

COLLABORATION IN HIGHER EDUCATION:
BEHAVIOR OBSERVATION INFORMING SPACE ARRANGEMENT

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What role does architecture and interior spatial arrangements play in facilitating spontaneous or arranged collaboration in higher education? This project involves identifying the architectural characteristics of spaces that facilitate collaboration in higher education, including deriving the spatial organization and circulation patterns that facilitate collaboration, and the simulation of collaborative environments. With today's use of integrated technology limiting face-to-face collaboration, a study was conducted to map conditions that stimulate collaboration in on-campus buildings. Behavioral observation was conducted at four strategic academic buildings on the North Dakota State University campus, each representing a unique case study in collaboration. Perceptions of how students, staff, and guests use different academic spaces were studied by tracking and monitoring multiple criteria. Results from the local study support current literature suggesting that students demand more collaboration within the classroom and on campus than the need or use of technology; supporting higher education's demand for technology integration may be wrongly allocated, as students today seek less technology and more face time while on campus. Research was commissioned to better inform a new Science, Technology, Engineering and Mathematics (STEM) building being built on the NDSU campus, in the anticipation that this would be a high performance building and promote collaboration.

INTRODUCTION

This project involves identifying the architectural characteristics of spaces that facilitate collaboration in higher education, deriving the spatial organization and circulation patterns that facilitate collaboration and simulating collaborative environments. This project is in partnership with the architecture firm BWBR located in St. Paul, Minnesota. BWBR received the contract from North Dakota State University (NDSU), located in Fargo, North Dakota, to design a new academic classroom building for Science, Technology, Engineering and Mathematics (STEM). BWBR is responding to the request, by NDSU president Dean Bresciani, that the new building become a center for higher education collaboration. This project is funded entirely by BWBR and all research findings for this project will be used to inform the design of the new STEM building. Gensler, a leading architecture firm, published an article on STEM building design, stating in their research that “successful STEM buildings encourage an active, hands-on approach to learning and teaching” (Burke-Vigeland, 2013 p.3). For this reason onsite research was a valuable aspect of the overall project. This research is being carried out through a graduate research grant at the North Dakota State University in the Department of Architecture and Landscape Architecture. Regular updates and conferences were held to immediately relay incoming research to the design team at BWBR. This was at the request of the firm as the project is in design phase and has currently moved to construction document phase, so that all current research become pertinent to informing design decisions in existing projects.

Research has been conducted through on line media, relevant literature and site observation. Please note that the literature is included in the literature review found at the back of this document. The most critical findings are from *Make Space* by acclaimed authors and researchers Scott Doorley and Scott Witthoft, published in 2012. It is a detailed study done at Stanford University d.School’s Environments Collaborative Initiative. Another leading resource is the research done by the international architecture firm, Gensler, which published a dynamic statement in their last education research report stating, “despite all of this connectivity, independence and study-alone time are the factors that define today’s study experience” (Changing Course, 2012 p.2). As Higher Education seeks to design more collaborative spaces, students still seek autonomous spaces for focused study in order to have more productive time on campus. In addition to these published resources, human observations were conducted on the North Dakota State University and their findings are important to understanding the local Fargo culture. Awareness of students’ habits allows designers to be more attentive to the spaces and “Intentional or not, the form, functionality, and finish of a space reflects the culture, behaviors, and priorities of people within it. This suggests that a space designer is simultaneously a cultural translator and a builder. Space design has its own grammar that can be tweaked to bolster desirable habits” (Doorley, 2012 p. 38). Lastly, Gensler’s research lab published a fascinating find that students prefer a pen and paper over a laptop and wireless Internet connection. A students need for spaces to facilitate pen and paper ranked first while the need for laptops ranked second. This sheds light on the trend of universities are incorporating high levels of technology into the academic environment when in reality it is being underutilized and furthermore not as important as traditional means of learning and idea development (Changing Course, 2012 p.7).

