



ReArrange:

Making Space Transform

Amanda Makis



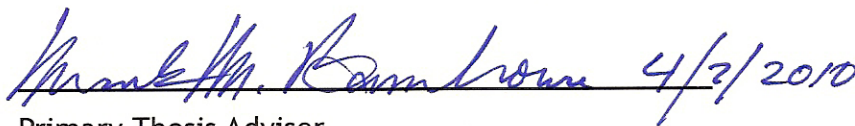
ReArrange: Making Space Transform

A Design Thesis Submitted to the
Department of Architecture and Landscape Architecture
of North Dakota State University

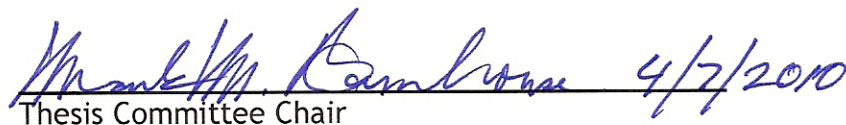
By

Amanda Makis

In Partial Fulfillment of the Requirements
for the Degree of
Master of Architecture

 4/2/2010

Primary Thesis Advisor

 4/7/2010

Thesis Committee Chair

May 2010
Fargo, North Dakota

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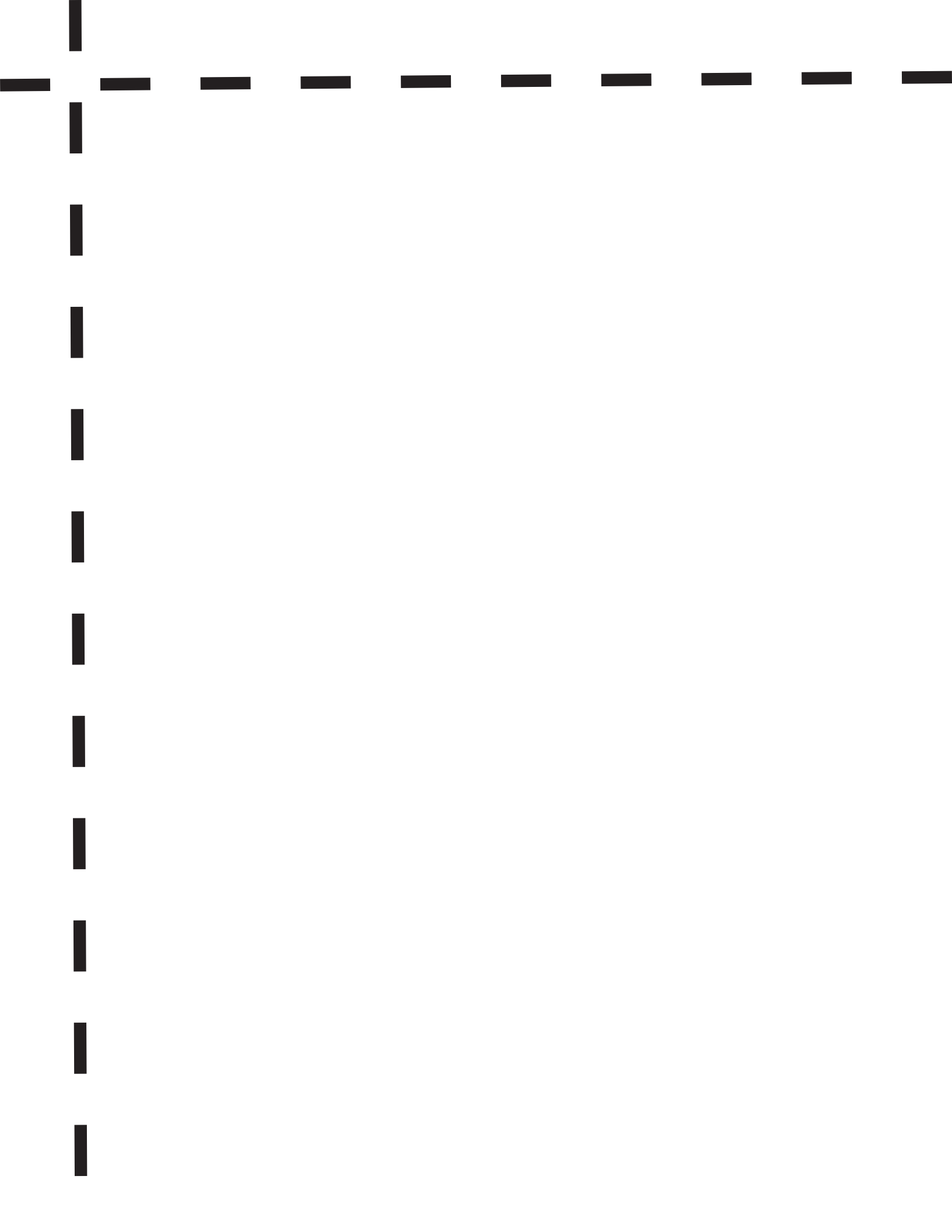


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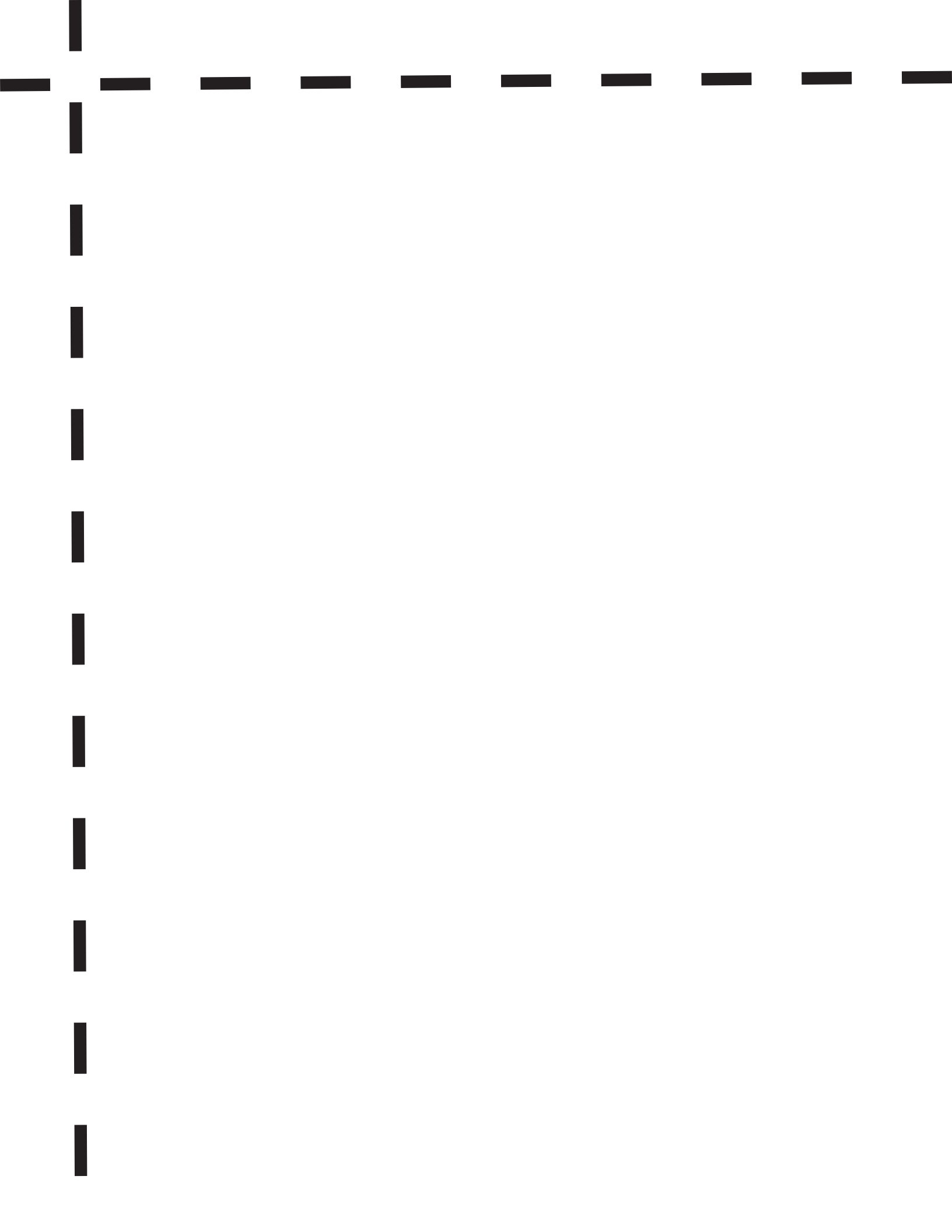
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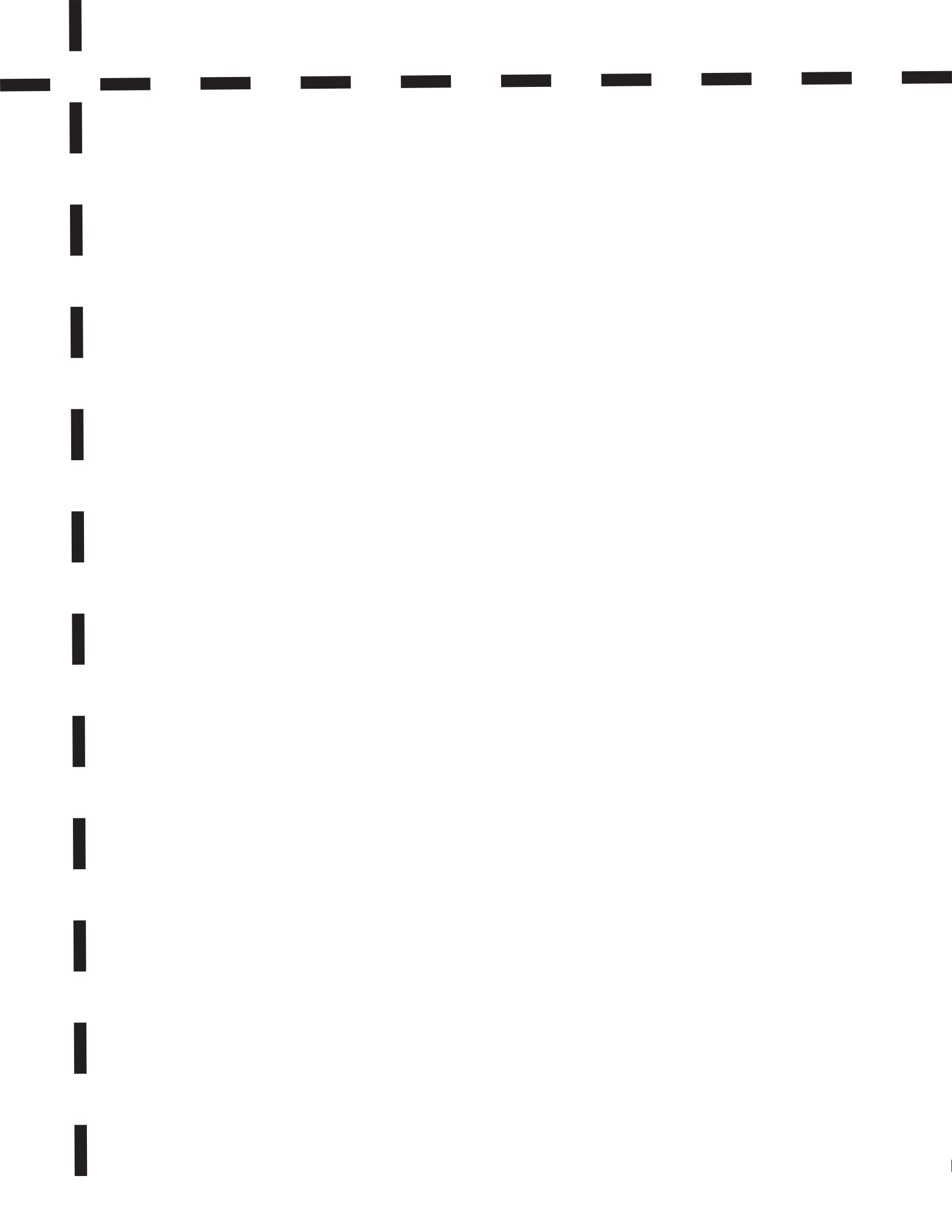
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This thesis explores the question of how kinetic architecture can promote learning in the general public. The typology that is being examined is a kinetic laboratory. The Theoretical Premise /Unifying Idea guiding research is, “as the technology and experimentation processes change it is necessary for a building to change through the use of kinetic architecture.” The Project Justification is, “as the technology and experimentation processes change there is a need for the spaces that these processes occur in to change as well.”

