AG ZERO:
ARCHITECTURAL DESIGN
+
MIDWEST AGRICULTURE

CHANDLER DICK + NORTH DAKOTA STATE UNIVERSITY + ARCH MASTERS PROGRAM

SIGNITURE PAGE

ARCHITECTURAL DESIGN + MIDWEST AGRICULTURE

PRIMARY THESIS ADVISOR DATE

THESIS COMMITTEE CHAIR DATE

A Design Thesis Submitted to the School of Design, Architecture and Art.

By

Chandler Dick

In partial fufillment of the requirements for the degree of Masters of Architecture

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ABSTRACT

The Urban Architecture communities and the Rural Agricultural Communities have been separated for so much of history. The profession of architecture can stretch far beyond just the typical urban environment. The implementation of architectural passive design should not just go towards the large scale urban projects but, barring they are as effective as claimed, they should be implemented into the most simple of Agricultural designs as well. It is our job as architects to design a solution, a connection, between the world of urban architecture that we know and the fields of rural agriculture that we know less of.

Title: Architectural Design + MidWest Agriculture

Typology: Agricultural Storage and Office Building
Site: Cavalier, ND USA.
Project Size: 10,000 ft

NARRATIVE + PROJECT TYPOLOGY

There seems to be one main issue that I see within the two communities of Architects and Farmers. There is no connection. I think that this is a pretty sad reality but it is something that we do not have to settle for. The reason why architects don't design for Farmers is because Farmers, when it is related to storage or shop spaces, are looking for a quick and cheap build. These cheap and quick builds very rarely have a great ROI after they are built however. Things like insulation values, building orientation and other possible passive design systems are not really considered. So the question that I ask is what passive design systems can we implement into a shop and storage space that allows a shop to increase their ROI. I have seen very little information that pertains to this project directly and that leaves for a lot of open doors. I think that this can become a template for future designs as well. That is the true intention of this project. To be the outline for future projects with only simple changes needing to be made.

I came up with this question/issue when I was actually a sophmore and I saw what the architecture field was like. I came from a community that was dominated by agriculture which is a community that I love. It somewhat bothered me that farmers did not see a need for architects and architects did not see a need to really help farmers. I think that we can design buildings that are helpful and buildings that embrace a space that is more effective to work in.

One of the strategies that I plan to use in research is the use of case studies. This is not a topic that has been greatly discussed so there will be a need for me to find bits and pieces from different projects. Another one will be running surveys on farmers that I know. I want to know what they are willing to pay up front and in turn how much more they would pay in order to get a good return on their investment. Lastly, I want to run a lot of my own calculations on passive design strategies. These will lead to figuring out what is actually effective and not and this is a crucial piece of this design. Actually using passive design systems that are effective.

PROJECT TYPOLOGY

Typology: Agricultural Storage and Office Building

Context: Farm yard or work site. Open space passive design.

Impact: Projects have shown what has been successful or not successful for the Agriculture community and the success and failures of passive design.

Function: These projects were created to be highly effective in a specific way or to create a new system that can become a standard.

The building type is being used to examine how the long term cost of Agricultural Storage and Office buildings can be enhanced to suit the farmers needs to a greater capacity through different avenues of passive design.

THEORETICAL PREMISE + RESEARCH

Architecture is completely intertwined with Urban America, whereas Rural America, which is heavily influenced by the agricultural industry, seems to have a disconnection between architectural design and it's structures. The driving force behind this is cost. Farmers do not need something with incredible geometry or even something that is unique. They need something that is functional first and foremost, and then they need it to be cheap, when it comes to building and maintenance. The question then becomes, "where is architectural design needed in this process?" I think this is a key question and it gets into what the roles of an architect are. One of those roles, I believe, is to know how to effectively save clients money, not just up front but down the road. I also believe that an architect needs to know the effectiveness of modern passive design systems and what their ROI is. Knowing these two things would lead me to the premise there is a design out there that can save farmers money in the long run and that they can easily see the ROI because of the implementation of very strategic and selective passive design systems. It is so important to understand that part of sustainability is financial. If we can not come up with systems that are financially sustainable then they will never catch on or last. There are simple systems that I believe can be implemented and opportunities that can lead to more visually pleasing design options. The research strategies I will use will consist of case studies, questionnaires, cost analysis studies and more.

PRECEDENT RESEARCH OPTIONS

CONSIDERED

WINDFARM SHOP, NORTH DAKOTA

ARCHITECTURE AND AGRICULTURE + DEWEY THORNBECK

TWIN RIVERS CHARTER SCHOOL, CALIFORNIA

SELECTED

AMARIS CUSTOM HOME, ST. PAUL MINNESOTA

THE GRAND FARM, FARGO ND

GES MECHANICAL BUILDING, FARGO ND

THE GRAND FARM

The Grand Farm is a local initiative/ project in Fargo, ND. It is a project that has various heads but one of the main heads in Emerging Prairie. Emerging Prairie, headed by Brian Carroll wants to, generally speaking, improve the human condition. The idea for the Grand Farm was initiated at one million cups, a local entrepreneurial meeting where business people from all over the community get to come and test ideas.
The question was raised, "What is out Major?" that being as the Fargo community. It was quickly realized that the community's major is Ag Technology. The next step was then to see how the two can continue to grow together and to see how the farm of the future can be created.

Right now The Grand Farm has 40 acres in South Fargo and several investors on board, including Microsoft. The objective of creating the Farm of the future right now looks like creating an operation that is fully automated.

FIG.13.1

It has been revealed that there are some major challenges to design around. Particularly there are 3 major ones.
Labor Shortage
Upscale work force for technology
Lacks venture capital (East Coast, Cali)

They also have stated their major goals. They have come up with five for now.
Have a world class eco system
Innovation Platform and bring venture capital to commercialize ideas
Place where people can work together. Maker Spaces. Develop things together
Upscale workforce to get ready for new technology.
Policy, what regulations need to be.

Ultimately the goal of the Grand Farm is to find problems and develop technology to
solve them but the long term goal is broken into three phases.
Phase 1: Reimagine the Farms of North America
Phase 2: Reimagine the Farms of Africa and India
Phase 3: Reimagine the Farms of Space. (Mars and Asteroids)

Will never be complete: Phase 1- Farms of North America
Farms of Africa and India
Farms of the Future (Mars and Space)