Findings have been presented in three categories to articulate architectural characteristics of spaces that facilitate collaboration in higher education more easily. The three main sections are as follows. First, Learning from Observation; Using Social Norms to Inform Design Decisions. Observing how people [students, faculty, staff and visitors] use a space is influential in the design process as it directly informs natural social responses to environments. Second, How Arrangements Maximize Usage; Creating Spontaneous and Intentional Interaction. This section lays out spatial arrangements to maximize space and helps create space that is foundational for facilitating interactions and collaboration because “the built environment impacts our personal behavior on multiple levels, including territoriality, crowding, situational behavior, and personal space” (Scott-Webber, 2012, p.2) Third, Making Space Relevant; Creating Nodes and

Destinations for Dynamic Usage. “Dynamic learning environments are the competitive edge” says leading architecture research firm, Gensler, in a report studying 250 universities. Utilizing the plans provided by BWBR highlights elements showcases how the space will promote collaboration and academics. It is validated that awareness of students’ habits informs designers better on how to design more specific spaces for collaboration. This research is to inform the collaboration related design strategies of the new STEM building.

HISTORICAL OVERVIEW

It is fundamentally indisputable that throughout history there has never been such growth in communication and digital collaboration as there is now. The list below is a summary of all types of collaboration throughout human history, from the invention of paper, to the postal service, the telephone, television, computers, and the Internet. Each one of these has played a role in how we collaborate today. It is remarkable that the most exponential developments occurred within the last 200 years. This immense growth has made this current generation Z dependent on communication technologies and media such as the internet, text messaging, social medias, iPods, iPhones and iPads (Riedling, 2007 p.11) forcing these next generation of higher education students to look to a variation in learning strategies and environments to best equip group work and private study time, which may pose a more significant challenge for this tech-savvy generation (Burke-Vigeland, 2013 p.6). There has always been collaboration and it is clear that “you don’t need an extravagant set-up in order to produce killer ideas and content” (Bedosky, 2012 p.1) as history reveals itself through simplicity and development. As a point of reference, a brief inclusion of manufactured elements having facilitated collaboration throughout human history has been added into the article.

3500BC: Word of mouth and images	1903 Wright Brothers invent and fly the first airplane
5th Century BCE: Pigeon post	1907 First modern Helicopter
105 BCE Invention of paper as we know it	1910 First talking motion picture.
101 BCE First bound book	1914 Cross continental telephone call made
14 BC Romans established the postal service	1925 Television signal transmitted
1450 Printing Press by Johannes Gutenberg	1927 Television broadcast in England
1492 Leonardo da Vinci theorize about flying	1944 Computers- government owned
1650 First Daily News paper	1949 Network Television Invented
1783 Hot air balloon invented	1951 Computers sold commercially
1787 Steamboat Invented	1958 Office use photocopier
1790 Bicycle invented	1938 Television broadcast recorded/taped
1814 First Photograph Image achieved	1963 communications satellite is launched
1821 First sound box “Microphone”	1966 Xerox Fax machine invented
1835 Morse code developed	1969 First Man on the Moon
1843 Long distance telegraph line Samuel Morse	1970 Jumbo Jet launched
1858 First trans-Atlantic telegraph cable	1971 Floppy Disc invented
1867 First typewriter	1971 First email sent
1869 Transcontinental railroad	1980 Sony Walkman invented
1871 First car invented (1985 First practical one)	1981 Space Shuttle Launched
1876 Alexander Graham Bell electric telephone	1981 First IBM PC computer sold
1877 Patents the phonograph, with a wax cylinder	1984 Apple Macintosh created
1889 Paten for the direct dial telephone	1985 Cell phones in cars becomes widespread
1902 First Radio transmission across the Atlantic	1990 Prototype system for World Wide Web
	1992 First text message sent
	1992 The Internet system is created
	1998 Mobile satellite hand-held phones
	2000 Mobile G3 networks
	2007 iPhone (1st generation)

LEARNING FROM OBSERVATION

Doorley writes in *Make Space*, “One of the best ways to develop a collaborative environment is to observe and amplify the ways in which your community already feels empowered to take control”(2012, p.36). This method was utilized by conducting human observations over a period of three weeks with multiple pre-selected locations for strategic time periods. This information has provided insight into the natural habits student culture. Perhaps one of the best statements aimed towards designers in regards to creating spaces to promote collaboration and interactions is “Do less. Leave some aspects of your space open-ended, even though your impulse might be to take care of every detail, resist filling every square foot with furniture or decoration” (Doorley, 2012 p. 76). Observing situations have revealed the benefits of this and the need for spaces to be built with room to grow and modify. On the other hand, positive collaboration spaces are not something that just happens by chance, nor by assuming that two human beings standing next to one another is going to make them collaborate, it requires “intentional space with tools” designed to facilitate collaboration (Searer, 2012 p.1). Furthermore, each space needs a post occupancy adaptation, which naturally occurs over time. This is a critical assessment where designers can further maximize the potential by paying close attention to the changes developed by users and in return the designers, instructors and building facilitators can respond to these natural adaptations of space (Doorley, 2012 p. 36). These two result in a satisfactory compromise between being drastically rigid and scientifically reliant for your collaborative goals, and assuming a fully experimental and trial design to enhance collaboration is best.