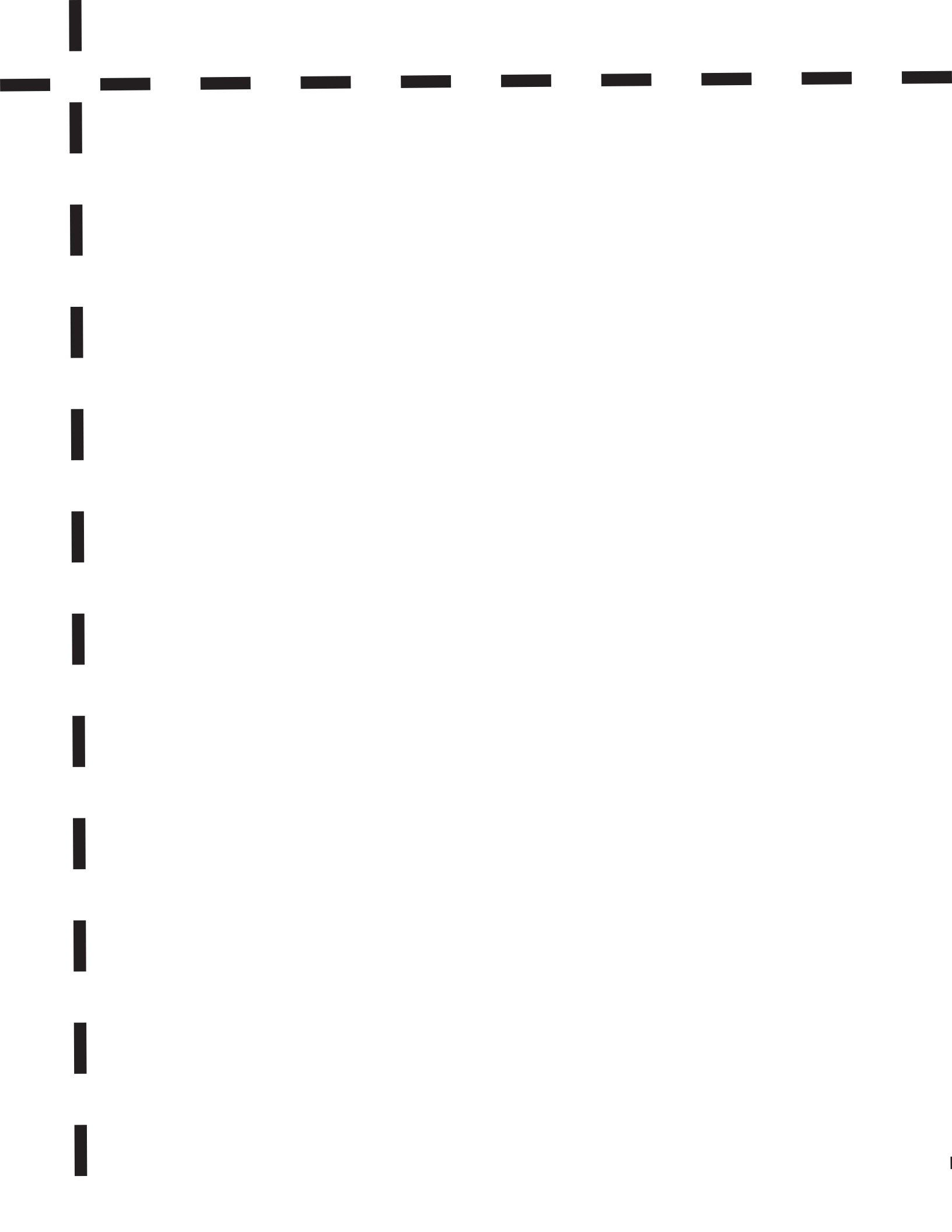
The building will be part of the North Dakota State University Research and Technology Park located in Fargo, North Dakota. The square footage needed to complete this project is 28,800 sq. ft.

Abstract Key Words:
Laboratory, Kinetic Architecture,
Learning



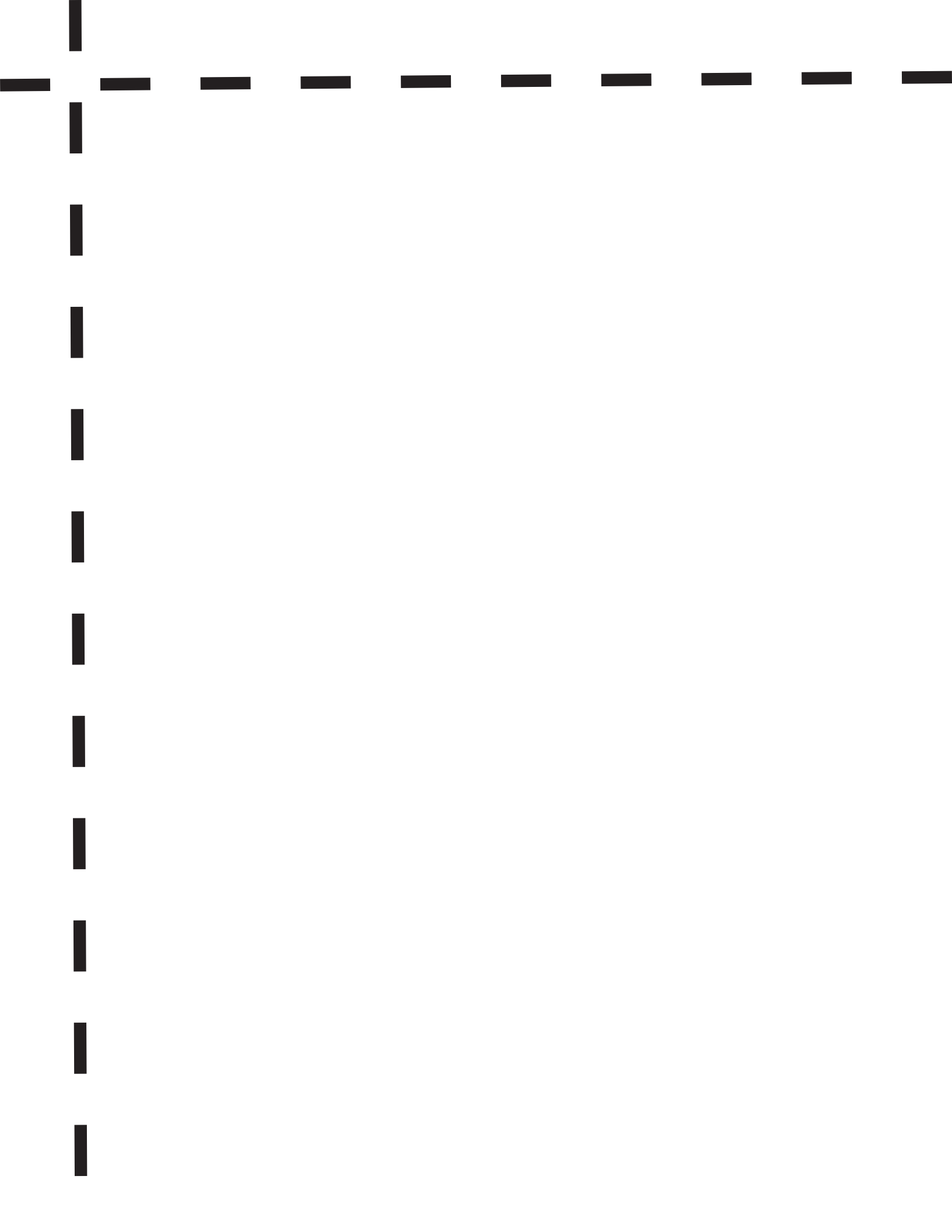
The Problem Statement

Can kinetic architecture help promote the development of scientific knowledge in the general public?





The Statement of Intent



Statement of Intent

Typology: Kinetic Laboratory

The Theoretical Premise/Unifying Idea:

The Claim:

Kinetic architecture provides a new medium in which to promote learning in the general public.

The Premises:

Kinetic architecture is the ability for a structure to change in order to create new spaces and serve new purposes.

An interest in learning is important to the furthering of ideas about the technology that is available to the world today and in the future.

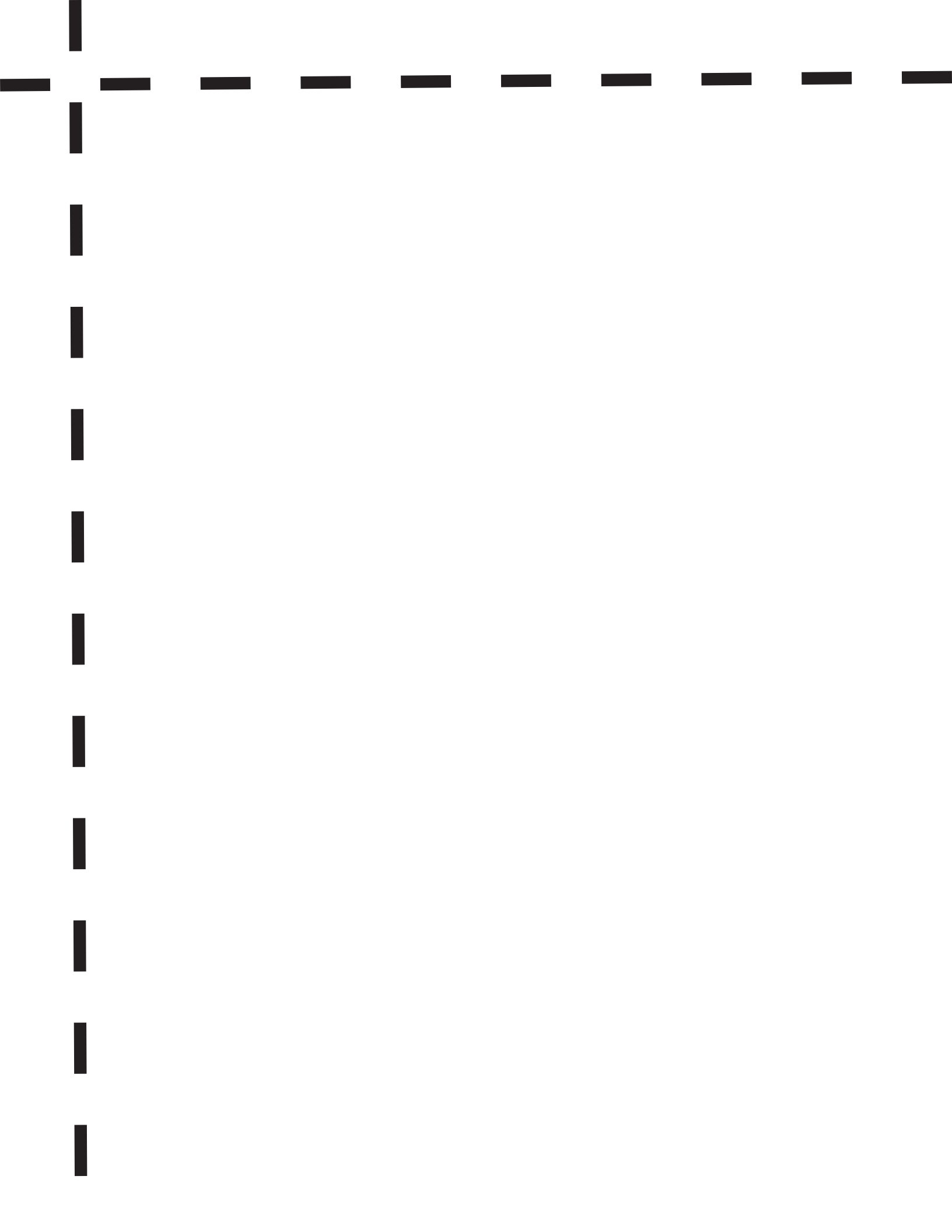
The general public interacts with the end products of the experimentation that occurs within these structures.

The Theoretical Premise/Unifying Idea:

As the technology and experimentation processes change it is necessary for a building to change through the use of kinetic architecture.

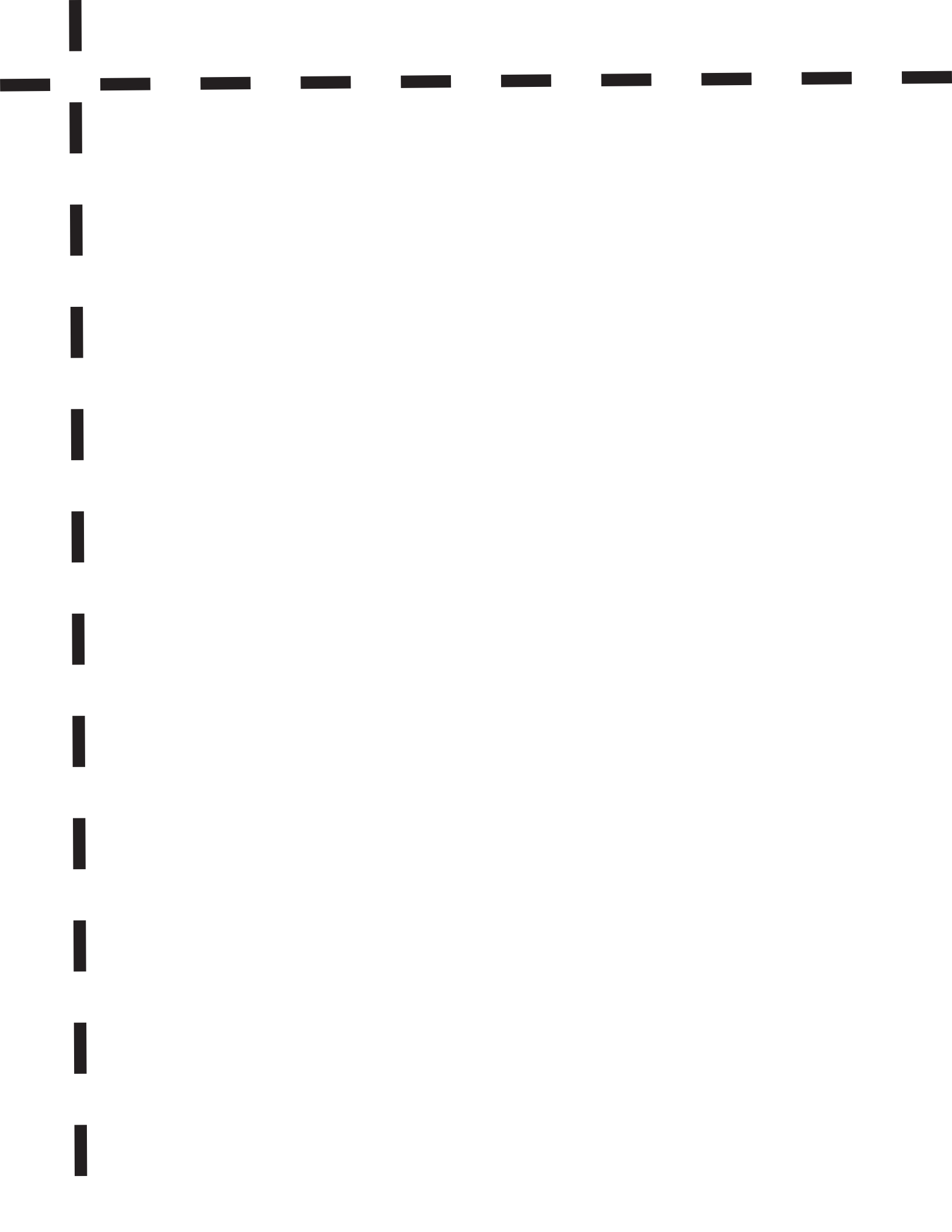
The Project Justification:

As the technology and experimentation processes change there is a need for the spaces that these processes occur in to change as well.