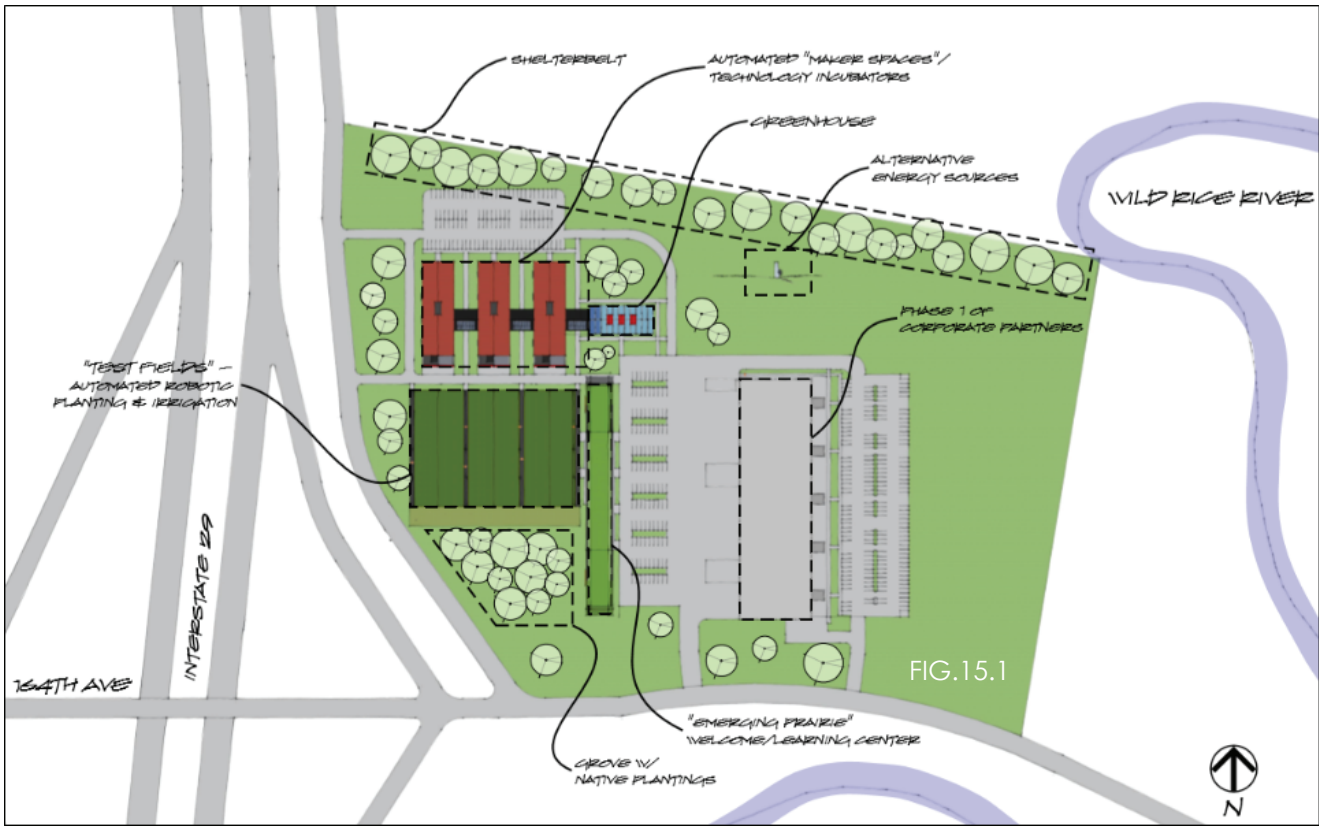


FIG.15.1

FIG.15.2

AMARIS CUSTOM HOME

The Amaris Custom Home is located in St. Paul Minnesota. The home designed not to be the cheapest per square food but rather the most value per square food. Ray Pruban calls in common sense building. There are plenty of ways that they have tried to implement some very strategic passive design strategies into this home that may be applicable for other buildings in a similar climate. Here is some information about the home.

- Location: St. Paul, MN
- Layout: 5 bedrooms, 4 baths, ranch with finished basement
- Conditioned Space: 3,542 ft2
- Climate Zone: IECC 6, Cold
- Completion: September 2013
- Category: Custom

Modeled Performance Data:

- HERS Index without PV 41, with PV 4
- Projected total annual energy cost savings (compared to a similar house built to the 2006 or 2009 IECC): with PV $3,805, without PV $2,388
- Projected annual utility costs: with PV $278, without PV $1,713
- Annual PV production revenue: $1,435
- Estimated annual energy consumption: – With PV: electricity 0 kWH, natural gas 726 therms – Without PV: electricity 9,166 kWh, natural gas 744 therms

FIG.17.1

FIG.17.2

FIG.17.3

The objective was to make this house use as little energy as possible and in turn save money in the long run, so here are several strategies they used in the design.

- Zero Energy Ready Home Path: Performance
- Walls: 2 × 6 walls, 24 in. on center, 1-in. continuous rigid exterior insulation, 3-in. closed-cell wall cavity insulation, total wall R-26. House wrap, engineered wood siding
- Attic: Energy heel truss, 2-in. closed-cell spray foam on lid with R-48 blown fiberglass, total R-65.5
- Foundation: Basement, 14-in. insulated concrete form, R-24
- Windows: Double-pane, argon-filled; polyvinyl chloride-framed; low-e windows with U-0.25 and 0.49 solar heat gain coefficient.
- Air sealing: 464 CFM50
- Ventilation: Energy recovery ventilator, motion-detector-controlled exhaust fans • Hot water: 95% efficient boiler provides domestic water, in-floor heat, and forced-air backup heat
- HVAC: 95 annual fuel utilization efficiency furnace, 16 SEER air conditioner (ducts In conditioned space) • Lighting: 90% light-emitting diodes, 10% compact fluorescent lamps
- Appliances: ENERGY STAR dishwasher, clothes washer, and refrigerator
- Solar: 10.5-kW PV
- Water conservation: Landscape designed to reduce demand by 25%, droughttolerant turf, 90% drought-tolerant plants
- EPA WaterSense fixtures: Lavatory faucets and showers
- Wegowise utility tracking and benchmarking
- Other: Passive solar design, thermal mass flooring.

WHAT MAKES A HOME DOE ZERO ENERGY READY HOME-CERTIFIED?

1 **BASELINE**
certified ENERGY STAR® for Homes Version 3.0

2 **ENVELOPE**
meets or exceeds 2012 IECC levels

3 **DUCT SYSTEM**
located within the home's thermal boundary

4 **WATER EFFICIENCY**
meets or exceeds the EPA WaterSense Section 3.3 specs

5 **LIGHTING AND APPLIANCES**
ENERGY STAR qualified

6 **INDOOR AIR QUALITY**
meets or exceeds the EPA Indoor airPLUS Verification Checklist

7 **RENEWABLE READY**
meets EPA Renewable Energy-Ready Home.

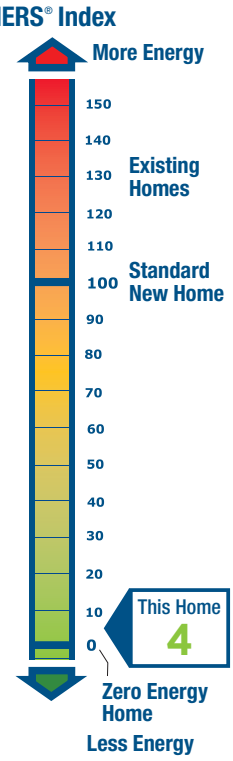


FIG.18.1

GES METAL BUILDING

This project is a very simple one. It is a rebuilding of the existing General Equiptment and Supplies. These buildings are ver simple when it come to the architecture, the design and the construction. Also the client simply wants the architect to create a functional floor plan rather than creating a design that can save them money in the long run using passive design or other zer energy strategies. This is simply a simple building and the type of building I want to see if we can improve upon.

The following image and drawings a provided by Foss Architecture and Interiors. A local Fargo firm that was asked to complete this metal building.