OBSERVATION

Universities run on macro and micro cycles, from classes in a day and to hours in bus schedules to annual cycles of semesters, holidays and graduations. Even at the most finite level, people’s habits and social norms are visible mappings of cycles. These are far beyond daily routines composed of class time, studying, eating and relaxing. These are nearly invisible characteristics of campus life, observed by onlookers studying students’ interaction and collaboration.

While it is beneficial to observe, it is more critical to strategically observe. Choosing specific locations, times and gaining clear understanding of the space and attraction under observation is crucial. Four strategic locations across the North Dakota State University campus were chosen for this observation. Gensler points out that “classrooms are only one facet of a college campus. Students and educators are using in-between spaces as lounges, courtyards, and atria to interact and learn from each other. Designing campuses to take advantage of the creative learning that takes place in these in-between spaces can help colleges and universities support diverse types of learning that students and educators partake in” (Gensler, 2011, p.3). As this is the case, each of the observed locations was chosen for a precise reason and for its importance to the project and final results. The four strategic locations selected for this study include quiet study spaces (NDSU Library), nodes where students retreat to and transition through NDSU (Student Union), as well as major transitional spots and bus drop off active spaces (Barry Hall Downtown), and a technology hub in a typical classroom building (IACC Technology Building). Observations studied not only aspects of social mapping and use of space, but also counted numbers of people and included tasks performed, such as trips to the drinking fountain, walking laps around the building and other interesting finds; even down to the detail of how often people got up to use the restroom or what type of snack foods people brought or bought. An estimated 5,200 subjects were observed on multiple occasions over a period of several weeks at varying hours between these four spaces.

Having spoken with staff members who manage each of the locations, this adaptation of space is an ever evolving process that changes as student’s needs and demands change. To best study the natural habits of local students and staff, it was critical that some observations needed to be done. Once university approval had been granted to perform documented site observation of the NDSU campus, faculty, staff, students, and guests, a strategic plan of observation times was prepared. It

was soon clear that observations proved so beneficial that additional sessions were planned to further gather and study student's collaborative and social mapping habits.

The need for original research was to find more refined local contingencies and then add them to the recent growing number of published works on higher education and collaboration. The intention was to simply support published research and statistics with local human observations, but the results proved extremely valuable so the number of observation sessions was doubled.

Basic criteria studied during observation sessions are as follow but not limited to:

- 1) Where does collaboration happen in higher education environments?
- 2) What are commonalities between design elements, which encourage collaboration of humans within, studied areas and spaces?
- 3) How long do subjects linger or rest in spaces, based on interior space configuration, lighting, airflow, noise and furniture?
- 4) Observation of tasks which subjects are performing within the observed areas (e.g. reading, studying, using personal technologies, writing).

1. RESULTS OF OBSERVATIONS

In 57% of cases where food was introduced into a quiet focused group study session, the food caused the group to dramatically turn socially-oriented.

Nearly 90% of all lounge furniture in the observed spaces did not have arms, but did have higher backs and often clustered around low coffee tables. The remaining percentage was made up of tables and chairs.

76% of students observed sought out solitude or were observed sitting alone and, in a majority of cases, students had laptops with them.

Students seated by window tables were more likely to stay longer [60+ minutes] in their spots than students on lounge furniture on the inner side of the space.

Students seated at tables were less likely to use a laptop or technology and primarily used other tools.

219 cases were observed of spontaneous interactions between people such as "running into each other" in the hallway. All but 11 cases lasted between 44 seconds and 1.6 minutes.

Doorways and stairwell-landings seemed to be the most probable places for interactions between students and staff. 2 out of 3 cases happened in said places.