The Proposal

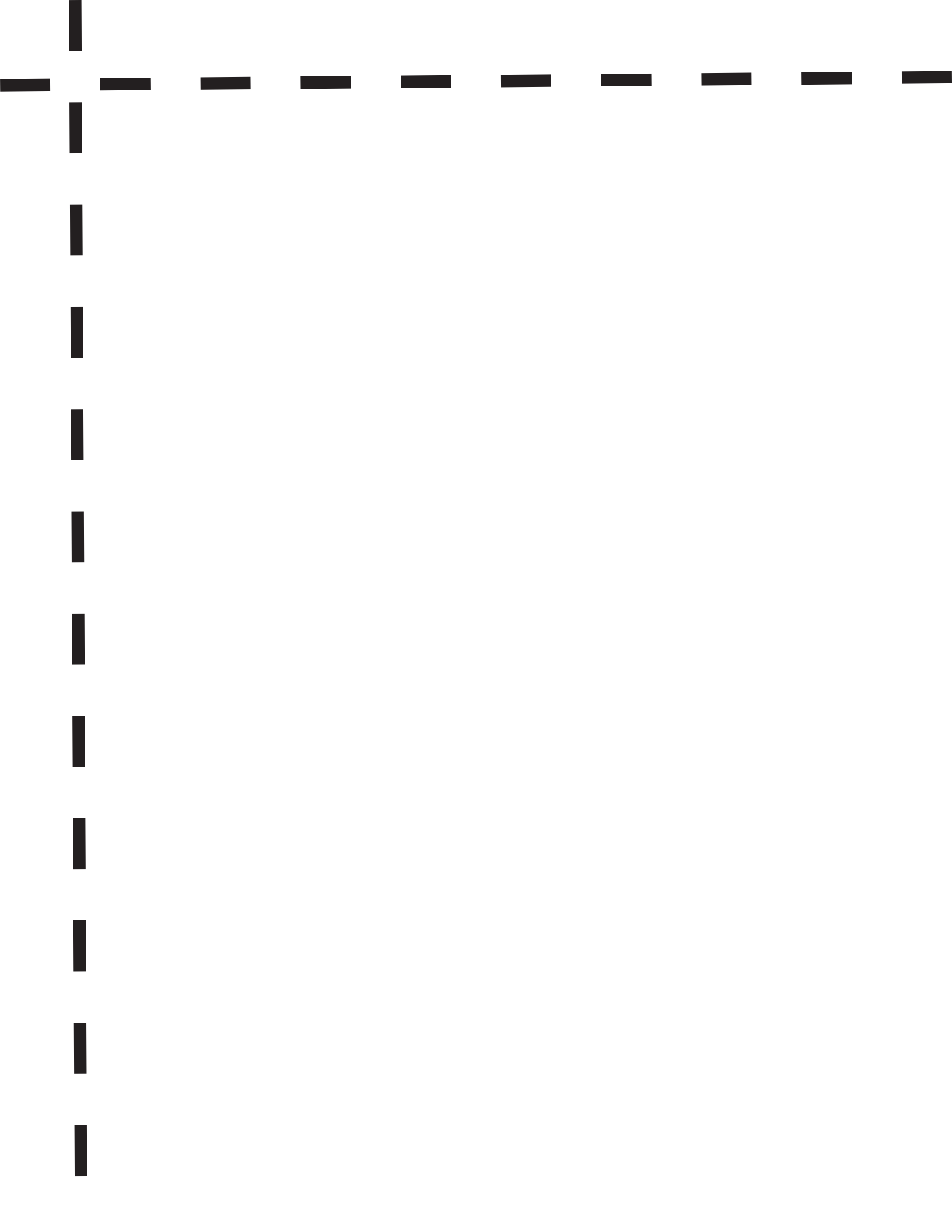


Narrative

This thesis looks at the question of how kinetic architecture is able to promote learning in the general public. The typology that is being examined is a kinetic laboratory. The Theoretical Premise /Unifying Idea guiding research is, “as the technology and experimentation processes change it is necessary for a building to change through the use of kinetic architecture.” The Project Justification is, “as the technology and experimentation processes change there is a need for the spaces that these processes occur in to change as well.”

Our buildings today need to be able to change and embrace changes that occur within the building. The idea that a building can be designed to change with little or no construction is one that I believe should be challenged.

Science is one area that is rapidly changing and the techniques used are changing as well. Scientific exploration allows society to move forward and create a new and better future.



User/Client Description

User:

This project is designed to be used by scientists and engineers for research. It is also designed to be visited by groups, either scientific or educational.

There would be a varying number of scientists and engineers who would be employed based on the needs of the facility at that time. The building would be used the most during daytime working hours.

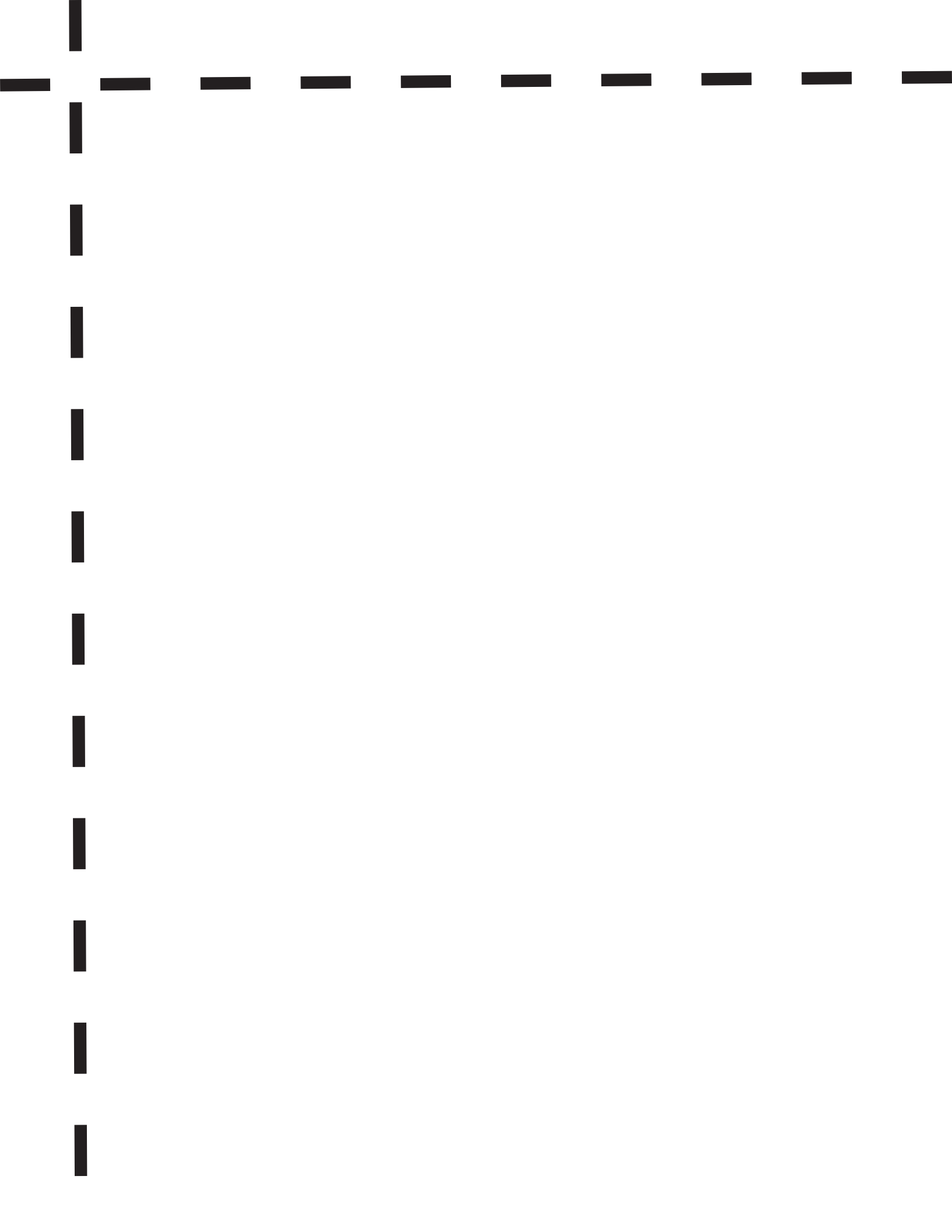
The main users would be scientists and researchers. They would consist of researchers, faculty from the college, as well as graduate students and engineers. It would provide jobs for the many graduate students at the university.

There are a number of issues that need to be considered when it comes to parking at the facility. Two types of parking are needed at the facility, parking for the staff as well as for visitors which could include buses.

The technical and experimental nature of the work that is performed here needs to be addressed within the building.

Client:

The client would be North Dakota State University and it would be part of the science and engineering departments.



Major Project Elements

Laboratories

Spaces for performing experiments and research. Requires specialized equipment and procedures.

Offices

Used for individual research and individual meetings.

Reception

Space for clients and groups to meet and wait. Contains a reception desk and seating.

Presentation Spaces

Space for holding large group meetings and presenting new findings to the public and other interested parties.

Administration Space

Space for accounting, filing and other paperwork functions of the building.

