work in the CC that's too much but the main floor of the library where there is some talking is good for me.
M: Now do you think that varies by the type of work you're doing?
A: Probably?
M: So does something more active like this make you want to work in a space like this vs something quiet like homework?
A: I'm just a quiet person so I think that's personal preference and I think it would be fine to have a little noise.
M: Back over to you B.
B: I think working in a group I would like something like this, but working alone I would prefer something more quiet and more intimate like a study suite
M: Is there anything else anybody would like to add? Anything interesting?
B: I wish I used the tinfoil. It would have been the easiest material and we would've gotten more points! And I'm really sad we didn't use it.
M: So using all your resources is the big take away there? So when you guys imagine the FIS, what is it that you imagine, what would help you be innovative, that could be resources that could be people…
B: When I imagine the FIS, at least the lobby I imagine something like this, there's couches and cushions and its really relaxed. You have tables and white boards around to do work, but I don't want it to be quiet like a study suite and library.
M: How would that be different that the CC?
B: Literally the same thing, I do all my work there now but sitting there with table space to do projects.
M: Do you think your ability to be more extraverted helps you with an energetic environment and being able to do your work?
B: I have to be in a loud environment to do work, I can't do it in my room.
B: One thing that is specific to me, I don't like not having a paper trail. I loved smart boards because I could do my work on a white board but could go back to it.
M: So not reinventing the wheel every time you start.
B: Pull the picture back up, I could pull it back up and do adjustments on it later.

M: So you would prefer that to paper, an electronic trail.

B: Yes

M: Any more comments from anyone?

B: This is really specific but I would've preferred a taller table because I was bending over and it was uncomfortable. I didn't really like the chairs. (Agreement from others) We really want fidgety chairs.

M: So fidgety group wants fidgety chairs. So I guess we just talked about chairs and staying on that, what do you actually enjoy in a chair that would make you want to stay in the chair?

B: Being able to fidget in the chair or bend back or swivel.

M: The movement of the chair matters more to you than the comfort?

B: Need a balance. Like I could go lay out on that couch over there and I could just do work that way. That would be really nice.

A: I'm personally awful at working on couches, it makes me want to fall asleep. It's way too comfortable and I'm reading and it makes me want to pass out. So an in between would be a firm comfort maybe, I didn't mind the chairs I fidget naturally but I could see about the swivel.

M: What about the height of the table?

A: I'm short so I didn't even notice.

A: A little uncomfortable for me but it's doable.

M: It would be nice to have a table that could adjust heights depending on the work that you're doing? (Someone agreed it was a good idea)

B: A round table would be helpful because it would be easier to see what everyone was drawing.

IV: Focus Group Transcription - Scenario Y

MODERATOR: Did you find it difficult to design so many iterations of the chair, if so why?

- We thought outside the box but we had so many ideas it was hard to narrow them, so we had some mix and match for different designs. Our last two were unique.

MODERATOR: When you were initially given your customer needs, did you think of one design or a bunch of different pieces?

- We started with several designs all at once. We started with elements.
- We started with a set design and branched off from that set idea. There would be a unique idea off of that and that's how they were differentiated.
- There were aspect-y pieces to all of ours but the chair was similar for the most part.

MODERATOR: Did you feel like the design order hindered you process?

- I think we anticipated it from the get go.

MODERATOR: What did you find the most difficult part of the prototyping process to be? Definitely time for us.

- We almost messed up because only one person was designing at first and it took three minutes then we all started drawing.
- Transferring the ideas from paper to prototype
- There are only so many ways you can design a wheel, especially with cardboard. So the actual materials were difficult.

MODERATOR: If I were to ask you to do this challenge again, what would you differently going into it?

- Be even more creative.
- We would've prototyped faster.
- We would've committed more time to prototyping because we kept running into obstacles and they were difficult to overcome the way we manage it. I just panicked and hit a road block, then I'd have to back track and hit another road block and so on.
- We also took a design and built it individually. If we had more time we could've worked on them together and made them more cohesive and all contribute to the device.
- More white board space would've been nice.

MODERATOR: Both of you had white boards in your room, you jumped right to the white board and the other team took right to paper.

- I would've like the white board because it is easier to erase lines and more people can draw on it at once where a piece of paper is smaller. Because the paper was right in front of it, I didn't even think about the white board option.
- We went into it thinking we were only doing one design and it just made sense for us to do it on paper. We didn't even think about the white board.
- The size and location of the white board was more convenient than the paper with the table in the other room.

MODERATOR: (in response) so you would've preferred to have a space you could modify to what you needed

- Yup
- Our group started working at the board and it was just easier to continue from there into the prototyping phase.

MODERATOR: If you were to do it again would you do it on the board or on paper?

- On the board
- We were upset when we found [the other board] wasn't a white board because we were planning on writing on it.

MODERATOR: If you were both working in the same space would that have changed our methods or how you worked as a team or your final product at all?