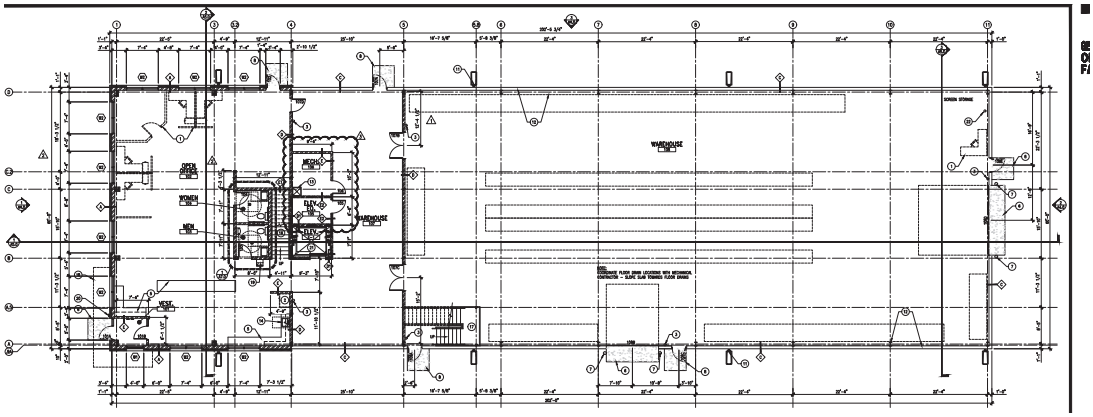


FIG.19.1

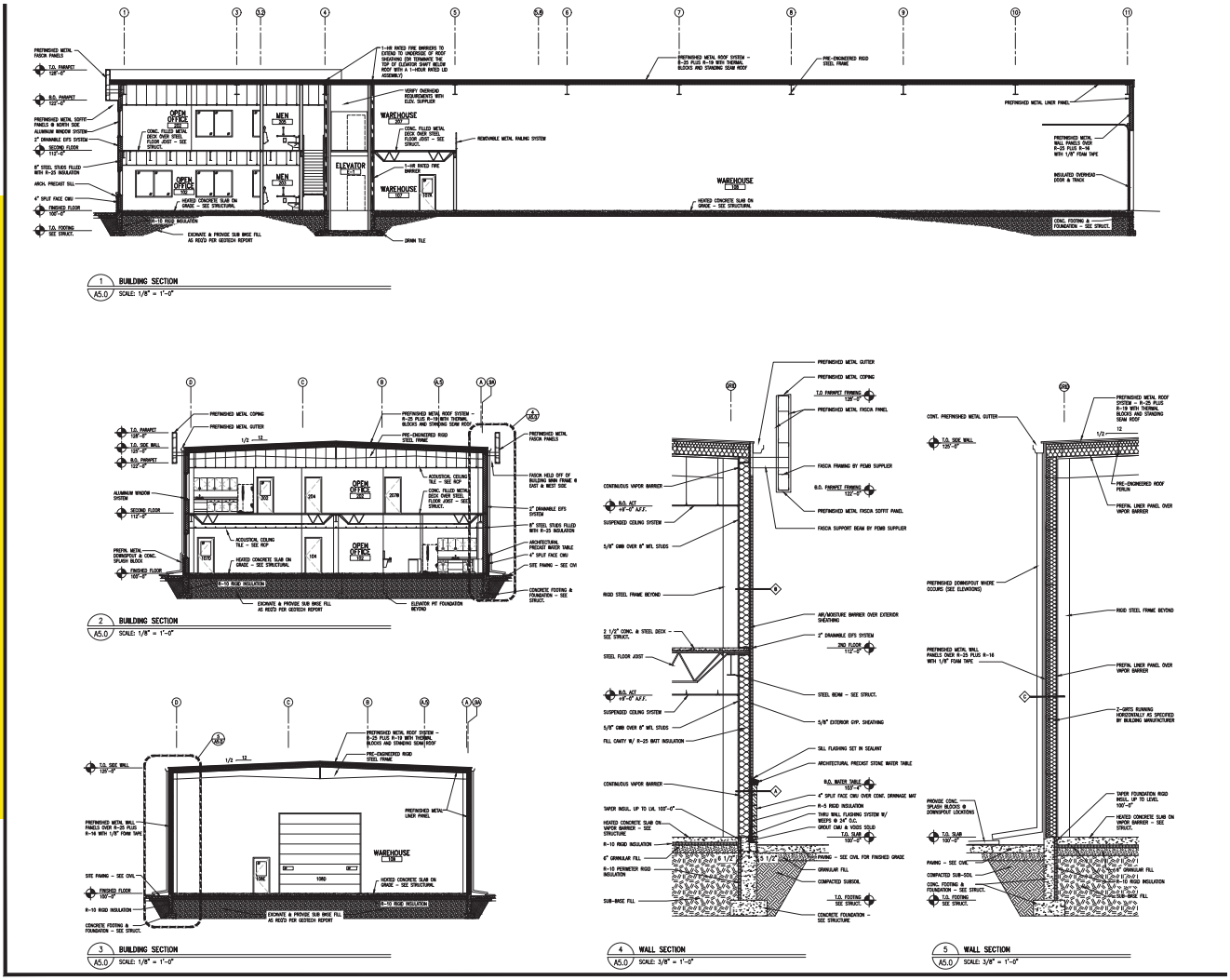

1 BUILDING SECTION
A5.0 SCALE: 1/8" = 1'-0"
2 BUILDING SECTION
A5.0 SCALE: 1/8" = 1'-0"
3 BUILDING SECTION
A5.0 SCALE: 1/8" = 1'-0"
4 WALL SECTION
A5.0 SCALE: 3/8" = 1'-0"
5 WALL SECTION
A5.0 SCALE: 3/8" = 1'-0"

FIG. 20.1

FIG. 21.1

FIG. 21.2

MAJOR PROJECT ELEMENTS

Shop Space

The shop space needs to be a space that is well designed and appropriate for all types of work. The work in shops typically consists of maintenance, preparation, cleaning, and general adjustments. There are a lot of little projects that need to be done on equipment of all sizes. Lighting will be key, and creating a space where the farmers will actually want to be is another goal of mine.

Office Space/Meeting Space

This space will be quite simple. The office space will need to be a space where a number of farmers may have offices. (Depending on how big the operation is.) This should be a space to do book work and also be a space where meetings can be held to get you out of the noise of what may be in the shop space. It should also be a good break space where the farmer can get away for a bit. This would also have a kitchenette and some cupboard space as well.

Storage Space

The storage space and the shop space tend to have some overlap. The shop being a large space can store large equipment when it is not needed out of season. Many farmers have other buildings on the site that do not have heating and those are their main source for storage but the shop will also prove an excellent controlled space.

Bathroom

The bathroom would be an easy addition. Due to code there would need to be a male and female bathroom but these would not have to be anything over the top. This is where a lot of extra money should not be spent. Farmers need a place to go to use the restroom and possibly clean up.

Passive Design

This is where many of the challenges lie. Farmers are not looking for this right now because a lot of it is not effective, especially for the Upper MidWest. I want to dive into passive designs that are highly effective and produce a good ROI, since many passive design systems imply a more expensive initial cost.

USER + CLIENT DESCRIPTION

This project is being designed for a local farmer but it is expected that this shop and office design can be used as a template for future projects so it will hopefully transcend a single client. The project would be used by the individual farmer and his business.
The specific needs within the space will be determined through the research process of looking at case studies and being in direct contact with farmers. This will directly influence the design of spaces and needs for openings and other aspects of design.

Shepherd Farms

Thomas is a local Farmer in the Cavalier, ND area. Here they farm Red River Valley land, which is some of the most fertile land in the country. He is a young farmer, only 27 years old and he has recently got married. He is very much so business focused and is looking to expand as he starts his career farming with his parents. His family and him farm Wheat, potatoes, soybeans and corn. With the future in mind he makes for a great client that can invest in a new shop that will only save him money in the long run.

THE SITE + MACRO

This project is located on the Shepherd Farmyard. The Shepherd family lives just South West of Cavalier, ND. Cavalier is located in Pembina County, which is located in the North West corner of the state. The site is also located near Icelandic State Park. One of the greatest hidden gems in all of the Upper MidWest. It features bodies of water and the Pembina Gorge, which comes out of nowhere and reveals some incredible views. The communities surrounding the site are very strong and thriving communities headed by Cavalier. They are dominated by the agriculture industry, as many other small communities are.