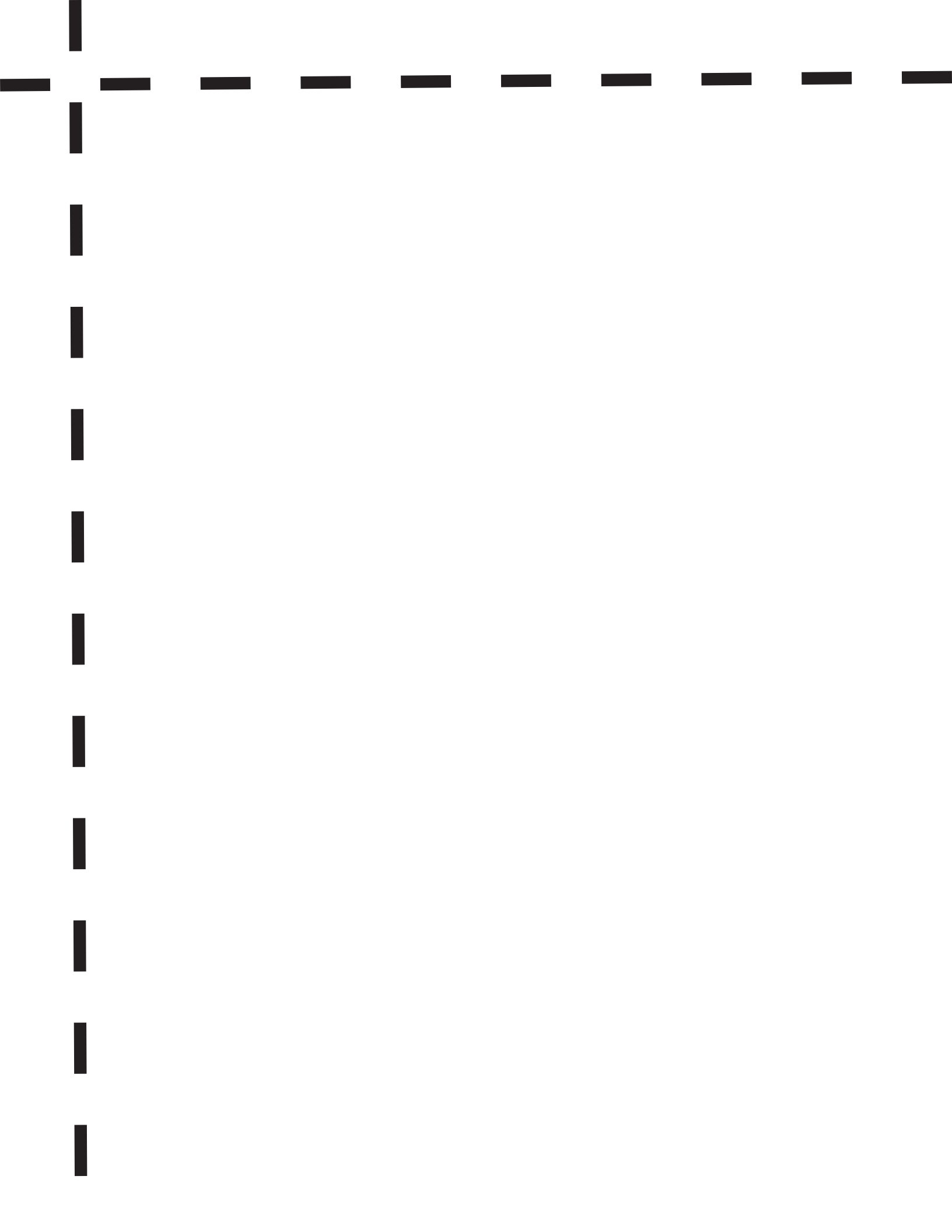
Storage

Mechanical Spaces

Restrooms

Kitchen/Breakroom

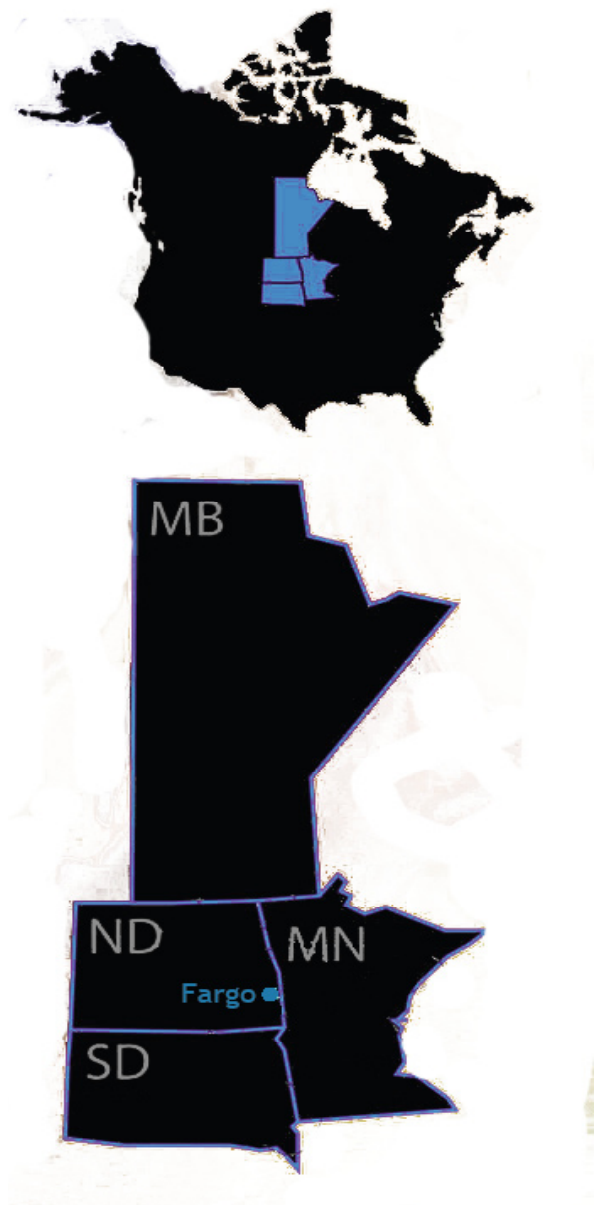
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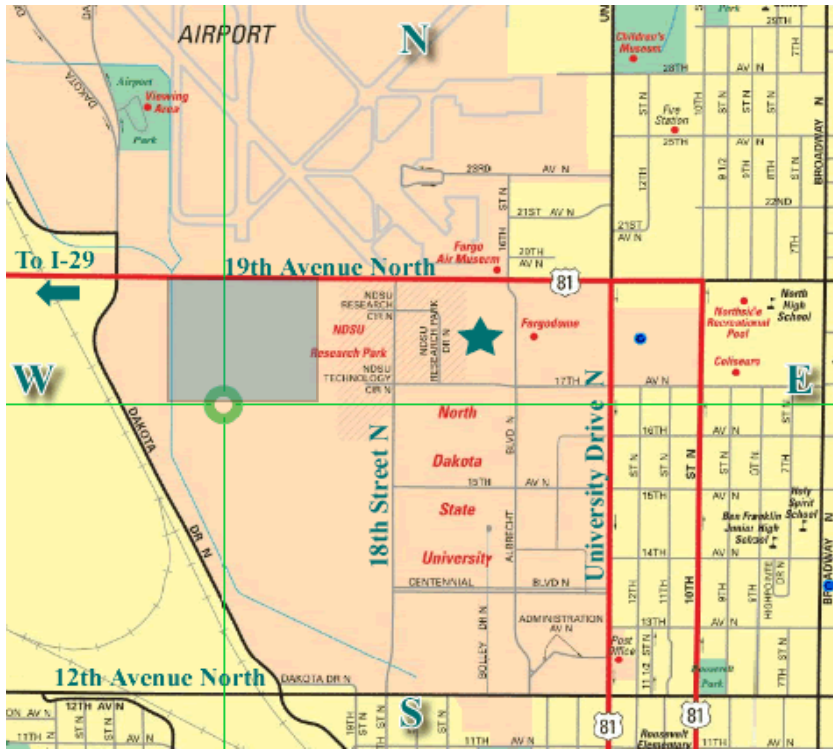


The site for which this project will be designed is in the North Dakota State University Research and Technology Park. The site is north of the Phoenix International building.

This is an ideal place because of its adjacency to the university and other businesses.

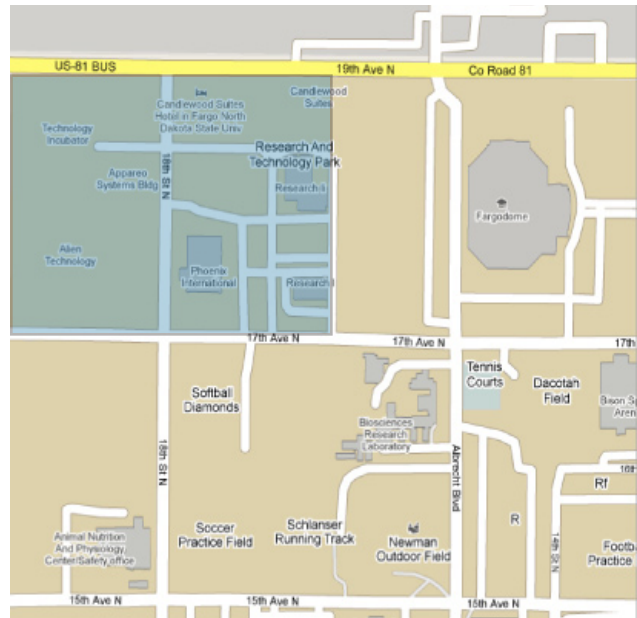
Site Information Region





Site Information City

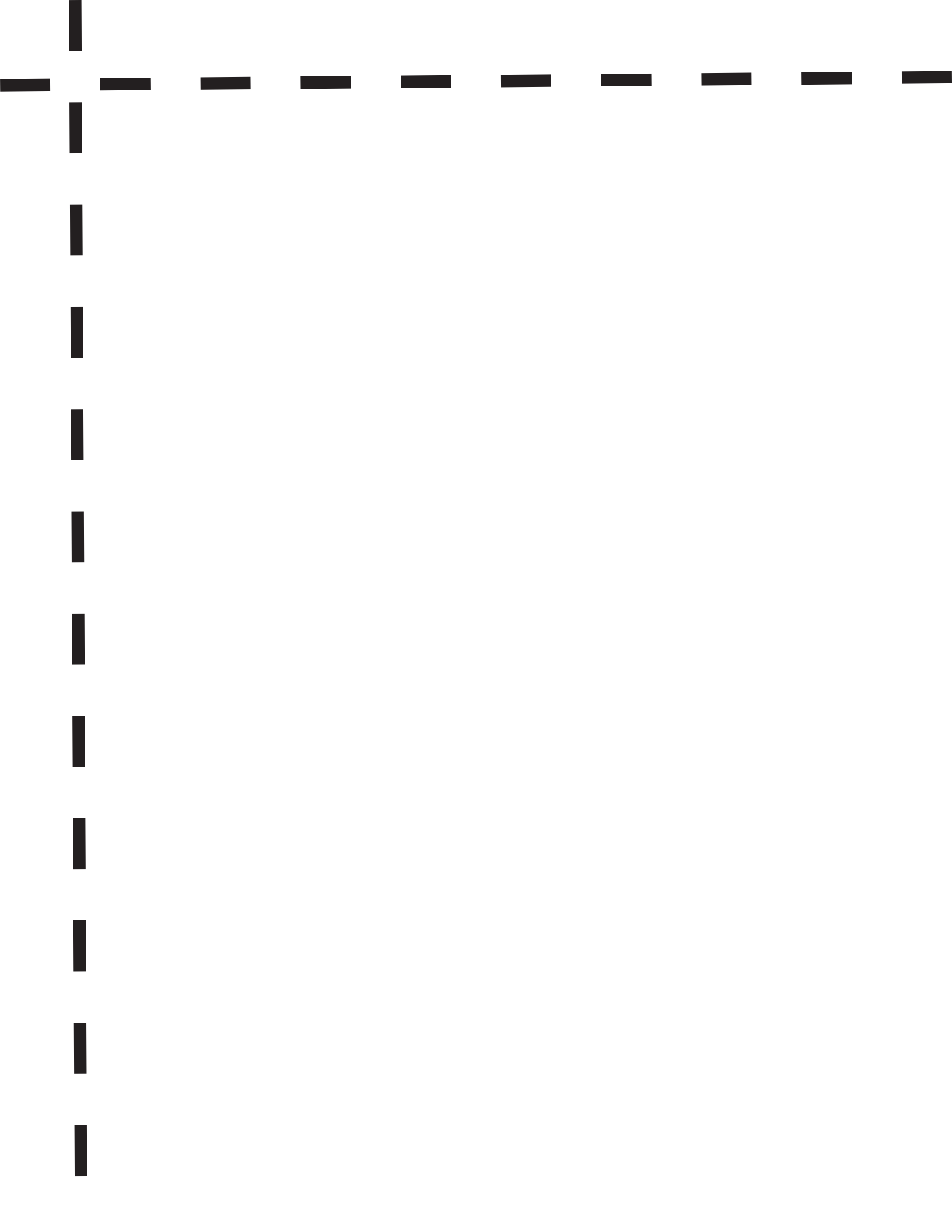




The site is important to the growth of the community and the growth of the Red River Valley Research Corridor. It will continue to help bring more high tech industries to the Red River Valley and North Dakota.

Site Information Site





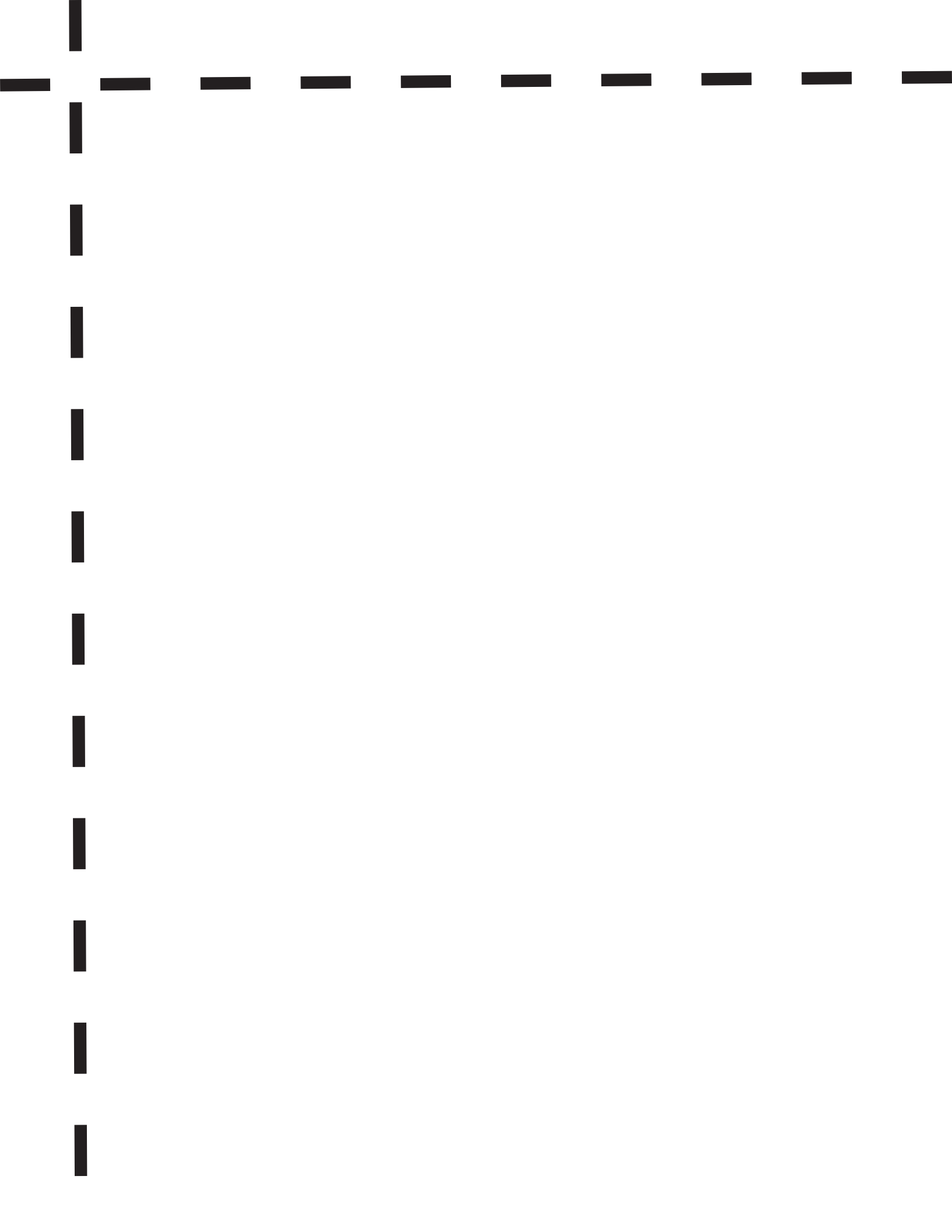
Project Emphasis

Adaptation

A building that can adapt to changes in function is key to keeping it functional for future generations.

Technological Advancements

Technology is always changing, as are the processes in which research is conducted.