- I think we might have split up the original design process faster. We got a pretty good way into our first design before we realized we were running out of time. We would have split up and worked on more than one chair at a time a lot faster.

MODERATOR: You would've learned from the other people?

- Yeah
- I would've worked 10-50% faster. Whenever I'm in the room with someone else it stresses me out so I think I need work faster. And if I saw other people working fast I wouldn't have slowed down as much to think. It would not have been good for me but it would've been good for the overall speed of the production.
- I think it would've helped if we were able to see the other team working. We would've picked up the pace and gotten the table on our third design.

MODERATOR: When you were in the separate rooms did you think it was a competition between you and the other team or were you just going for it?

- I thought it may be, but then I saw customer two on the sheet so I thought we had different projects.

MODERATOR: So you thought you had different projects or you figured at least?

- Yeah

MODERATOR: It was not a competition, just working to see if you were successful or not from the metrics. If you were in the same space would you have been more competitive?

- Mostly agreement
- I think if we were in the same space I would've been worried about being too loud and disturbing the other group because when you're working in a group space two things happen; everyone is silent because they are worried about being too loud or everyone is yelling because that is the best way to get above all the other noise.
- It's like being in the library upstairs versus being in the main floor of the CC.
- I think it was a situation where we knew we were at least working on a comparable item or at least I thought and I think if we were working in the same room it would've been a completely different dynamic. I would've wanted to give them their space and not disturb them.

MODERATOR: What space you're working in, does that vary if you're working on a group project or something individually?

- Lots of yes

MODERATOR: How so?

- Well for group projects its really nice to work in a tech suite. You can close the door, you have the white board, you can be as loud as you need or want.

MODERATOR: Do you think it matters more visually or auditorily to be closed off? For example, a lot of people make their own rooms upstairs in the library with the white boards.

- It gives you the false sense of insolation so it may help a little. It also could make you think that you're isolated and could be louder and bother the people working next to you.
- I think it depends person to person too. I'm very visual about my learning style and like being around people. Like if I'm taking a test and I see a lot of other people in the room struggling, I will stress less knowing other people are also struggling. I learn a lot from how I perceive other people are doing.

- I think it also depends on the tone that is set for the space. Like upstairs they do have the flex space, but you feel like you have to be quiet because it is the fourth floor of the library. I feel like a lot of people use it for personal work space instead of group work because you feel like you have to be quiet up there.

MODERATOR: So if you're working on a project and everyone around you is working on a different project and it's not competitive, do you feel like its ok to be in loud space or do you prefer a quiet space still?

- It depends on what part of the project you're on. If you're in the phase where you're just throwing around ideas, I feel like its ok to be in a louder space, but if you're doing research or writing, I'd want a quieter space because I need to be able to concentrate on that because I get distracted. I think it differs depending on what part of the project you're on.
- I prefer to be around other people because I can just put on headphones if I need it.

MODERATOR: If you could choose any type of space to do an activity like this in, what would it look like?

- The RBE lab. In there you have a bunch of different people working on similar projects and the space has computers next to each other if you want them to be there. Also, all the tools you need for it are in that lab. If we ran into a problem, there are other groups working on similar projects who may be able to help you through your struggles. Like they would know where a tool is that I need but don't know where it is. It's like a nice medium between group work and individual work and it's a very manageable volume in there.

MODERATOR: Do you see a lot of cross collaboration because of the environment?

- Yes, there are a lot of times where people will help others out in the lab.
- I spent a lot of time in the RBE lab for intro to Python and was having a really hard time. Someone stopped behind me and asked if I was having a hard time. They just stopped and helped me out. I agree that the RBE lab, as a not RBE major, is a good space to get work done but have people help you out. Sometimes I feel like the tables are a little too close together, a little too squished. I want that environment where people can see that someone else needs help but I would like a little more space to comfortably walk pass each other.

MODERATOR: Anybody else, what kind of space would you do this in? If you could make it, what would it be?

- I would want white boards (background agreement), with different color markers, I'm a visual person so I'd like each aspect to be a different color. Having a space to design something on the ground. I like tall chairs and working at one of the big work benches, I feel more productive if I'm able to sit up and not leaning back in a chair. I love having an open space with lots of natural lighting, when it's like this with lots of fake lighting its tough to go outside and it's dark, I feel like I wasted a day, but if there is natural lighting I would be a lot happier.
- Kind of like the ME MQP lab in Higgins, there's a lot of tall chairs but open space too. You can be sitting and working at a computer on a work bench or you can be standing and working on building something. I love that there's a white board that's a full wall.

MODERATOR: What do you think of a table where you can raise it up and down? You can sit or stand at it?

- Some affirmative responses

MODERATOR: Essentially you want spaces that can adjust to the kind of work you're doing?

- Lots of agreement
- I would love windows that you would be able to write on with white board markers.

MODERATOR: So as much writing space as possible is essential?