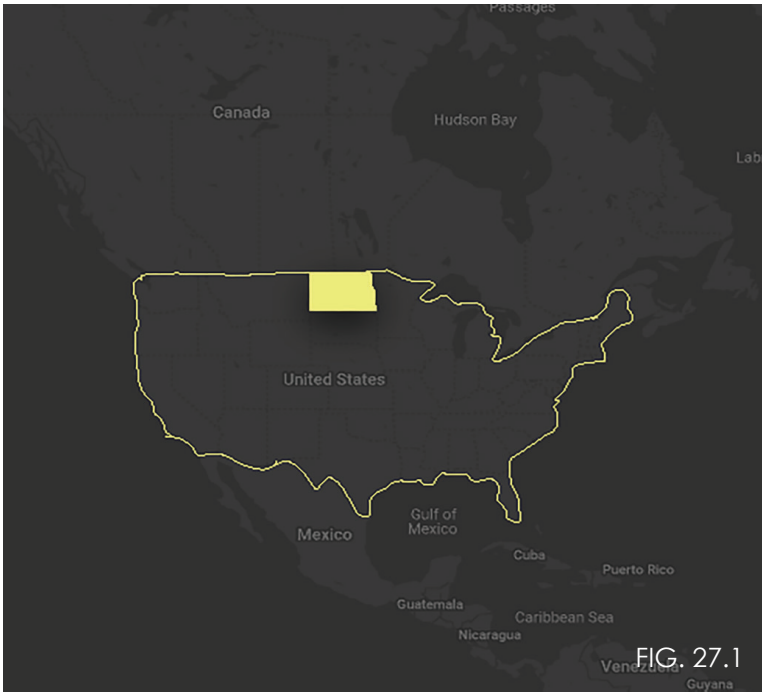


FIG. 27.1

NORTH DAKOTA

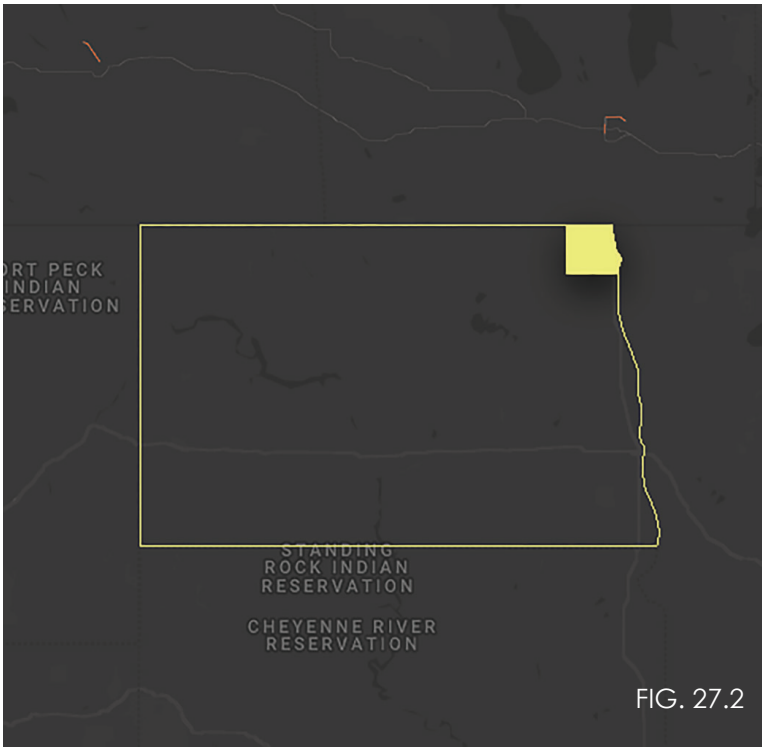


FIG. 27.2

PEMBINA COUNTY

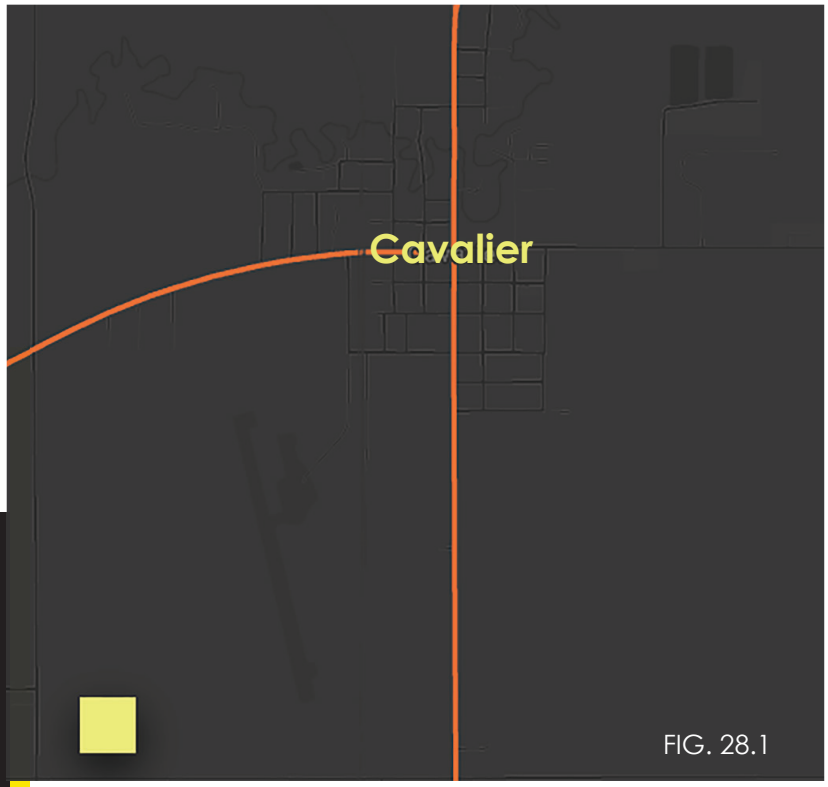


FIG. 28.1

CAVALIER AREA

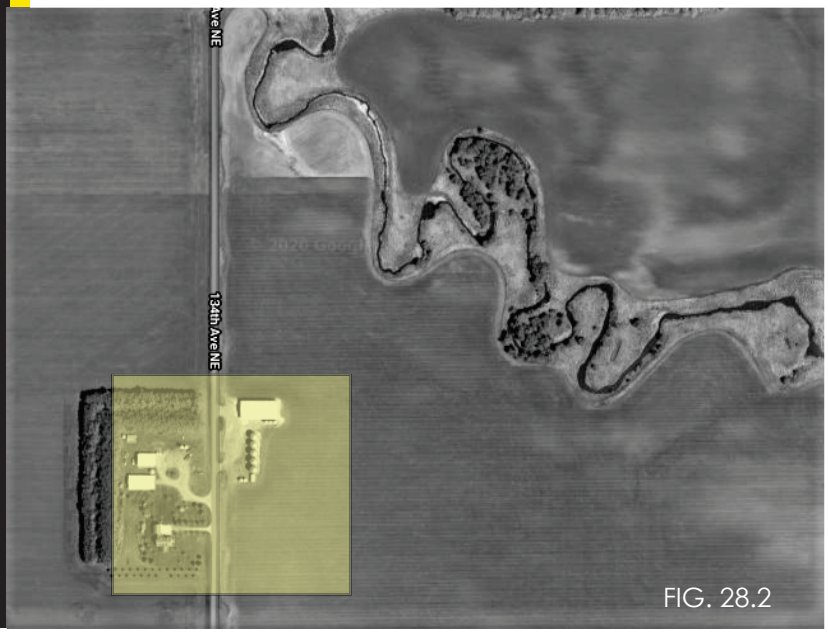


FIG. 28.2

SHEPHERD FARMYARD

There is currently a structure on the site where the new shop would be located. This existing structure is owned by the Shepherd's but they are currently looking to upgrade that particular structure. Around the building site there is a shelter belt located to the north and the west. The yard is well protected from the most harmful winds due to these tree rows. The idea is that this project could be used all across the upper midwest as a foundational design, and so picking a typical farm yard site is important, and this site fills the typical layout of a farm yard.

It will be important to take a look at the following in the research phase.

Soil Type

Typical Wind Patterns

Sun Patterns

Climate/ Temperature

Electrical, Plumbing, Natural Gas Accessibility

These are just some of the factors that will need to be studied in depth in order to create a proper design.

THE SITE + MICRO

These are just some of the factors that will need to be studied in depth in order to create a proper design.

This site was selected for a variety of reasons but one of the main ones was the geographical location. This project is personal for me and the agriculture community that I am around is located near here. Many of my family and friends farm near the Canadian border so I would like to create a design solution that can be used throughout the area.

When designing much of the site around the building structure, it will be very important to give proper space for equipment to move around and enter the shop. Much of the farm equipment is very large and that needs to be taken into consideration. The site as it sits now functions well, so the changes that need to be made will likely be very small but that is something that needs to be analyzed.

Architecturally speaking I want to create something that represents the upper midwest well as that is the long term goal for this project. I also do not want to throw out the architecture that is on the site already. Possibly looking at their home, bins and other storage structures for some inspiration.

FIG. 30.1

FIG. 31.1

FIG. 31.2

PROJECT GOALS

The academic goal of this project is to truly take a look at the cost effectiveness of passive design in our region. It seems that so much of passive design is financially ineffective. It also seems that passive design is not implemented in the upper midwest, and a lot of that has to do with climate. I want to find ways to passively design a shop space that is truly financially viable.

From a professional perspective I want to create something that can actually be used by farmers across all of the upper midwest. I believe that I can create something that is truly architecturally designed and extremely cost effective for farmers. I think this can be used as a template for future shop designs.