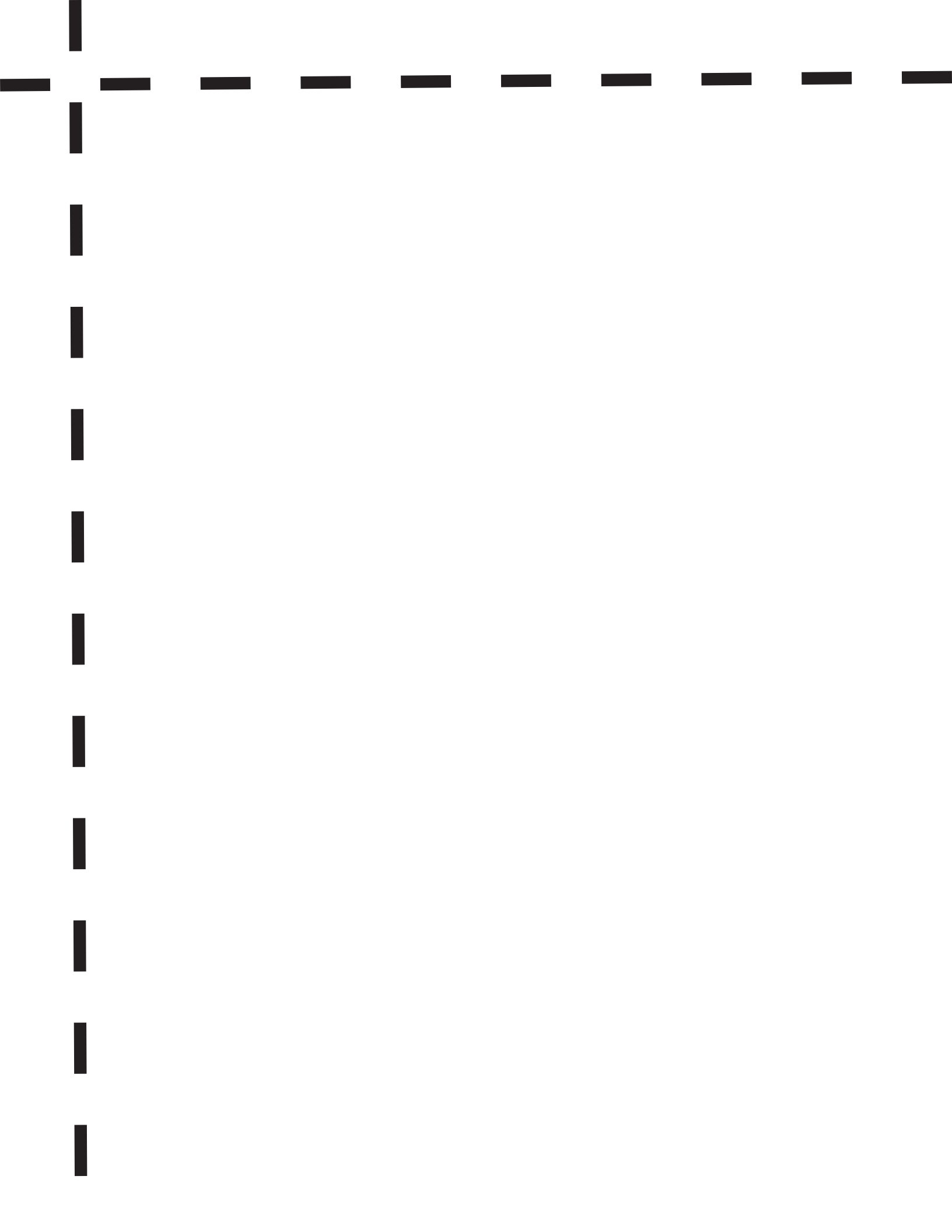


The Unifying Idea will be the guiding element for the research. A mixed method of design methodology will be used to in the following areas of research:

- Theoretical Premise/ Unifying Idea
- Project Typology
- Historical Context
- Site Analysis
- Programmatic Requirements

A concurrent transformative strategy will be used in the gathering of information of both the qualitative and quantitative nature. Integration of the data collected will be every two weeks and when deemed necessary. Qualitative research will be gathered from observation, local data, archival research, and direct interviews. Quantitative research will include data of both scientific and statistical means. The design process will be documented through the use of photography, models, digital drawings, and scanned images or sketches.

A Plan for Proceeding



Previous Studio Experience

Second Year

Fall 2006

Instructor: Joan Vorderbruggen

Tea House

Boat house

Mountain Dwelling

Spring 2007

Instructor: Darryl Booker

Prairie Dance Academy

Montessori School

Third Year

Fall 2007

Instructor: Steve Martens

Extreme Environment School

Out Patient Medical Center - Duluth, MN

Spring 2008

Instructor: Ron Ramsey

88 West Parkway - Chicago, IL

Downtown Redevelopment - Fargo, ND

Forth Year

Fall 2008

Instructor: Don Faulkner

Vertical High Rise - San Francisco, CA

Spring 2009

Instructor: Darryl Booker

Santa Domingo Redevelopment

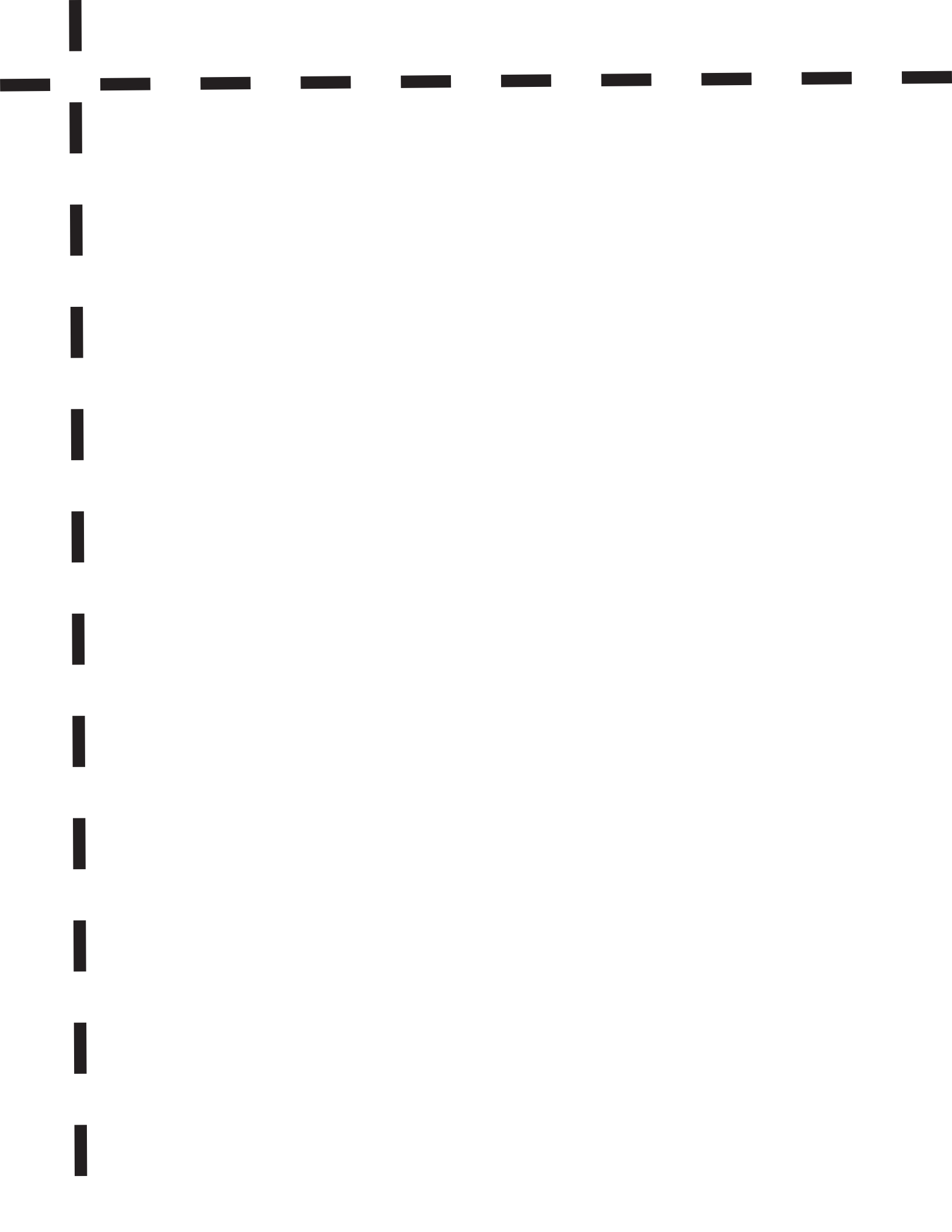
Marvin Windows Competition

Fifth Year

Fall 2009

Instructor: Mark Barnhouse

Water Resource Center - Linton, ND





The Program Document

Biomimicry and Innovation

A stronger kinetic architecture can be achieved through research and innovation based upon investigations into biomimicry. How we design and construct buildings can be aided by research into spider silk and the mussel. They both provide unique attributes which could change the way in which we think about materials.

Spider silk is a marvel of nature, having been created as a composite, millions of years prior to our attempts to create such a material. The spider has the ability to create six kinds of silk, one of which is drag line. This drag line is created from a protein that can self align into a fiber. “Compared ounce to ounce with steel, dragline silk is still five times stronger, and compared to Kevlar it’s much tougher - able to absorb five times the impact force without breaking”(Benyus, 2002, 137). Creating a material of this strength and durability could have a number of applications within the building community; tensile structures could become more elaborate and lighter weight in the design.

The process creating such a material is highly complex and the closest thing that we have created today is Kevlar; the process which involves “pouring petroleum derived molecules into a pressurized vat of concentrated sulfuric acid and boil it at several hundred degrees Fahrenheit in order to force it into a liquid crystal form. We then subject it to high pressures to force the crystals into alignment as we draw them out. The energy input is extreme and the toxic byproducts as odious” (Benyus, 2002, 137).

Results from the Theoretical Premise/ Unifying Idea Research

Biomimicry and Innovation

The idea that something as small as a spider can do this in the confines of its own body while we have yet to create a space that small to create a similar product compels us to study the spider and the silk that it produces in order to gain a better understanding of how it is created and how it can be used in the designs of the future.

Another creature that we can use as a source of inquiry and exploration is the mussel and the adhesive that is used to create the bond that holds the mussel to a rock or any other underwater surface. There currently is not an adhesive on the market that can provide the underwater stability that the mussel has at its disposal. By researching the composition of the adhesive that is used by the mussel and the process by which it is applied, we can find a better way to seal our buildings in the adverse climates in which we live. “We have to add not only an inhibitor to get things going and a catalyst to speed things up but also a separate cross-linking chemical” (Benyus, 2002, 124).

The ability to create this in one simple step as the mussel does is still a dream for researchers today; this is a point of great research for the future of design and the materials that we use. All throughout the process of adhering to a surface the mussel brings out design marvels that are still wonders to us today.

There is a great deal of research that can be done in this area to allow us to create better materials as well as to create better processes for making these materials. This will create better buildings and more innovative structures in the creation of modern designs.

Morphology

Morphology can be described as “the study of the forms observable in static and mobile art”(Munro, 1970, 3). It can also be described in terms of “the elements, details, parts, materials, images, ideas, or other ingredients involved; and the ways in which these are interrelated” (pg 3). To look at a building in terms of the morphology of a design can provide a new approach in which to analyze and quantify a design.

Taking time to analyze the individual pieces of a building and their relationship to the whole allows for a better understanding of the design as a whole and the impact that it has on the whole. There are aesthetic forms: in which there are multiple dimensions of concrete forms; the static form, the mobile form, and the performance. Each of these can be applied to the built form; the static object is a general built structure with fixed parts and no moving parts. This could be described as your basic built form in which the building is analyzed for how it is designed and how it is constructed.

The second dimension is the mobile form, in which portions of a built form function to provide other parts and create a simple action. This could be part of a building where there is an automated sunshade, which once installed only needs to be maintained and which will function on its own. It tends to be simple functions that allow for continuous visual animation.

Results from the Theoretical Premise/ Unifying Idea Research

Morphology

The third dimension is the performance; this can be looked at as a structure in which there are multiple functioning parts that are serving multiple purposes. These can be parts such as a panel that works as a sunshade in the day and is able to be closed to reduce heat loss at night. This could also be done through illumination of a surface, and providing changes in the levels which are achieved.

There are a number of factors that can be integrated into a design. One of these is Kinesthetics, which includes “effort; tension; relaxation; impulse; inhibition, direction, balance, strength, weakness, fatigue, rhythm, velocity, intensity, extensity, duration, texture, definiteness, change” (Munro, 1970, 93). The use of these qualities allows structures to express these ideas in a way that allows an observer to experience the building in a new way on several occasions as well as providing the same experiences to the occupants.

Morphology is important to design, with its ability to allow us to analyze that which is encountered daily. In doing this a level of analysis is reached that is objective and not subjective to the ideas and mindset of the observer. By incorporating these aspects into designs, it is possible to create objects and spaces that are cohesive in form and dynamic in design.

What it means to Research?

Research can be thought of as a job but for many it is more than that, it is their life. The sole goal is to find the answers to questions. Research is a number of things: it is teamwork, a global phenomenon, and competition. Each of these bring individual characteristics to the ability to research and the results that are produced.

Research is teamwork because more than one individual is necessary for progress. It can be described this way: “every scientist deals with projects partly alone, partly in collaboration with others” (Braun, 2005, 10). Teamwork provides a structure in which research and collaboration take place. Research is not only for the formation of new ideas and experimentation but for global unity with a central goal of producing knowledge.

There is a global phenomenon in the perseverance of knowledge attainment. Being the leading innovators in technology and design is a goal for many. Research that is done does not benefit just one but benefits everyone. Knowledge is not confined to a single country or region but is generally available to all through the use of the internet and other sources.

Research can be looked at as a worldwide competition, not for resources or other materials but for knowledge, the knowledge that can improve the quality of life for many. Competition fosters rivalry between researchers and the work they produce. This leads to many different approaches and many different results.

Results from the Theoretical Premise/Unifying Idea Research

What it means to Research?

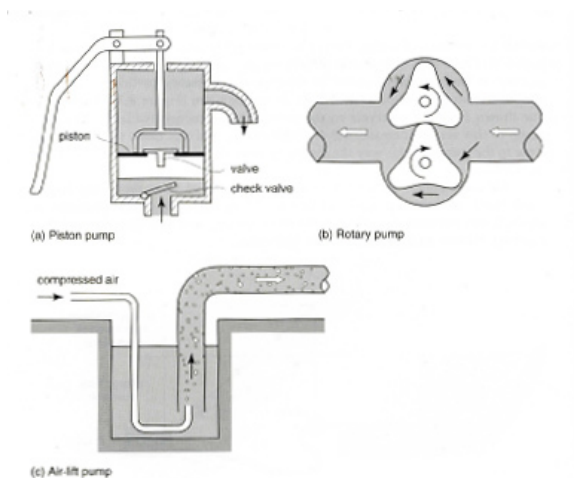
Research is fostered most in an environment in which trust and openness are abundant. This provides for the easy exchange of ideas. This can influence the way in which an environment created within the building should be composed. Providing a place that fosters ideas and the exchange of ideas is crucial to the exploration and innovation that comes through research.

“If they are able to pursue this job in a pleasant and functional research facility that recognizes the communicative and playful aspects of research they can count themselves among the happiest professions within our society” (Braun, 2005, 10).

Research is not for the present but for the future, and buildings need to be designed with this in mind, allowing for change to affect how things are researched and how experimentation is done. This means that there needs to be a focus on the future not only in research but also in the facilities that house it.