80% of all observed phone usage was done on a smart phone such as an iPhone or Android.

Directly in front of bathroom doors is where conversations often started and lasted for several seconds.

94 observed study sessions took place, where students studied similar material and "helped" each other; this was primarily between two people.

Lounge furniture in an open space and high traffic area does not deter people from sitting in the space.

Students seek out space to retreat to and work. Highest commodity space is lounge furniture with a nearby coffee table or end table.

1% of students observed used lounge furniture for sleeping. Shortest observed "nap" was 19

minutes and the longest was 105 minutes.

Providing clusters of lounge chairs and tables with odd numbers of seats, 3, 5, and 7 provide the best ratio for maximizing space. This was observed as students gravitated to sit in every other chair rather than every seat. By designing clusters of 5, 3 chairs [the same three] will be used most, while two chairs will sit more often than not empty. This could minimally be solved by spacing out furniture.

Students tend to first seek out electrical outlets located near seating before choosing a study location. One thing lacking was an adequate number of outlets, specifically for the seats more in the center of the room.

71% of students observed who find a seat to study/sit, do not get up after sitting for anything, including the bathroom, food, water, printing, etc. They stay seated.

In most observed cases the demographic was roughly 50/50 men and women.

When students sought out spaces to sit, in nearly all cases the person sitting down or already present did not say hello or greet each other in any way.

Approximately 10% had a spontaneous interaction caused by crossing paths with a friend or faculty. In most cases one of the observed was seated or seemingly studying while the other(s) walked through the space.

In 69% of observed group study sessions, not all people studying in groups used their laptops/technology. In most cases, members of the group used other tools such as notebooks, textbooks and phones. Also, food was nearly always present in larger groups.

While observing people's frequency at a coffee vendor, 81% of people would order to-go and left the space. 16% of people look for the closest table or chair to sit down, while 2% would wander around in circles looking for an isolated place to sit.

The average length of study in the Union was between 44 and 48 minutes, the time often between standard 50 minute class periods.

There was a dramatic surge of traffic beginning predictably 12 minutes before the hour on Monday, Wednesday and Friday, as buses drop students off and faculty and students prepare for classes.

People studying alone are more likely to travel long distances to seek out a quiet study space than those in groups.

3 different groups [women] around lunch time, 11:00am - 1:00pm, were observed walking laps. One group was counted doing 14 laps with 3 minutes between each sighting.

The coffee shop and convenience store were the most active locations for spontaneous interactions between people.

Clusters of between 3-7 students form while waiting for a bus. The lobby would fill up for several minutes until the bus would arrive and everyone would leave.

2% of all observed people using the space took the time to sit down in the atrium lobby space, which was mostly used by students preparing for class or eating lunch.

An estimated 95% of students arriving at Barry Hall Downtown arrived by NDSU bus from main

campus only to attend class.

76% of students were observed studying alone rather than in groups between the Student Union, Library and Barry Hall.

89% of students seek out the library as a destination study space. Regardless of working in groups or alone, students spent about of 2 hours there.

4% of all observed students left their spot in the library to get coffee from the Union, many of which returned within 15 minutes to their seat. Meanwhile, they left their laptop or set up on the desk surface.

Cross talking, between people seated at separate tables or desks, happened more in the library spaces than other campus spaces. Students did not tend to adhere to the quiet environment.

Spontaneous interactions happened just as common within the setting of the library as other campus space.

31% of observed people in the library used technology in the form of laptops. *This does not take into account the use of iPods or phones.

During all observations sessions in the library, computer clusters were nearly always occupied. When one computer became available, it was re-occupied in an average of 4 minutes.

An observation of tasks revealed that the majority of tasks performed in the library did not consist of laptops of technology. Most common is text books, and note books.