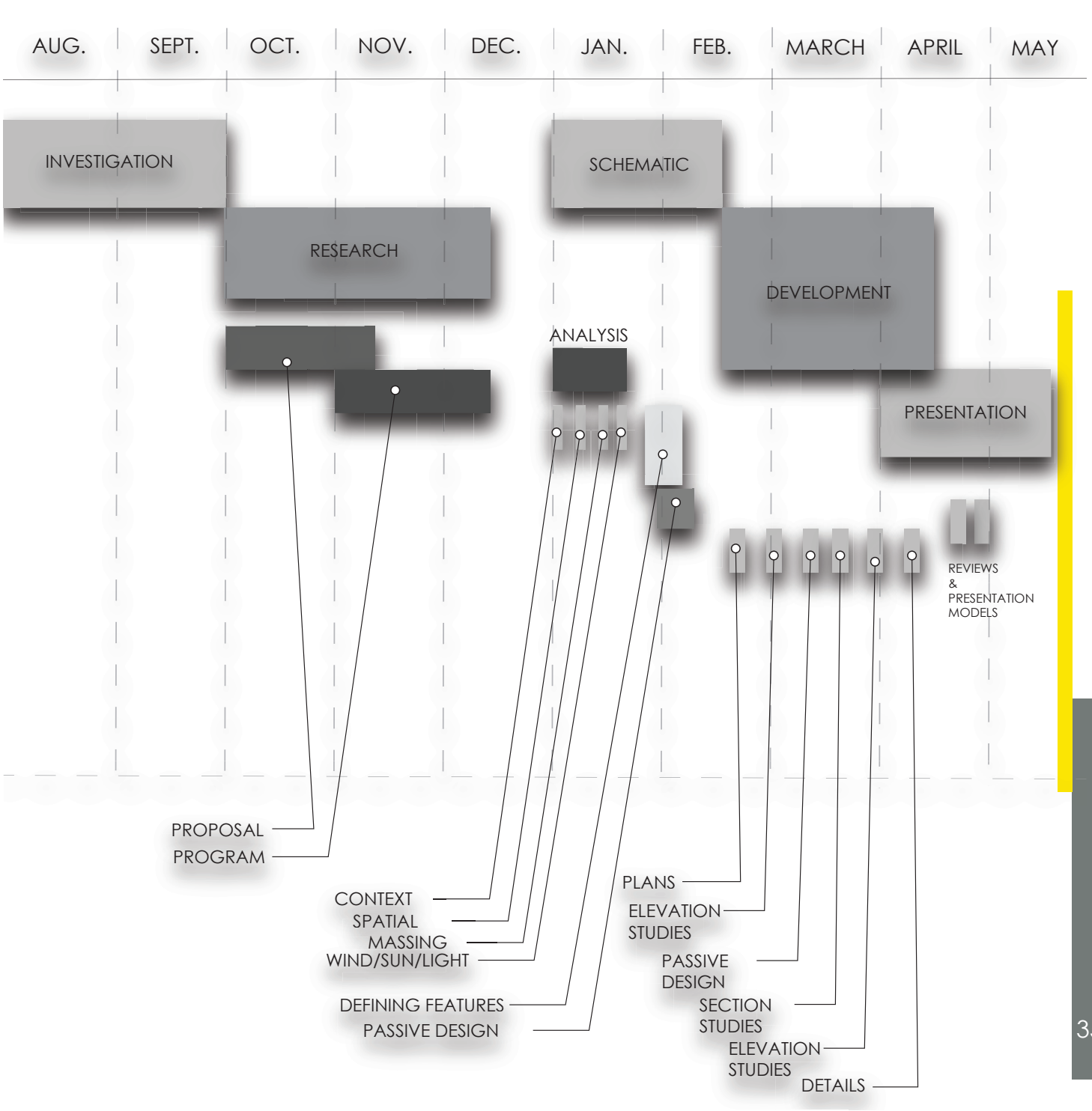
From a personal perspective I have not seen a lot of passive design that seems usable. So many of these strategies need to be financially effective because if they are not then they will never hit the competitive market. If I can find something that I am passionate about, like the farming community, and combine it with in-depth cost analysis studies of passive design then I believe I can find a solution that will change the connection between farmers and architects.

PROJECT EMPHASIS

The project will emphasize 2 key things that will work together. The first focus will be on the shop design. This will create a more effective use of space for the farmers and hopefully a more visually pleasing atmosphere for them to work in. The second focus will be on passive design. I want to look at passive design systems that will truly be effective and save farmers money within 10 years of construction.

PLANS FOR PROCEEDING

M-F 19-23	Oct. Midterms for ARCH 771
W 11	Nov. Veterans' Day Holiday
W-F 25-27	Nov. Thanksgiving Holiday
F 11 Dec.	Last day of classes
R 17 Dec.	Final Thesis Research document due for ARCH 763/LA 563/763
M-F 14-18	Dec. Final Examinations
T 12 Jan.	First Full Day of Classes
M 18 Jan.	Martin Luther King, Jr. Holiday
M 15 Feb.	President's Day Holiday
M-F 8-12 Mar	Mid-semester Thesis Reviews (only for Architecture)
M-F 15-19 Mar	Spring Break
F-M 2 Apr-5 Apr	Spring Recess
F 23 Apr.	Thesis Project Final Exhibits in digital form due to thesis advisors at 5:00 p.m.
M 26 Apr.	All physical exhibits for the Thesis Project due at 9:00 am on the 5th floor downtown
T-R 27-29 Apr.	Annual Thesis Exhibit opens on the 5th floor downtown
M-R 3 May-6 May	Final Thesis Reviews
F 7 May	Last day of classes, Awards Ceremony
M 10 May	Digital copy of Final Thesis Documentation due to Thesis Instructors
M-F 10-14 May	Final examinations, Thesis Awards Finalist show in the Flakoll Gallery downtown
F 14 May	Final Thesis Book due at 5:00pm in the Institutional Repository
SA 15 May	Commencement at Fargo Dome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REVIEWS
&
PRESENTATION
MODELS
PROPOSAL
PROGRAM
CONTEXT
SPATIAL
MASSING
WIND/SUN/LIGHT
DEFINING FEATURES
PASSIVE DESIGN
PLANS
ELEVATION
STUDIES
PASSIVE
DESIGN
SECTION
STUDIES
ELEVATION
STUDIES
DETAILS

Design Methodology

The next step in the design portion of the project is to start forming a conceptual design. Alongside this there will be in depth research into what passive design strategies will be effective for the building located near Cavalier. This will involve in depth site studies as well. This will lead to modeling of the site and conceptual form models of the structure that will maximize the performance of the building.

Conceptual modeling will be done using SketchUp and Revit. Energy Modeling can also be done in revit. Much of the floor plan concepts will also be performed within Revit. Revit provides a sense of simplicity while also having the capabilities to help provide information on building performance, which is extremely important to me. Through this process there will be several iterations that are created.

The most effective interactions will then be taken to the next level and analyzed into what, according to the numbers is the most effective. It will have to be countered by an effective visual design as well.

Sketching will also be used as another medium. Sketching will help quickly iterate some of the ideas that are in my head. This may range from simple form sketches to more detailed design ideas. I may also use sketching to conceptualize some floor plan ideas.

Referring back to modeling, I want to analyze ideas in a similar fashion. Looking at concepts from saved views will make for a simple process of choosing interactions. Views will be established as needed but the focus will be on human perspective and the human experience.

By Mid-Terms in the spring I would like to have my final design completed. This will allow for the time needed to produce a presentation that can represent the project well.

Production and Presentation

The final production quality of this project shall be very high. This project is designed to be used in the real world, not just in a functional world. That makes the importance of a high quality presentation very important to me. This would hopefully be used as a reference for many more projects like it in the upper midwest.

The final presentation will include photo realistic renders of the project that show off the most important design features. It will also include detailed drawings of th building that will be vital to making the logistics of the project possible.

These drawings will include ones like a fully furnished floor plan, along with at least one section, elevations and details that are necessary for the understanding of the project.

There will be several iterations, so I would like some of the iterations to also be displayed. This will help show the process of what has really been important throughout the project.

The book will also be an important piece of the final design. The book will include the Thesis Proposal, Design Solution, Program and the Appendix. This will be physically printed off and shipped in order to meet our deadlines.

The oral presentation will represent the project well as it will make the major pieces of the design the major focus. The minor pieces of the project will then be treated as minor pieces of the presentation.

Last, the final digital copies of the presentation will be submitted to the North Dakota State university Institutional Repository. This will make the project available for all students and professors.

RESEARCH

RESULTS FROM RESEARCH

Overview

The research of this project proved to be critical leading into design development. There are several literature reviews that have shaped how to make this shop a successful project, while also opening even bigger questions on how accessible the rural and agricultural markets are. The literature reviews touch on three key pieces, starting with the importance of getting into the market of innovation. Innovation that is taking place in a rural setting. The next is now how implementing passive design could be one of the factors to helping innovate rural communities effectively as architects, even in a cold and cloudy climate. Then the last piece of literature goes into how practically a shop needs to be designed and what is effective for farmers in day to day life of these designs.

Continued Research

This research has helped push the project along but it will now stop here.There will continue to be research done while the design is formed. This project, more than any of my other projects, will need to be guided by research and the forms that are created will be tested and tried to see if they can meet the performance that is required.

Literature Review

Are Rural Communities (Untapped) Hotbeds Of Innovation?

Overview

In this article we will take a look at the importance of Rural America. Rural America rarely gets any recognition, which they are probably fine with, but they maybe deserve some. The markets and innovations in rural communities are so untapped, while at the same time thriving. They seem to be less volatile.