- Multiple agreements
- But we need it to be actually erasable. The white board wall in Higgins is not a very high quality one and it stains very easily.

MODERATOR: So in those kind of spaces, do you prefer them to erase their work when they are done or would you rather they left it and you could see it and take the 5 seconds yourself to erase it? Does it inspire you and give you any ideas or is it just annoying?

- It depends on how much they put on it. If it's the whole thing, it's a little bit annoying but if it's a small portion it doesn't bother me as much.
- It's tough out of context, like cool, there's a bunch of letters on that wall that I need now. Very rarely do I see a white board with words and numbers that I can relate to.

- I really like the tech suites in Faraday because of the full wall white boards where you can do full flow diagrams. But it's also sometimes tough to identify which wall is a white board because I may have written on a wall that isn't a white board once.

MODERATOR: What do you think about a smaller room like a tech suite except all of the walls are white boards.

- LOTS of agreement.
- My only issue is as a short person, I can't use the whole white board (someone shouts stools) or I'd need a small step ladder and I can then use all of the white board. I just can't reach and it's an issue sometimes.

MODERATOR: When you use a tech suite, do you use it more because of the technology that's in there, the table that's in there or because it is just a quiet place?

- All of the above (general agreement)
- To guarantee you'll have a space where your group can meet at. Because if you just go to the library you don't know there will be a space where all of you fit, but if you book the tech suite you know you have it.
- It also makes meetings more efficient because you have a time limit on the space you are using so you get more done or do a better job of dividing up the work later.

MODERATOR: So what would you do if the library took out all the tech suites?

- Be sad

MODERATOR: What would you actually do?

- Are they doing that?

MODERATOR: No, just a hypothetical question

- Move back to Faraday

MODERATOR: There are no more tech suites on campus, then what?

- I think there would be a lot more group meetings in apartments because that's the only other way you can guarantee you'll have that space. Otherwise you will lose a lot of time wondering campus trying to find a space to work.
- People would also try to save their spaces by leaving their backpacks while they're in class and that's not fair to someone who can use that space at that time. Having bookable space helps.

- That's what people used to do with the cubes on the top floor of the library, they would get there early in the morning and they would leave a backpack there or have someone stake it out for the entire day.
- And you don't want to be that person that takes someone's backpack out of the cube.
- You don't know if they're just going to the bathroom.

MODERATOR: Would you worry less about booking out spaces if those sort of things were better moderated? Would that stress you out less? From a cultural stand point and not a usability stand point.

- Maybe?
- If it was moderated I would be worried that someone would come up and say you've been here too long and you need to move.

MODERATOR: No I mean moderated in the sense that a backpack has been sitting there for an hour with no person at the table. So someone from that building takes it to the front desk and now that space is open.

- That would be better.

MODERATOR: So it's more of a matter that you worry that other people are taking spaces and you won't have a place to work rather than there's not enough space?

- A little bit of both
- The number of times where I've done an entire lap of the library and there are no open table spaces is high.
- And when you're trying to have a group meeting that's tough.

MODERATOR: Now imagine the library is twice as big. Would you still have the need to book spaces?

- I think my issue is that there are people that are working by themselves but are at a table for 6. If that's me I'm not going to join them, but I'm also not going to kick them out if they join me in that space if I'm alone.
- Finding a table that has an outlet is also an issue. You need those especially as your battery life on your laptop grows shorter so it limits the places that you can work.

MODERATOR: What's more important, being able to move the table the way you want and making it fit your need or an outlet?

- For me, an outlet

- I'd like a table that had a range of motion, but also had the outlets in the table.
- I'd like to have the table, I can have the range of motion but I can also get an extension cord from the info desk.
- I'd be worried about how cluttered something like that could be. There would be power cords going everywhere and some people won't bring them back so you will have a tangled mess on the floor.
- Think of a fire and ice style circle table where the center is just a giant power station, that would be cool. Usually it's just one person that needs the power and they take up a giant table, but it would be better if there was something like an airport charging station to free up that space. Something where people don't have to be on top of each other, but a place where a large number of people can assemble and power their devices would be nice.

MODERATOR: So when you're working in a group, circular tables or rectangular tables then?

- I read somewhere that Starbucks makes their singular tables circular so you feel less alone, but it's easier to see people at a circular table, so depending on the group size you can pull up multiple chairs, but square tables are easier to put together to build so I think I prefer square tables.
- It doesn't really make a difference because if you need to fit an extra person at the table you make it work.
- I'd prefer a circular table the you can break in two halves, and put on the ends of a rectangular table.

MODERATOR: Is there anything else, any other takeaways that people want to share?

- I don't like carpeted floors. It's really hard to move stuff on carpeted floors and if I spill something, I feel really bad.
- I don't like linoleum floors because it makes it feel like a hospital.
- I prefer hardwood or tiles, tiles like the CC has are perfect.

MODERATOR: Anything else? [No response] Thank you for coming!