Hydraulics

A focus within the field of hydraulics is that of the hydraulic pump. There are two major types of pumps, the positive displacement pump and the roto-dynamic. The typical examples of a positive displacement pump are “the piston pump, rotary pump, air-lift pump, and the Archimedean screw”(Kay, 1998, 218). All of these have characteristics that make them pertinent to different fluids and forces.



The piston pump is one of the easiest understood of the hydraulic pumps. It is, to put it simply, “a piston (that) moves up and down in a cylinder”(Kay, 1998, 219). It works through the up and down motion of a lever. The piston rises within the chamber when the lever is pushed down which causes the fluid to be drawn into the chamber through a non return valve. As the lever is pulled up the fluid is then forced through another valve on to the top side of the piston and discharged.

Results from the Theoretical Premise/Unifying Idea Research

The Burj Dubai is an example of the advancements of hydraulic pumps. The main structure of the building is cast in place concrete, having been pumped up to a height of 1900 feet, creating a new record height. This involved using a large pump developed by Putzmeister to handle the new heights that needed to be reached to complete this building. This means that buildings of the future can be taller and still have the stability and other economies that come with concrete cores and structures.

The advancements in hydraulics and the development of new applications are allowing for structures to advance and be built taller and stronger than in the past. The ability to pump concrete higher allows concrete cores and floor plates to be built to ever increasing heights.

Hydraulics

Summary

Research brings together those things that seem to be distant through allowing for a deeper look to be taken into each of their individual qualities and the effects that they can have on each other.

Biomimicry can provide for new technology and innovation for the future. It is important to allow nature to influence and provide a basis for the research that is being done. This potential new knowledge can be applied to the materials and ways in which buildings are constructed. Two examples are the spider and the mussel. The spider and the silk that it creates is stronger than steel and could have many possible applications in design today. The same goes for the adhesive that is created by the mussel to hold it to underwater surfaces. The applications of materials that could be created in result of research of of these two creatures are endless.

Morphology is a way in which to describe and analyze art. Architecture can be described in these same terms, in its three dimensions of static, mobile and performance forms. The ability to analyze a building through the the elements and properties of morphology allows for a standard by which to measure a design and properties by which to create a unified whole in design. This is important to architecture because a link is formed between the form and order which is integral to great design and how it is perceived by the general public.

Results from the Theoretical Premise/ Unifying Idea Research

Research is important to those who see it as their life's goal as well as to the general population who gets to see the benefits implemented into everyday life. It is about teamwork and the rivalries that are created that provide the desire to learn and discover. It is a phenomenon that is encompassing the globe; the attainment of knowledge is not for the benefit of one but for the whole world.

Hydraulics is a field in which many advancements are being made in the capacity and the power that is available. This is made apparent in the creation of the Burj Dubai, which is the highest that pumped concrete has reached at a height of 1900 feet. In this advancement the ability to build taller and stronger is a possibility of the future.

Summary

Each aspect is individual in theory but they work together to create a common goal of improving the future and the world and structures that will be part of it.

Schlumberger Cambridge Research Center

Architect: Micheal Hopkins and Partners

Project Type: Research Center

Location: Cambridge, UK

Year: Phase 1: 1988; Phase 2: 1992

The Schlumberger Cambridge Research Center has a very modern and high tech design which used almost entirely prefabricated parts in its construction. This complex contains two major buildings: a reception building and a test station building. The test station building is designed as two major elements; there are two linear office/laboratory structures and the tensile structure that joins them. The cable structure that creates the adjoining space houses a pit drilling station and a winter garden.

Case Study Research



The research center houses a number of different functions, including laboratory space, office space, and additional supporting spaces. The laboratory/office wings house a series of laboratories, including a rock physics lab, drilling mechanics lab, fluid mechanics lab, and a wellbore physics lab. Each of the laboratories are on the inner portion of the double loaded corridors and are opposite the researchers' and scientists' offices.

Schlumberger Cambridge Research Center



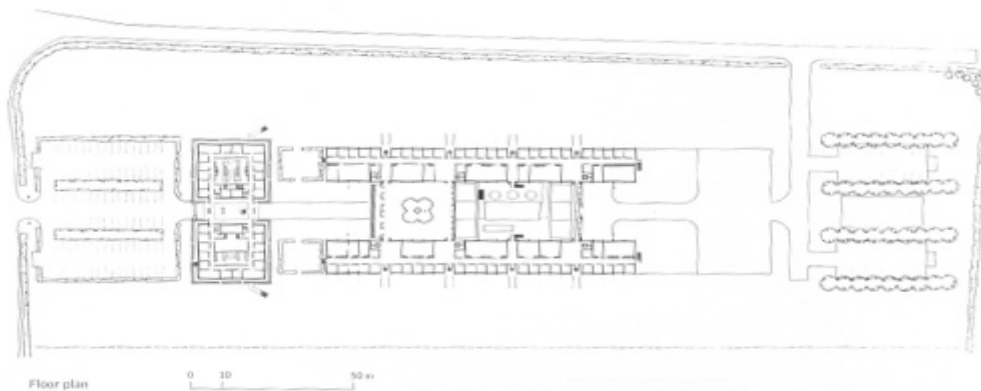
The office structures are set on a 3.9m module; within which there are a series of supports from which the roof is suspended.

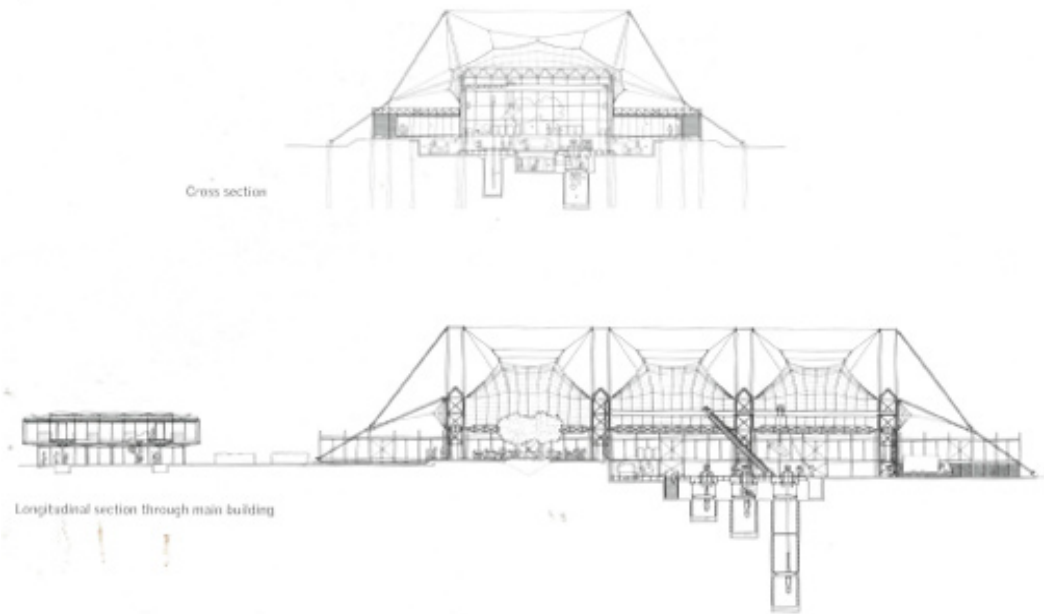
A goal in this facility was to provide for social interaction among the scientists. This is done through the winter garden space, providing this point for interaction through the movement between the different laboratory wings.

The center can be thought of as two independent operating structures, one of the membrane roof system and a second in the office/labratory blocks. These blocks are constructed of prefabricated parts, creating an extoskeleton that is visible only on the exterior. These structural members are set on a 3.6x14m grid. This allows for easy expansion of these portions of the building. Meanwhile, the structure that holds the tension roof in place is completely seperate and self-supporting.



Case Study Research





Schlumberger Cambridge Research Center

Natural light is abundant in the extensive use of glazing, and the membrane of the tension roof allows for a highly diffuse light to filter into the spaces below.

The building can be perceived as two separate masses serving different functions, one mass of the block structures and a second of the tension structure.

The division of space and the volumes are read clearly in the section in relationship to the spaces in the plan.

Circulation is central in the block elements and through portions of the central tension structure. This circulation creates and promotes conversation among all groups within the facility.

The unifying idea is better understood through the ability to promote the linking and growth across all fields.

Falkirk Wheel

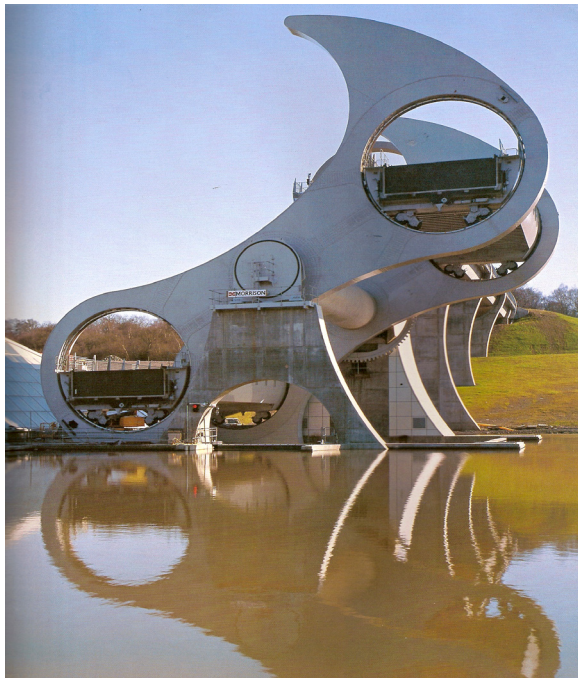
Architect: RMJM

Project Type: Lock and Dam

Location: Falkirk, Scotland

Year: 2002

The Falkirk Wheel is a rotating boat lift that is the first of its kind. It was created to join the Forth & Clyde canal with the Union canal in one simple step, which had previously been connected through a series of 11 locks over a distance of a mile. The Falkirk Wheel has the ability to seamlessly transfer two boats in each direction of the 115 ft elevation change in as little as 15 minutes.



Case Study Research

The Falkirk Wheel allows for free movement between Edinburgh and Glasgow for the first time in more than 70 years, allowing for full travel of the waterways between east and west Scotland.



Falkirk Wheel

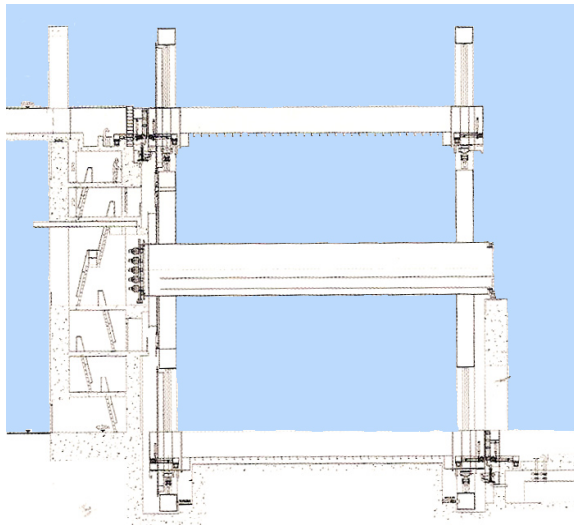
The design is based upon a rotating beam, not a wheel as would be generally assumed. It is instead based upon a contemporary form of a classic stone and brick aquaduct form. Two cassions are supported by a series of reinforced concrete piers. The cassions remain stable through the use of gears that allow it to rotate along with the wheel. The wheel itself is driven by a series of eight hydraulics which are attached to the last of the supports of the upper portion of the lock.

The structural supports are reinforced concrete and along with many steel components create the whole assembly.

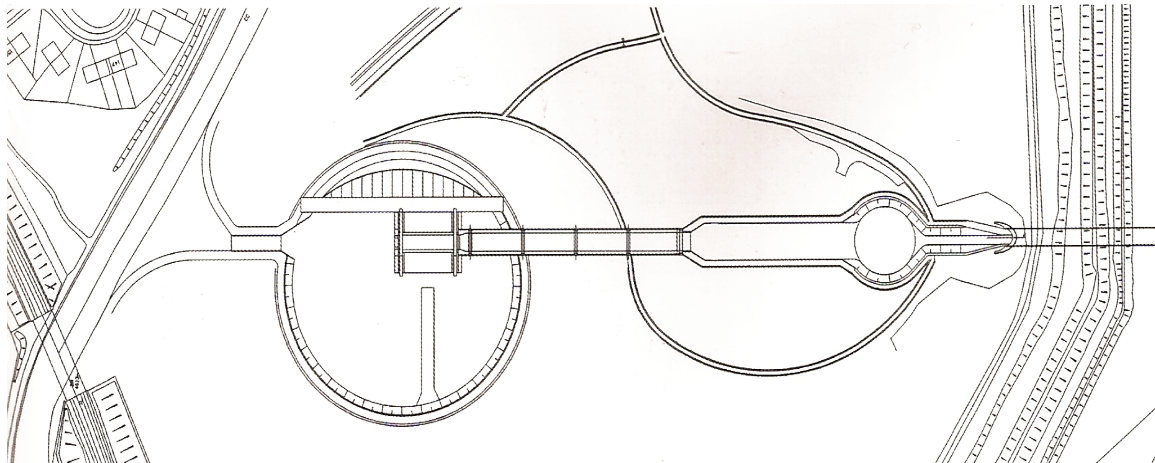
Natural light is visible in all aspects of this structure. It plays an important role in the approach from both the upper and lower portions; through the concrete arches that form the entry to the upper portion of the lock, it casts a shadow upon the water.