The reason I am looking at an article like this is because I have seen the power of Rural communities. They are as innovative and wealthy in ideas as any in the country. They are innovative people and they are looking for the next big step to increase the efficiency of their operations. I believe there is a lot of room for architecture to grow in the rural community as well.

Opening Points

The author opens by saying that when we think traditionally, we think that all of the innovation in the world comes from something concentrated in urban areas with massive amounts of financial opportunity. We tend to think that rural areas are living in the past. The market is small there and the innovation there is even smaller. We want to go to the city so that we can make an actual impact on the world. A study by Penn State suggests that this way of thinking may be a bit unwarranted and the rural areas may actually be 'hotbeds' for innovation. These researchers are making the case that 'hidden' innovators in rural areas bring a massive range of benefits economically and socially to communities and businesses. The researchers stated the following: "The way we traditionally measure innovation is very narrow, and focuses primarily on new products or processes that result in a patent or involve R&D spending. This overlooks another kind of innovation—the incremental improvements that businesses make to their products and processes as a result of information they obtain from outside their firm.. Our measure shows that this latent, or hidden, innovation is at least as important to local income and employment growth as patent-level innovation."

Latent Innovation

The author then proceeds to look farther into the researchers findings and how it applies to Latent Innovation. The researchers start by looking at the importance of networks in innovation. Networks are crucial to innovation because they can help extend innovation across multiple industries. Most people have assumed that large cities are the best place to find these connections but that may be in question now.

"We know that inter-industry exchanges foster cross-fertilization of ideas, or knowledge spillovers, which in turn seeds innovation," the researchers explain. "We wanted to explore these interactions more closely in order to better understand where the opportunities for innovation are greatest, including in rural and urbanized areas that are remote from cities."

They proceeded to look at the Input-Output table, which takes note of annual sales and purchases across all industries in the United States. After looking at all industries, both past and present, they proceeded to look at the factor of geography. Through their analysis they were able to form the 'latent innovation index'. This ranks all of the counties in the U.S. based upon their potential for latent innovation.

Untapped Potential

From the researcher's results, it was concluded that the counties with the highest innovation scores also scored high in income growth and employment levels. This means that a lot of people are in the work force and incoming money of these countries is growing quickly. Now when they applied this to geography they found that the both urban and rural counties are very high on this list. They bring up patents, which are often correlated to innovation but they say that even though patents are produced as often in rural communities that the economic growth derived from innovation is still great in these rural areas. Meaning that just because the innovation is official in urban areas with patents does not mean that unpatented innovation in rural areas is any less viable to produce economic growth. They state that places like Silicon Valley produce great technology advances but there are so many innovations in rural places that move industries forward and help them keep moving.

Providing Infrastructure

This section of the article the author focuses on how rural innovation can be supported, with the focus being on being on networking. He brings up how Switzerland has done a good job of helping innovation within the rural communities but their policy countered some of the rural innovation progress. He says another struggle is quite simple. Technology is lacking often in rural areas. This is always an issue for new entrepreneurs but there are more hurdles to overcome in this area for rural innovators. He closes by saying that the policies that our government writes should not just benefit our urban innovators but also our rural innovators. They help change the industry as much as anyone.

Conclusion

This article goes into studies that show how innovative the Rural communities of America are. They play such a big role in our economy and push us forward. However, it does not seem to be seen by the vast majority of people in the Urban setting.

This article shows how important the rural market is to the country, but I also believe that it also shows how much potential it has. One of the biggest drivers of Rural America is agriculture and we as architects should be able to recognize that this is a viable market for us to step into. This can start to bridge the connection between Urban and Rural America without having to become each other.

Literature Review

Passive Design Strategies for Cold and Cloudy Climate

Overview

In this piece of literature the author analyzes a few unique design strategies that can be used within cold and cloudy climates. The studies take place based upon the location of Shimla India. Several tools are used to numerically study what passive design strategies are most effective. We will clearly find in this literature that there are some passive design strategies that will help builders save on auxiliary costs. Living in a cold climate is never easy on its own. Trying to take advantage of passive design within cold climates is another beast of its own.

Opening Points

The author opens the literature by stating what passive design is and why it is used. One important statement and clarification that he makes is based upon the simplicity that passive design is a new strategy to save on energy or auxiliary costs. He also states that living in cold climates requires far more energy than hot climates. Designing a building with the proper form and orientation in mind can lead to a special opportunity for passive solar applications to be effective. The costs that come along with these applications are also very minimal and lead to an effective ROI. The literature also leads by stating how we have grown in our desire to harness solar energy and this is just the start. We have not figured yet how to access this energy well.

Introduction Studies

Studying takes place in Shimla, India in this literature.The first tool that the author uses in this piece of literature to ensure that his passive design strategies are effective is a bioclimatic chart. From the chart you can see that the temperature during the year is low, meaning that the strategy he will need to use will have to involve some sort of heating. One way is to take advantage of this is to orient your building properly. Using a south-facing facade will allow the maximum amount of sunlight to penetrate the building. Buildings that are longer east to west than North and South allow for more exposure to the south facing Sun and in turn will allow for more passive heating opportunities. This layout is also most effective for summer cooling strategies, so weather designing for passive heating or passive cooling building should be placed along the east to west axis.

Sun Space Studies

The next portion of the literature the author goes into sun space studies. Sun spaces are used to absorb heat centrally and then disperse it into rooms around the building. These however are not always the most effective but depending on location they certainly can be a viable option. These are also far more common than you would expect. They are not always taken advantage of however and are sometimes designed unintentionally.

Earth Berm

The next portion that the author focuses on is earth berms. Earth Berms are what you would expect them to be. Earth that is pushed on or beside a structure. Much of the effectiveness of this strategy can be seen when I just look down. On a day-to-day basis when you look 2 feet under the surface the temperature changes are nearly unnoticeable. So placing an effective insulation layer of nature around your building may be a possible strategy to passively maintain heat within your structure. The author states that this will lead to more consistent internal temperatures. It does so by increasing resistance to heat flow within the walls, roof and floor. A key piece to this is that there should be some elevation change in the land. Placing your building on the side of a hill will lead to a natural amount of Earth insulation.

Radial Path Calculations

The author now proceeds to take a more technical approach to finding passive design solutions in cold climates. In this portion the author performs radio path calculations. In turn, these calculations lead you to finding the R-value of the earth surrounding your building. From his findings you can see that a building that is covered by 8 ft of soil will give you an R-25 value without any insulation being placed within the walls.

Rock Bed Solution

The next technical aspect of the literature is what the author calls the Rock Bed solution. Rock beds are what they sound like, they are masses of rock that are bedded below the floor of your structure or building. These rocks serve as a thermal mass that can collect heat throughout the day and then release the same heat at night when temperatures are falling. The Rock beds are heated by channels through the floor which pass the heat from sun spaces to the rocks. If this is a continuous cycle and the amount of heat that will be entering the building through the rock bed will increase and in turn be more sustainable.

Other Solutions

A few other solutions are brought up by the author of this literature. He states that simple things like placing windows and glass with a low U-Value or a high R-value will allow for a much better effect on passive Heating and Cooling. This will be effective because heat will be retained within the building at a much higher rate. He also states how entryways or air locked spaces are great to protect from the harsh outdoors whether they are hot or cold. This is a very common strategy in our area as vestibules are nearly required in all buildings. There are many more strategies that can be approached but these are a few simple ones that can be applied to almost all buildings within cold and cloudy climates.

Authors Results

The author concludes that with the studies that he has performed can save 5 to 25% in auxiliary costs without adding much to the initial cost. This is a very modest form of passive design and can be implemented into all buildings within cold and cloudy climates. The author also precedes to say that a more aggressive approach can be taken to passive design. This more aggressive approach can lead to 25 to 75 percent auxiliary costs being cut while still remaining cost-effective in the life cycle of your building. That at the end of the day is the most important piece of information. If these strategies are not cost effective then the purpose of passive design is being misrepresented. The author concludes by saying that these strategies, whether modest or aggressive should be considered for many small buildings in cold and cloudy climates.

Conclusion

I can conclude from this literature that there are several passive design strategies that can be effective within a cold and cloudy climate. I can see that the rock bed solution is plausible according to the numbers. I also can see that the earth berm solution is plausible according to the numbers. Each has the possibility to be used within my personal project upon further investigation. I also can see the simple solutions laid out at the end of the article can lead to simple savings. At the end of the day the strategies shown seem to be effective and seem to be strong candidates for use within our cold climate in the Upper Midwest. With that in mind the numbers for this area will still need to be run in order to find a truly viable and transferable solution for our location.