2. HOW ARRANGEMENTS MAXIMIZE USE

Based on Section 1 and the observations, this section, written out over the next several spreads, depicts spaces which will maximize and explain uses of furniture arrangements. This is perhaps the lowest level of informal (intentional) collaboration. How spaces are design to facilitate group dynamics and idea sharing. Universities today are far too technology oriented and are not investing enough in developing a foundation for meaningful interactions between students and professors. Even though social media and other online forums continually preoccupy students; today's young adults seek out and are looking for more intentional face time (Gensler, 2013 p.2). While furniture arrangement does not create collaboration, it can facilitate how people linger within the boundaries of a space or what task they are most likely to perform within those given spaces. In order to create a positive atmosphere where people can "cross-pollinate" and freely express ideas, designers must pay attention to attributes that affect peoples environment, freeing them up to share ideas (Moggridge, 2007 p.722). This interaction between students is vital to socializing. Moreover, researchers at Gensler identify that "A building's design can play an active role in this engagement by integrating the subjects that students learn into their physical environments. The building itself can be a teaching tool, exposing its structure and systems to promote discussions around engineering, sustainability, and relationships between he built and natural environments" (Burke-Vigeland. 2013 p.3). Students and faculty intentionally seek spaces out to perform tasks, this may be computer work, reading, meetings with others, tutoring, meeting fellow faculty, students meeting fellow students and even regional and global collaboration. Humanity often follows the one-size-fits all philosophy assuming what will work in one situation will work across the board. Spontaneous collaboration happens naturally in stairwells, hallways, and elevators and at the drinking fountain, which are where people meet. Good design maximizes these transitional spaces and builds in space for seating, additional space, material changes, and pleant spaces where further collaboration can happen. As it pertains to higher education little attention is geared towards transitional spaces, which is where the majority of collaboration takes

place. There needs to be a dialog between students and faculty to develop situationally specific, modifiable spaces for transformational learning (Gensler, 2013 p.1).

Below there is a list of criteria studied within each of the spaces, reviewing such characteristics as light, temperature, sound, tasks, and location. A key element in collaboration is to comprehend what places make people comfortable and provide the essential environment to connect with other and develop ideas. These primarily are referred to as nodes or idea sharing environments, or further more brainstorming spaces; “these areas are designed to promote new ideas, and tighten up current ones. This could include a whiteboard or a board to hang up notes and images. Even if it is just one part of the wall in the office [school], it helps collaborative efforts to be able to see student work displayed. This process takes away from the computer screens to see the big picture” (Bedosky, 2012 p.1). Everything can affect the environment and each of this play a role within creating spaces that facilitate random and strategic gathering. Everything from amount of sunlight in a space to humidity, noise and ideal temperature affect how people collaborate and engage. Research indicates the ideal temperate “zones overlap in the 73 to 75 degree range. In this region, people in summer dress tend to be slightly cool, while those in winter clothing feel slightly warm” (Bradshaw, 2006 p.22).

Here are the criteria studied: Task: Studying, Reading, Writing, Computer work, Socializing (talking), Eating, Movie Watching, Printing. Location: Small Alcove, Lounge, Hallway, Private Room, Classroom Type Space, Outdoor Space (weather permitting), Access to Food/Beverage Service, Access to Printing Access to Entry/Parking/Arrival, Access to Faculty Offices, Accesses to Toilets. Pedestrian Movement through space: No Traffic, Little Traffic, Average Traffic, High Traffic, Connection Point Traffic. Lighting: Out Door Spaces, Indoor Direct, Naturally Lit Space Indoor, Indirect Naturally Lit Space, Artificially Dim Lit Spaces, Artificially Indirect lit Spaces, Artificially Bright Lit Spaces, Artificially Direct Task Lighting. Sound: Decibel Level, White Noise, Decibel Level, Ambient Music, Background Noise, Pedestrian Movement Noise, Other Conversations.

This section analyzes the difference between arrangements for 1 person, as well as for small groups of students, and how the dynamic of collaborative spaces change when faculty members or academic staff members are added to the group. To include the furniture arrangement before the space arrangement may appear out of order when designing a building. However, if the desire is to creating the right atmosphere and space for intentional and spontaneous collaboration it begins in the smallest details. Making sure that productive space is left in strategic spaces and each space is designed with specific flexible and extreme versatility, not rigidity and isolation.