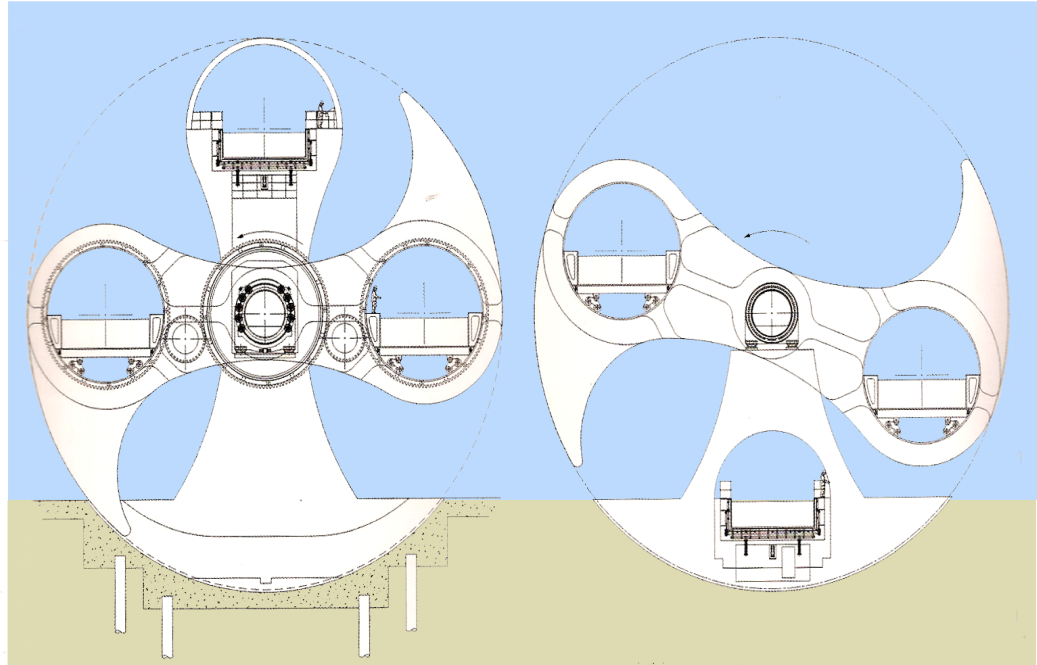
The massing of this structure is very slender in relation to its function. It is designed as a series of vertical and horizontal elements. These horizontal elements express movement in a horizontal direction, while the vertical elements express a circular movement.

In plan this structure is very linear, while in section the structure expresses the circular natural of the function which it is designed to perform.



Case Study Research





Falkirk Wheel

Much of this structure is designed with the underlying shape of a circle. This is based upon the movement which is required of the structure.

The structure is symmetrical on multiple dimensions. It is symmetrical when in motion through the equal and opposite reactions that occur; as one ascends; the other descends following the same but opposite pathway.

This structure adds to the knowledge base of the Unifying Idea through the process that the Falkirk Wheel functions with very little noise and visible means of movement generation. This creates an element of interest in the way it functions and the way that power is generated.

NOAA Satellite Operation Facility

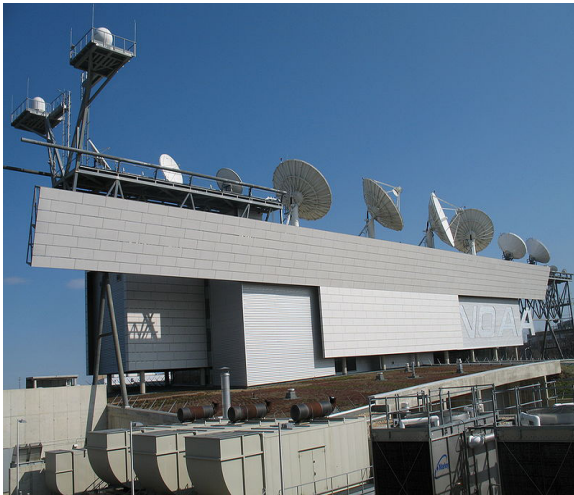
Architect: Morphosis

Project Type: Satellite Control Center

Location: Suitland, Maryland

Year: 2005

The satellite operation facility has a number of very distinct features, one of which is a series of 16 satellites that are located on the roof and manned through an electronic system housed inside the building. Images captured by these satellites have been integrated into the interior of the facility. This created a relation between the form and the function in which it serves.



Case Study Research

The facility contains: office space, computer rooms, satellite control center, and a conference center and rooms. There is also a café that has the capacity to run 24 hours a day, seven day a week, due to the nature of the work that is done in the facility. The building is designed to be occupied at all times.

NOAA Satellite Operation Facility

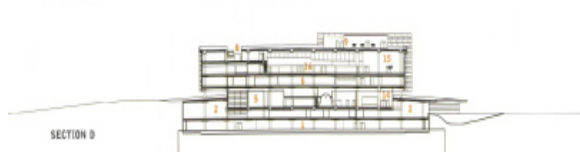


The building was designed to prioritize open space. Integration into the landscape allowed for the reduction of the facility's built forms' impact on the site. This is done through a large green roof on the lower portion of the building.

The building is classified into two separate elements: the lower portion which is referred to as the body, and the upper portion which is the brain. The brain houses the control center for the satellites that are located on the roof, while the body houses the offices and support spaces.

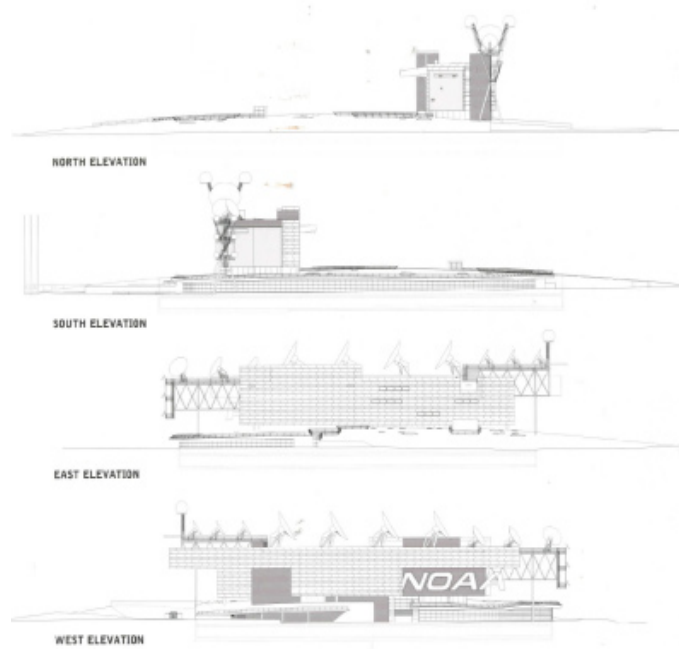
The ability for natural light to penetrate portions of this building is difficult due to the integration into the landscape. Portions of the building receive natural light, mainly the upper portion and the entry lobby.

The plan further expresses the two-part design, which is reinforced with the section. This also shows the relationship between the major element, the satellites, and the building as a whole. This is important to both the function of the facility and the cohesiveness of the design. The section also shows the integration into the site and how it minimized the visual impact of the building on the site.



Case Study Research





NOAA Satellite Operation Facility

Circulation is integrated into the spaces through the use of open office spaces within the lower portions of the building. In contrast, circulation is very limited within the computer control spaces of the upper portions of the building.

The building is created as a composition of rectilinear and circular forms. The rectilinear forms are present in vertical planes, while those of a circular nature are horizontal in plan. The combination of the two creates a seamless composition of the two geometric elements.

As a building, this facility brings the knowledge and ideas of how to deal with the highly functioning components, and the ability to do so while also allowing for integration in to the environment.

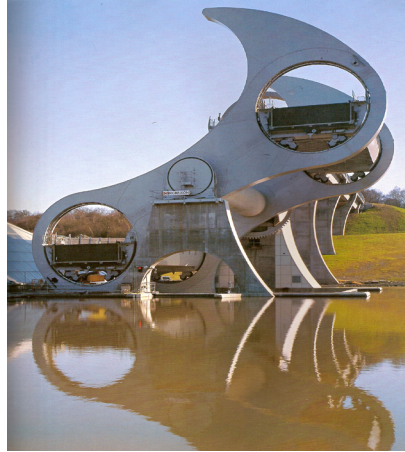
Case Study Summary

Each of the case studies examined provided a different aspect which had its own dynamic function. The Schlumberger Cambridge Research Center is dynamic in the tensile structure that is the roof for a major portion of the facility. The movement of the Falkirk Wheel is extreme in terms of the dynamic functions that can be achieved. The NOAA Satellite Operation Facility is a blend between the two with functioning portions that allow the structure to further express its purpose.

Each had a different type of site that each building responded to in a different way. The NOAA Satellite Operation Facility embraced the relatively flat site in which it is situated to allow the lower portions to spread out and become the home to a green roof, thus invading the site but then returning a portion to it in the application of the green roof. The Falkirk Wheel addresses the differences of the elevation across the site by having the function of the structure provide the link between the extremes.

Case Study Research





Case Study Summary

The technical aspects required for each of the case studies to function properly are extreme. The Schlumberger Cambridge Research Center has a number of varied functioning laboratories that are each individual in their needs of materials, electricity and other resources. The technology that is required for the Falkirk Wheel to function is technical because each part needs to start and stop in sync to keep all elements stable and prevent disastrous results occurring. Finally, the technical aspects required in the operation of the NOAA Satellite Operation Facility are the most important to the proper function of the facility, allowing the satellites to serve the purpose in which they were designed.

Although there are many different issues that arise between each of the cases, there is still a level of unity in that they all reflect characteristics of kinesthetics. This linking factor brings the cases together with a common goal of providing this quality.

Laboratory Facilities

Research has been part of life since the beginning; there has always been the desire to know more and be better. As a society we strive to be better, and we need to create spaces that promote this within the creation of the facility. By doing this a facility can adapt to the changes that are not yet necessary in the laboratory for experimentation.

Laboratory facilities were found throughout history. They are found “in Alexandria in the third and fourth centuries A.D., but probably had its origins some centuries earlier in the chemical industry which had sprung up in the Mediterranean” (Nuffield Foundation, 1961, 1). In Sicily, King Frederick II established “a school of practical anatomy, and subsequently an anatomical school” (Nuffield Foundation, 1961, 1). In the following centuries many more schools of scientific methods were created throughout the world.

Andreas Libavius deemed the conditions that were found in many laboratories of the time Andreas Libavius deemed unworkable. In order to fix these standards, “he published a project for a complete chemical institute, which is of particular interest as the earliest record of laboratory planning” (Nuffield Foundation, 1961, 1).

With interest in the sciences growing in Britain, “Thomas Thompson, Professor of Chemistry at the University of Glasgow, opened the first chemical laboratory that students could undertake their own practical work in 1824” (Nuffield Foundation, 1961, 7).

Historical Context

Historical Context

During the same time students in the United States were undertaking “their own experiments at Rensselaer Polytechnic Institute at Troy, New York and Massachusetts Institute of Technology in Boston” (Nuffield Foundation, 1961, 8).

There was a great number of advancements that had happened at the end of the seventeenth century. “The laboratories and lecture rooms of the Jardin du Rio (for the culture of medical plants) had been formally opened in 1640” (Nuffield Foundation, 1961, 1). There have been many milestones in the growth of the laboratory design, one of which was “the founding of the Royal Institute in 1799 with its theatre, model-room, and workshops” (Nuffield Foundation, 1961, 3).

In a look at a laboratory from the nineteenth century, “more and better-equipped laboratories came into use in the universities. Attention was beginning to be paid to ventilation and lighting” (Nuffield Foundation, 1961, 10). These advancements created spaces that were better and healthier for the occupants of the building.

At this point in time research that was being conducted in these facilities began to branch out. Industrial research was also beginning to emerge at this point, but would not come to full force until the end of the First World War.

History of Chemistry

Alchemy was one of the first undertakings of research. It was undertaken in many different regions of the world for a number of different reasons. It can be looked at from many different views, those of the Chinese, Greeks, Arabic and Medieval.

The alchemy that was undertaken by the Chinese, as early as the fourth century BC, became an important part of life. It also influenced many aspects of life and “the Taoist religion and philosophy devised by Lao Tzu and embodied his *Tao Te Ching*” (Brock, 1992, 6). Their main focus was to achieve a state of harmony and perfection between the body and the universe by creating elixirs, which allows immortality to be achieved.

As a result of this work, gunpowder and many other practical discoveries have been made based upon “preparing elixirs from substances rich in Yang, such as red-blooded cinnabar, gold and its salts, or jade” (Brock, 1992, 6). This was to adjust levels of Ying and Yang that was found within the body in order to create harmony and immortality.

Some of the characteristics of Chinese alchemy are “also found in Arabic alchemy, it seems highly probable that Arabic writers and experimentalists were ‘deeply influenced by Chinese ideas and discoveries’” (Brock, 1992, 7).

Historical Context

Greek alchemy dealt with the idea that all materials could be created from “a prime matter as featureless, quality-less stuff into which the various qualities and properties of hotness, coldness, dryness and moistness could be impressed to form the four elements that Empedocles had postulated in the fifth century BC” (Brock, 1992, 12).

At this point it was more than just the study of things on earth, “for Aristotle there was a fundamental distinction between the physics of the heavens and the sublunarsphere of the earth.” (Brock, 1992, 13). The earth was thought to be composed of the four elements of water, air, fire and earth, which are also the four elements proposed by Empedocles.

Historical Context

“Chemical compounds to the Greeks were mixtures of these four elements in varying proportions,” (Brock, 1992, 14) is a greatly understated in its actual perceived complexity at the time. As the central theory of alchemy of the time would allow it “could be seen in one of two ways, either as what we would call chemical change caused by the different proportions of elements and their rearrangement, or as a real transmutation in which the qualities of the elements are transformed” (Brock, 1992, 14).

History of Chemistry

The alchemy was practiced by the Arabics was similar to that of the Chinese. It is the first encounter with “the notion of the philosopher’s stone and potable gold or the elixer of life” (Brock, 1992, 19). Many of these ideas were credited to Jabir and Rhazes. These ideas along with that of “the Latin *Summa* were important for introducing the sulphur-mercury theory of metallic composition” (Brock, 1992, 20).

From this came the idea of molecules, which produced the idea that “metals varied in weight and form because of the different degrees of their constituent particles” (Brock, 1992, 21). The idea was that the molecules that made up lighter metals were larger and further apart, whereas those of gold were smaller and more compact. This provided the alchemist with the task of reducing the size and increasing the compactness of another metal to transform it into gold.

From this point to the Medieval times a number of advances had been made with the tools and processes that were used by the alchemists of the times. With the adoption of apparatuses and techniques used by craftsman and pharmacists, distillation was one of the processes that underwent a number of advances at this time in history.