Literature Review

PLANNING FARM SHOPS FOR WORK AND ENERGY EFFICIENCY

Overview

Overall, in this article we are getting a great look at what it takes to design a space which can properly house the modern-day farmer. Many of the details that we do not think about from an architecture standpoint are explained in this article. There are several great rules of thumb followed along with several other practical and statistical suggestions. This more or less supplies a way to meet a farmer's need when it comes to spatial organization, however there are several other needs that I believe need to be covered.

Opening Points

The author of this article opens by stating how important it is to have a well-maintained and energy efficient shop for the modern-day farmer. These shops are responsible for protecting farmers while they are performing servicing, repairs, overhauling machinery, assembly and seasonal changes. Farmers also use this space for daily use equipment like family vehicles. He closes his opening points with the purpose of this article. To show how any sufficiently and properly spaced shop can provide optimal working conditions for your local farmer and family.

Warm Weather vs. Year Round Shops

One distinction the author makes here is the difference between a self-contained and a year-round shop. A self-contained shop is one that does not need to maintain a certain environment. They simply need to cover the farmer. Year-round shops are shops that have an element of environmental control. In this instance the control is against the harsh Winters in the area. With these two shop forms in mind there is also a hybrid which can combine the two, placing self-contained units adjacent to year-round shops. He finally closes the section with the clarification that within his documents he will be focusing on year-round shops.

Finding the Best Shop Site

Finding the best shop site according to the author is extremely important. There are several considerations that we as designers and Farmers should be taken into account.

The author makes a general statement that the ideal distance for your shop to be away from your home is 150 ft. This will allow for noise protection and traffic protection for your home. It will also leave the shop close to your home for security purposes. Another reason for it to be 150 ft away is that it reduces the fire hazard threats that can be caused from a building of that scale. There are several other considerations when it comes to distance and security.

It is important to keep your shop well-lit outside as you want to protect what is inside but as mentioned above you do not want to keep your shop too close to your home. Another consideration is the orientation of your building. the author states that it is important to have your large openings away from prevailing winds to reduce the odds of wind damage upon your large doors. Lastly, the author states that it is important to have at least 12 inches of change in the grade to allow for proper drainage.

Principles of Farm Shop Layout

it is important to understand the major functions that are performed within the shops. The author breaks these functions into two main categories. The first category Falls within repair. Repair includes overhauling and other types of mechanical work that would include annual preventive maintenance and reconditioning. The second group is servicing. This includes maintenance and things such as oil changes lubrication and minor adjustments. You often want to separate these spaces if you have room for a larger shop and a large arrangement of workbenches will need to be designed into those spaces.

Repair/Overhaul Area

Some keys for the repair and overhaul area include lighting, size and the consideration of what will be worked on within the space. The space first of all needs to be well lit. This will lead to easier work and much more efficient maintenance and repair. The size of the space must also be considered. This is important because equipment on farms is very large and knowing what type of equipment will be worked on will determine the size of the space needed. There will also have to be considerations for what type of implements will be worked on and whether they will need to be attached to another pieces of equipment in order to access the desired maintenance location.

Service Area

The service area is where typical daily services take place. This includes many things like oil changes and greasing joints. Many of these things can be done outside if needed but things like welding and lubrication will want to be performed inside the shop. There is a wide array of things that need to be done on a day-to-day basis so this space should be able to hold almost all types of equipment.

Tool and Bench Areas and Parts Storage

This can oftentimes be Farmers greatest weakness. The arrangement of tools can help farmers become more efficient and ultimately safe when operating maintenance procedures on equipment. It is important to factor in spaces for benches and tools into work and service areas. These areas can also be used to store carpentry, electrical and plumbing tools. Farmers tend to do a lot of work on their own and that is important to meet all of their needs within their shop. The author then proceeds to show a few basic floor plans that can provide efficient uses of space and how to lay them out properly.

Layout Rules

The author provides several active layout rules that can be applied to almost any project within the realm of a farm shop. The first that he states is that all workbenches should be 3 feet high and should have freestanding tools around them. You also should have 8 to 12 feet of work space on each side of your repair bay as well. If your shop is smaller you may only need about six feet of space. When factoring in space for welding there should be about 10 ft along your wall and a width of 8 to 12 feet should be factored in as well. This will allow you to use an arc welder, a grinder and an anvil as well as the provision of space for plenty of storage, where things like scrap pieces of metal and welding rods would be kept.

He then goes on to break down some rules on each area which start with the Machining area. You should allocate between 8 and 24 ft for your Machining area and there should be plenty of rolling tool boxes and other movable tools factored in that can be used in this area. The next area is the carpentry area. In this area you will want to have several wall mounted storage units. The tools need to be placed and hung strategically in order to reduce fire hazards and increase organization. Last, he covers the lubrication area. She says that this should be an area in the corner of the service Bay entry. This is a place where you will locate oil and other lubricant equipment. You will need at least eight feet along the wall for this. Other pieces of equipment should also be factored in like a wall mounted air compressor, which you would want to be near your large entry. It is hard to consider adding too much storage room for flexibility within one of these projects.

Office Area

An office area can prove to be very effective in a modern-day shop. This is a place where farmers can store repair and service records along with machinery manuals. On some Farm operations a larger office will be needed so that farmers can house employees or host conference meetings. The author does state that offices larger than 10 by 12 ft should be attached to the outside of the building. You do not want to take up the space within the shop with an office.

Rest Room Area

The restroom area has also proven to be pivotal in the design of a shop. The restroom is typically adjacent to the office enclosure. There may be an added expense for a restroom but the convenience and safety of having one outweighs the cost. It makes cleanup extremely convenient and allows for a better work facility for many of the employees and the farmers. Laundry facilities are sometimes implemented as well although they are not deemed as necessary. Whatever the farmer can keep separated from the home is usually deemed as a victory.

Sizing the Farm Shop

Sizing the farm shop can be the next piece that is difficult in the project. The author states that the length depends on the length of the equipment that will be repaired in the shop. It will also depend on how much wiggle room is desired based upon convenience. For the most part the width is likely the same. The author does state that the width of the building should be at least twice the size of your large opening door. However, if the building exceeds 50 ft wide then your large entry door should be relocated to a sidewall instead of an end wall. This will help with work and space efficiency within all of the space that is required. In the projects both man passage doors and Machinery access doors will be needed. This is not only based upon convenience but based upon Energy Efficiency. Having man access doors will reduce the amount of heat loss in the winter and reduce the amount of times that the large door opening will have to be open. The author recommends that all doors are insulated in order to help again with heat loss. It is also important that all doors that are operated by machines have a man operated door beside them. This once again helps with heat loss but also provides a safe exit. It is also convenient to have a man access door on the opposite end of your machine operated door. This will allow for cross ventilation through the summer months.

Other

The author mentions several other features that help with the design of a shop but many of these features will need to be determined if they are effective or not by myself. There are several useful construction features that he mentions along with heating evaluation statistics but as the project proceeds those will be determined based upon location and specific design requirements.

Conclusion

In this piece of literature the author clearly gives practical steps to providing an energy efficient Farm Shop design. This is helpful because the Energy Efficiency of the building is important but the spatial efficiency of the building is equally as important. Taking many of these rules of thumb that the author has provided will enhance the design that I will be creating and will allow me to create a project which will properly suit most Farmers needs.

Literature Review Summary

Putting all of these research pieces together we can see that a picture is beginning to be painted. You have to start with the agriculture market and see what is available. Then you can move onto passive design and see what passive design may be effective, and actually help save in auxiliary costs in a climate that is cold for most of the year. Then you can look to design a shop for the farmer that implements passive design and meets all of their needs in the day to day life. As the process moves on, hopefully architects will begin to see the value of the agriculture community and market and slowly we then can grow valuable relationships that will run for years to come.

Starting with the agriculture community, the article about untapped hotbeds of rural communities helps us see that there is more than meets the eye to most of these communities. Rural communities in America are largely dominated by agriculture. The agriculture community is also full of people that know how to work hard and get creative. That is why it is no surprise that they provide so much for the US in the area of innovation. Innovation spurs and sparks markets to keep moving. It is so often believed that innovation only occurs in large creative urban spaces but studies have shown otherwise. I personally have seen the rural communities create several creative solutions for complex issues. I think the statistics back up what I have seen and what the rural community believes.