“Two things that can be adjusted in almost any space are orientation and ambiance. Orientation: how are people positioned to engage objects or each other? Do you want the group to have shared focus on an object or do you want them to be able to engage each other? Ambiance: what is the vibe or mood you are trying to create, and what is the duration of the gathering? Lowering the intensity or limiting the number of lights in a space can shift a mood from active to reflective. Opening windows can provide some energizing fresh air for a long meeting and a little background noise that raises the energy level and increases awareness of the surroundings” (Doorley, 2012 p.25)

FINDINGS

3. MAKING SPACE RELEVANT

This section is the combination of the observed and researched elements conducted in this study, taking the most applicable elements from observations and published resources and applying them to the working plan of the STEM Building. A study revealed that “Inside the classroom, the student wants to d-plug and interact with fellow classmates. They can watch lectures at home and would rather engage in collaborative learning on campus [in the classroom]” (Changing Course,

2012 p.3). This changes the demand for strict collaborative spaces and makes the challenge; designing spaces which are flexible and can work well for individuals and in a moment can turn into a burst of spontaneous collaboration between people. Providing all the components within a building is a start towards creating collaboration, yet knowing what you want out of each space and designing for them is more important. Developing spaces to have everything they need for the current generation to promote collaboration may change within the next five to ten years as technology and norms evolve. In contrast with face to face collaboration, students want to cooperate with each other more in the classroom than only sit for lectures. Gensler asserts that “online videos and readily available podcasts allow students to access information from the comfort of their dorm rooms or apartments. When they come to class, they want to step into an environment where hands-on collaborative learning takes place in small groups” (Gensler, 2011 p.3). Their research goes on to conclude that each space needs to be well supported with a plethora of integrated technology for people to use, but as technology develops and adapts, the rooms primary focus is the collaborative and explorative process not the technology (Burke-Vigeland, 2013 p.6). The most accurate summary is that simply leaving enough space within your project and enough flexibility within the overall design so that it is not bound by time but can be modified, as generations and students/staff need it. Perhaps an even more socially unplanned and undesigned space is the “metaphorical Cul-de-sac [which is] a spot at which to linger and chat before or after a gathering. Aim to create a comfortable pause zone, where conversations can transpire that might otherwise have been lost. . .our most successful cul-de-sacs are simply the arms and backs of couches” (Doorley 2012 p.98).

Several key areas which were incorporated into the new BWBR STEM building scheduled to break ground in May 2014 are listed below. This list has been derived from above observations, research and literature.

- Technology Hub Centers: Computer clusters for short term work and printing. These are key locations as students pass through the building from busses to classes. “Being tech-savvy with a cutting edge environment is not necessarily about installing the latest of everything but supporting the technology that people instinctively use.” (Doorley 2012 p.185), “A mix of learning settings foster individual and group work” (Burke-Vigeland , 2013 p.6).
- Building Dashboard: digital wall display of events, news, and school related information.
- Entrance Lounge Nook: Students who sit by the window and in a corner are more likely to stay upwards of 2 hours observation says. “Student Teams with access to a corner sport spent far more time in a space working on their projects than teams whose spaces were on an open wall” (Doorley 2012 p.142)
- Tables on the Center Corridor: This will become an extension of the Union and people will gather here and eat and study. This should be outfit with numerous outlets and trash receptacles as students and staff will use table space for studying, meeting, study groups and eating. “If possible, these smaller interactions should convene in a “heart” space- a central area where all parts of student life interact. For maximum impact, locate the heart at a key intersection between departments and circulation paths.” (Burke-Vigeland, 2013 p.4)
- Gallery Display of Student work and current research projects happening in the building. “Visible projects and academic achievements foster a learning culture. . .Create teachable buildings that support STEM curriculum through direct and indirect educational tools” (Burke-Vigeland, 2013, p.5)
- Open Group Study Nooks: Open group study areas which are semi-secluded with even a sight hint of a corner will create a “sense of ownership in an open space” (Doorley 2012 p.142). These should be fit with whiteboards and possibly a projection screen or TV

which can help facilitate collaboration and idea sharing.

- Closed Study Rooms: “Larger, open spaces should always have smaller, close-able spaces available nearby to provide privacy and escape” (Doorley 2012 p.133).
- Open Lounge: Flexible seating in a lounge style will be used for fix use studying and socializing. “Transitions are important. Let guests feel the energy of the space immediately, but allow them to enter it on their terms by offering a visible threshold between themselves and the action- through floor treatments, a glass wall, or a partial partition” (Doorley 2012 p.101).