About this time there was a change in the terms used to describe alchemy, which was “increasingly confined to esoteric religious practices and ‘chemistry’ used to label the long tradition of pharmaceutical and technological empiricism” (Brock, 1992, 29).

Historical Context

The Red River Valley Research Corridor

The Red River Valley Research Corridor is a project that was undertaken by Senator Byron Dorgan in 2004. The goal of the project was to bring federal research dollars to North Dakota.

The major areas of research that are being done at North Dakota State University includes:

- Nanoscale science and engineering
- Wireless Networks
- Microsensors
- Polymers and Coatings
- Agriculture
- Combinatorial Sciences
- Spintronics

Historical Context

The benefit of having these facilities in the region allows for the growth of the science and technology-based economy of the area. By using North Dakota State University and the University of North Dakota as anchors, these research parks can be moved throughout the state of North Dakota, boosting the state's position in the country when it comes to research.



Professional

The goal of this thesis in the realm of professional practice is to design a facility that creates an environment that causes resurgence in the interest in science in those who come in contact with the facility.

Another goal of this thesis project is to create a facility that incorporates the latest in material and structural technology.

The final goal in the professional realm is to look at the complex in which the facility will be housed and make conscious choices in the placement and the surrounding landscape.

Academic

The goal of this thesis in the realm of the academic is to provide a thesis that will be valuable to others within the academic community and by doing so allow for a continued interest in the advancement of facilities of this typology.

Goals for the Thesis Project

Personal

My personal goal for this project is that in its completion I will further my understanding in designing a facility that requires many technical aspects as well as the proper functioning of such a facility.

Another goal is to provide a plane on which to learn and provide a practical application of many skills that have been learned.

A final goal for this project is to create a design in which i have personal satisfaction with the completed product.

Goals for the Thesis Project

Site Analysis

As the site is approached there are a series of other facilities that have similar functions of research and development.

As one approaches the site there is very little to obstruct the view of the farm fields to the west and elements of the airport to the north. This allows for a structure to be prelevant in the landscape and become a point of interest. The openness of the site allows it to receive a great deal of natural light and ventilation to all parts of the site.

The site is currently an open, grass-filled lot. This allows for full control of the site and the ability to provide a landscape which many of the surrounding buildings lack. This reduces the constraints of the site.

The facilities that surround the site are all of a similar two or three stories in height and similar in a material pallet of concrete and metal panels. This allows for both a constraint if a similar pallet is chosen or it allows for an opposite and complementary material pallet.

Site Analysis

Site Analysis

Light Quality

The light at the site is not obstructed and can reach every aspect of the site. It is a warm natural light.

Wind

There are two main directions in which the wind is encountered on the site. It depending on the time of year from the North-Northwest and the South-Southeast at speeds of 15-20 mph base upon data collected through NDSU between 1991-2005.

Human Characterists

The effects of the human interaction with the site is visible in the manicured grass and the concrete curb that has been put in place.

Distress

The site shows no or very little distress.

Soils

The site has soil that is viable for building due to the ability to build on the surrounding landscape and the paving that has been done to allow access to the site.

Utilities

Utilites are available to the site and are currently surrounding the site.

Vehicular Traffic

There is vehicular traffic primarily on the western edge of the site. There is secondary traffic on the northern and southern edges of the site. The building upon the site would not cause a major increase in traffic.

Pedestrian Traffic

Much of the pedestrian traffic around the site is from the University. There is very little impact of this traffic on the site.

Climate Data

The average yearly temperature at the site is 41.5 degrees F based upon information acquired from North Dakota State University.

Annually the site receives about 21.19 inches of precipitation.

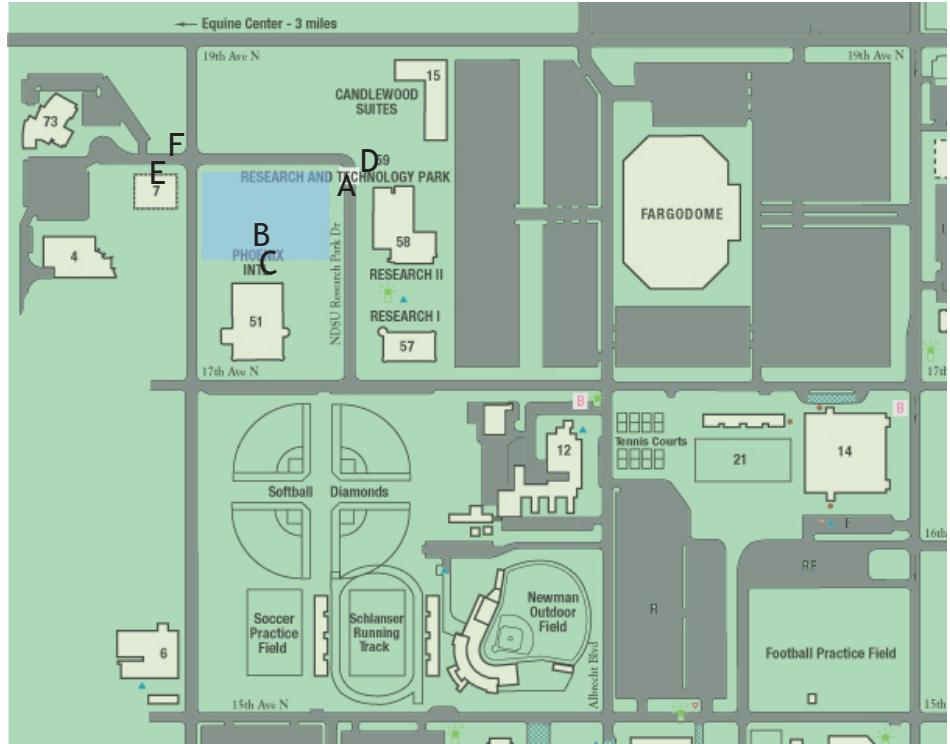
Site Analysis

A



B





Site Analysis

C



D



E



F



Presentation & Conference

Lecture Areas

Sq. Ft.: 427

Quantity: 2

Total: 854 sq. ft.

Teleconferencing Center

Sq. Ft.: 265

Quantity: 2

Total: 530 sq. ft.

Conference Rooms

Small

Sq. Ft.: 265

Quantity: 2

Large

Sq. Ft.: 535

Quantity: 1

Total: 1065 sq. ft.

Total Sq. Ft.: 2450

Laboratory Spaces

Open Laboratory

Sq. Ft.: 5404

Quantity: 1

Total: 5404 sq. ft.

Storage

Quantity: 6

Total: 1582 sq. ft.

Teaching Laboratories

Sq. Ft.: 700

Quantity: 2

Total: 1400 sq. ft.

Write-Up Areas

Sq. Ft.: 50

Quantity: 13

Total: 650 sq. ft.

Total Sq. Ft.: 9036

Programmatic Requirements

Programmatic Requirements

Office Spaces

Breakout Space

Sq. Ft.: 110

Quantity: 4

Total: 440 sq. ft.

Individual Offices

Sq. Ft.: 150

Quantity: 20

Total: 3000 sq. ft.

Group Offices

Sq. Ft.: 180

Quantity: 4

Total: 720 sq. ft.

Total Sq. Ft.: 4160

Administrative Spaces

Reception

Sq. Ft.: 275

Quantity: 1

Total: 275 sq. ft.

Lobby

Sq. Ft.: 580

Quantity: 1

Total: 580 sq. ft.

Total Sq. Ft.: 855

Supporting Spaces

Cafe

Sq. Ft.: 400
Quantity: 1
Total: 400 sq. ft.

Staff Lounge/Breakroom

Sq. Ft.: 400
Quantity: 1
Total: 400 sq. ft.

Restrooms

Sq. Ft.: 250
Quantity: 4
Total: 1000 sq. ft.

Library

Sq. Ft.: 1500
Quantity: 1
Total: 1500 sq. ft.

Total Sq. Ft.: 2530

Circulation

Circulation

Sq. Ft.: 8600

Mechanical

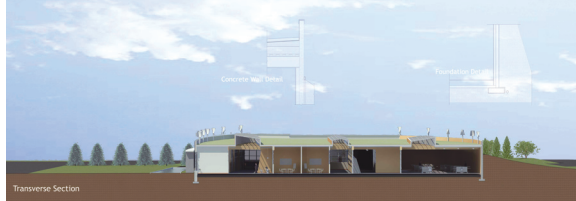
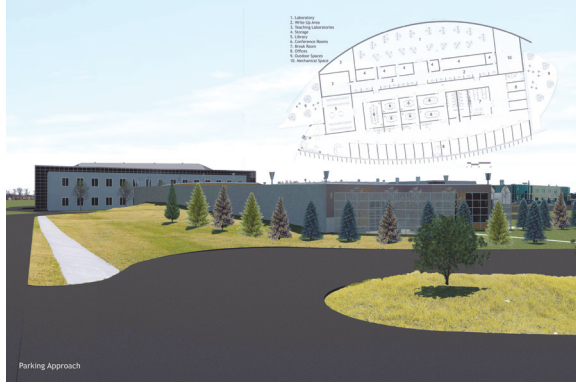
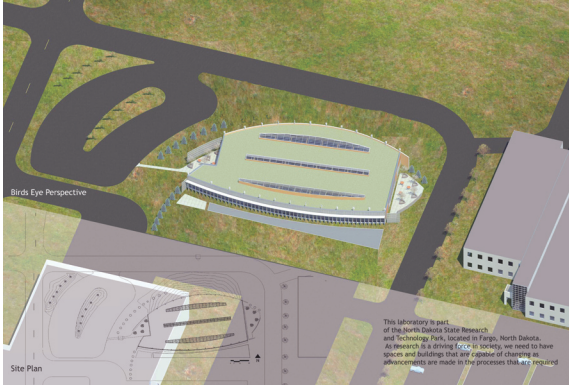
Mechanical

Sq. Ft.: 1200

**Total Space Requirement:
28,800 Sq. Ft.**

Programmatic Requirements

The Design



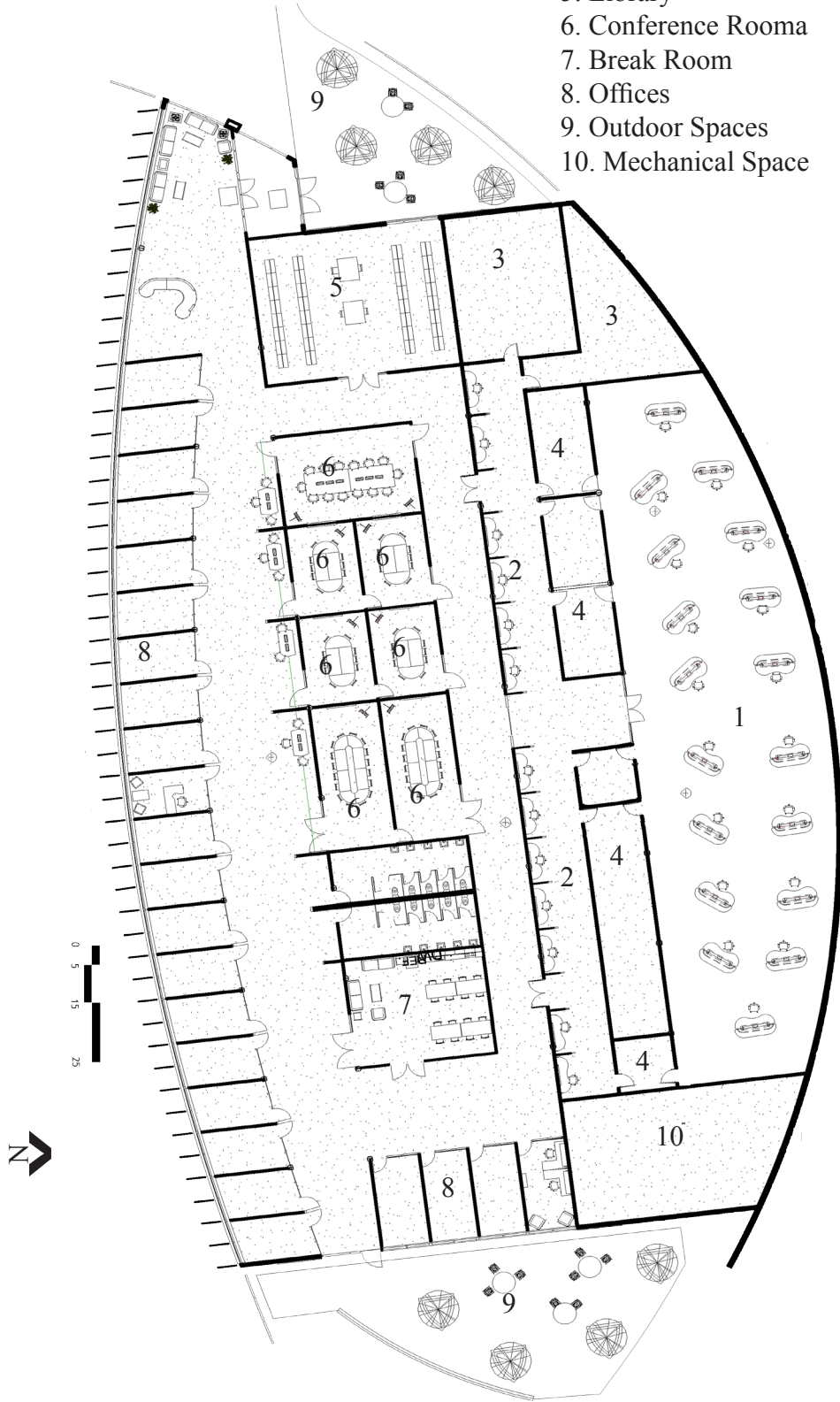
Board Layout



Interior
Views



- 1..Laboratory
- 2. Write Up Areas
- 3. Teaching Laboratories
- 4. Storage
- 5. Library
- 6. Conference Rooma
- 7. Break Room
- 8. Offices
- 9. Outdoor Spaces
- 10. Mechanical Space





Interior Views



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“The long sleepless nights eventually pay off”