SECOND LEVEL

- Technology and White boards: Wall mounted televisions for interactive group study sessions. The wall would be entirely white-boards allowing students to perform equations and solve problems on the white-board like a classroom. “Corporate- style dry erase surfaces are often conventional and costly. Try using alternative materials in various shapes and configurations to inspire your audience” (Doorley 2012 p.191). “Leverage circulation as an opportunity to provide space and furniture solutions that promote collaboration and interaction between students and teachers...” (Burke-Vigeland, 2013 p.4)
- Sought Out Study Nook: Creating destinations and spaces which are unique help students feel comfortable and designed right can be an inspirational and strong learning space. “Dynamic learning environments are the competitive edge” (Gensler, Changing Course, 9), “Nooks and other semi private meeting places enable productive gatherings” (Gensler ABCs 4)
- Visibility Between Rooms: Windows through the atrium space will allow things happening in the building to be open to onlookers and walkers, engaging the entire community. “Transparency between classrooms, circulation spaces, and the outdoors encourages students to participate.” (Burke-Vigeland, 2013 p.5) and “See through walls; both visual transparency and acoustic privacy are important in collaborative spaces. Visual overlapping elevates the energy of being able to see others, while acoustic separation eliminates the distraction of overlapping conversations” (Doorley 2012 p.129), “Classrooms, labs, and offices in proximity promote visual connection and integration” (Burke-Vigeland, 2013 p.4)
- Variation in Furniture: “Deliver experiences, not just technology” (Gensler, Changing Course, 10). Having a mixture of tables by the window and lounge furniture will allow students a choice of destination. Complimented with lounge furniture along the inner wall supported by white boards and televisions will engage the space as a after-hour collaborative tutoring learning space. “Various physical, social, and psychological dimensions of the learning environment have been shown to play a role in affecting students” (Scott-Webber, 2013, p.2)
- High-Top Study Space: A Bar surface allowing individual study or lunch with a pleasant vantage-point. People like to “see and be seen”(MIT,73) giving them a sense of security and peace. “A peanut gallery is a space where spectators can drop in and out of...Provides a strong visual delineation... A bar surface is terrific for this” (Doorley 2012 p.86)

THIRD LEVEL

- 3rd Floor Escape: The higher up one goes in the building the less people that transition through the space. This three story building has the advantage of creating quieter spaces

on the top level which students will demand for studying and on-on-one tutoring. “A mix of learning settings foster individual and group work” (Burke-Vigeland 2013, p.6)

- Sought Out Quiet Space: “...While students may not be going to the library for books, they still see it as prime space for studying and performing individual work- space that seems to be increasingly high demand and short supply” (Gensler, Changing Course, p.3 (Doorley 2012 p.103)
- Flexible Use Space: These spaces should be supported with a variety of tools, even being in the open. Such as whiteboards on the wall, window shades for light control, televisions or projection for group media work and outlets for entire groups of people to plug in. “Collaboration can shift from a hush to a scream in a moment. When teams are flaring, or generating ideas they might be physically standing, moving around, and doing things” (Doorley 2012 p.144)
- Quiet Destination Study Space: “Encourage relaxation amid a stressful and strained work environment by providing spaces for quiet reflection and temporary escape. Outfit these spaces with appointments and surfaces- pillows, wallpaper, etc- that grant permission not to work” (Doorley 2012 p.83)
- Sought out Study Destination: Students seek out destinations which are considered to be hidden from main places. Students will tend to linger in these spaces longer and often with peers and study.

CONCLUSION

In conclusion, architecture and interior spatial arrangements play a significant role in facilitating spontaneous or arranged collaboration in higher education. This project involved identifying the main architectural characteristics of spaces that facilitate collaboration in higher education, and deriving the spatial organization and circulation patterns that facilitate collaboration. Through minute modification with air flow, temperature, volume, and strategic decision on furniture arrangements and placement, a facility's capacity to promote collaboration and inter-departmental connections can multiply. With today's use of integrated technology limiting face-to-face collaboration, this study conducted to map conditions that stimulate collaboration in on-campus buildings found that a majority of students, upwards of 71% prefer studying alone, and would rather have collaboration in the classroom than just lectures. Gensler Research revealed in their round table discussion that students would prefer to work in small group while on campus and do individual private work at home. Observations done at North Dakota State University revealed multiple facets of people and their near-subconscious actions and tasks performed. This information both from literature and observation proved to be beneficial in applying these elements to the NDSU STEM building project.

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Autobiographical Sketch

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