The innovation that happens in rural communities is not something that just benefits them though. The studies show that they help move several markets forward. The potential for innovation shows that there is also so much room for growth here. This is where architects have an opportunity to step in and contribute to the innovation that is happening.

The next thought is then, how can architects step into this innovation. I believe that with our background of passive design we can make a big step in innovation. Shop designs have remained, generally, the same for the last half century but I believe that with smart passive design strategies we can lower costs long term for farmers. I also believe that the quality of space can be increased significantly. Implementing strategies like rock beds and sun heated spaces alone can lead to a lot of savings on auxiliary costs. At the end of the day, these strategies must provide a positive ROI that will make the farmers want to change their current shop designs. More site specific research will be done in this area but this research shows that there are certainly strategies that can be effective in our tough cold climate.

Once we can see that the market has room for architects and that there are areas where we can improve designs for farmers we can start to look at actually designing. The last article gives a great example of how to practically design a shop space for farmers. We can come up with as many cool conceptual ideas as we want as architects but if we do not have designs that work efficiently then we will never sustain any success. There are so many details that go into effeicenty. Big aspects like where to put openings and building orientation. Along with small details like where to add tool racks and shelves. These things must not be taken for granted in the process of the design.

Overall we can see that Architects have missed out on the innovation of rural farm communities, however, it is not too late. Architects should get creative with how they can provide their services for farmers. Whether that is redesigning the typical shop or coming up with something that thinks about the future of farming and fully automated vehicles. The possibilities are already endless and I believe that they will only continue to grow.

Project Justification

For me personally, this project is extremely important because it bridges a gap that has never been bridged before. The project is starting to bridge the gap between architecture and Agriculture while tying passive design in the midwest into the mix. I have seen so much separation between architecture and agriculture.One reason I believe that this is important is because, at this stage, it will be very relevant to my professional career. I believe that this project can lead to a lot of success in the MidWest, in the real world. Overall, the idea for this project is that it will not just be for theoretical purposes. I want this to be a way that I can gain trust with the agriculture and architecture community now.

Some of the knowledge that I would like to grow in, is knowledge in the area of passive design. Passive design sounds like it could be very effective but I would like to find a way to use it in the upper MidWest. I want to see if there is an economic solution to the issues that we are presented with in the area. I will learn and put into practice professional documentation and find how to refine documentation of passive design all together. The knowledge that I will gain will then be poured into people around me in the profession, and hopefully lead to a greater desire to interact with the agricultural community. I believe that the profession, especially in this area, has very little connection with agriculture, which is sad, because the area we live in is so driven by agriculture. I believe that the profession needs to have a connection with agriculture and can have that connection.

Another important piece that needs to be justified is whether this idea is justifiable economically. So much of the issue with passive design in architecture is the economic issue. We do not take it seriously enough that for something to be sustainable it must be economically sustainable. That is half the battle. I want to see a number of passive design strategies combined in a simple shop structure out on the farm that would be exposed to the elements, can be economically sustainable and have an ROI that is appealing to all farmers in the Upper MidWest. Expending funds on this project would lead to hopefully saving on funds in the future for the agriculture community. It would also be extremely helpful to those who are looking to push for effective passive design. A solution will come to be and it will either be successful or not, but the reward is far greater than the risk at this point I believe. I would also like the project to be funded by private businesses. Private investments help everyone along the way and stay motivated to use the money efficiently. I do not want any government investments in this project and if it were possible I would love to fund this project myself. If you do not have a good return on your investment, there is very little incentive to have to project done.

I also believe that the project can have support from people that may identify themselves as environmentalists. The project would be very safe within the environment. As passive design is used the impact on non renewable and limited renewable resources would be very limited, in theory, depending on the findings.

At the end of the day, this project could be left for a professional to solve but the research will likely take a good chunk of time so it would likely not be very desirable. I believe that school is the correct place to begin and complete the majority of the research for this project.

Historical, Social and Cultural Context of Thesis

For most of my life I have grown up around the farm setting. I grew up in a town of 7,000 people that is driven by agriculture. My parents and grandparents all farmed, although right before I was born my parents decided to move off of the farm. This did not stop my family's love for the farm though. Most family holidays we would go up to my grandparents family farm. Many of our friends were also farmers so the concept of farming was nothing new to me. The culture was also nothing new to me. A culture that is built on working hard and being grateful for what you have, because as a farmer you're much of your financial success relies on the weather and what each season brings. That is not to diminish the incredible base of knowledge that farmers have to have in order to even have the opportunity to have a successful planting and harvest. As I came to college and pursued architecture more I realized that the fields of architecture and agriculture do not seem to have a lot of areas where they intersect. I did not know why and still do not fully know why but my goal is to begin the process of bringing the two fields together in a simple yet strategic way.

FIG. 58.1

This project relaties indirectly to so many projects throughout history, however there is nothing that exactly relates to this project. The focus of the project ties into both passive design, which has been studied in depth over the last half century, and creating a farm yard shop design. Farm yard shops have been designed to be the same everywhere. It makes for a cheap design process and easy construction but does it really save the client, the farmer, money in the long run? That is the biggest question that will be answered through the process. I also believe that if farmers are willing to invest in this new type shop, then they can also have a higher quality design, both on the interior and the exterior.

To my recollection, a project of this exact scope has never been done before. In the scope of work and research it is really a hybrid project, but the greater goal of tying the architecture market and agriculture market together is something that is completely new. I think we can maybe find out why by taking a look back at history.

FIG. 59.1

Agriculture is work that we as humans have had to do almost since our creation. We are responsible for taking care of and providing for each other and the provision of food is one of those most basic needs. Architecture however has been a field that maybe at its core has not changed a lot since we started building shelters, but beyond that aspect it has completely transformed. Agriculture is not lacking transformation either. As they have transformed though certain cultures and identities have been taken upon each field, and rightfully so. Architecture has become more Urban. The system of the modern day city has allowed for a great pool of money to be accessed and in turn be spent on a variety of architecture projects. Architecture has in a sense become art. Buildings are a symbol, a piece that represents what you or your company really is. Architecture is a piece of your marketing.

FIG. 60.1

FIG. 61.1

Where Architecture has embraced the Urban culture, agriculture has embraced the Rural culture. Logistically, to farm you need to have a lot of acreage to farm. That way you can be as efficient as possible. There is really not a lot of room for practical and efficient farming within an urban setting. Our farmers provide food for the world and they are always looking to improve efficiency and returns. Logistically there is good reason for architecture and agriculture to separate into Urban and Rural, physically. I think the bigger issue over the years has been that the Urban setting of Architecture has forgotten that the cultural difference of Rural Agriculture does not have to remove the access to their market. I think that Architects do not know the money and market that the agriculture community has and the agriculture community does not always want to open up to something different. There are certainly pieces that farmers should hold to as non negotiable but if there are forms of architecture that can either improve efficiency or personal experience then I think that they should be considered.

Looking at cultural differences and where we can make connections allows us to relate this project to social trends and developments in our society. Relating heavily to culture the social trends of architecture are becoming more and more Urban. However the Urban trends are changing. In a lot of ways, I see design in the urban setting paying homage to rural design. I see that within hard urban spaces we are trying to tie softer and more natural materials. I think that's why so many people in rural communities love where they live. There is something in us that was created to desire and be in awe of the natural world. At the very least we can all hopefully agree on that. So as we find ways that we can relate on a human creation level I think the barriers between Urban and Rural along with Architecture and Agriculture can start to fall. I think then when we get to this point we can start to see there is a really unique and untapped relationship that can be created here. My goal is to start this relationship by showing how architects can help farmers while not throwing efficiency and great ROIs to the side.

FIG. 62.1

FIG. 63.1

Site Analysis

Site Extents

The site is located about 25 miles southwest of Cavalier North Dakota. It currents serves as a Farm Yard for Shepherd Farms. It hosts a couple of storage/shop units along with a house and a small grain bin. Across the road there is another shop and bin site. There are 5 bins located there along with a dryer. There is room for circulation and plenty of vegetation on site. As a whole the site is just about 9 acres.

FIG. 64.1

FIG. 64.2

Views

When considering views I want to look specifically at where the new show would be located. The new shop would be replacing the existing shop which is tucked in along the shelterbelt along the west side of the property. Views will be considered from inside the shop along with the views of approaching the shop.

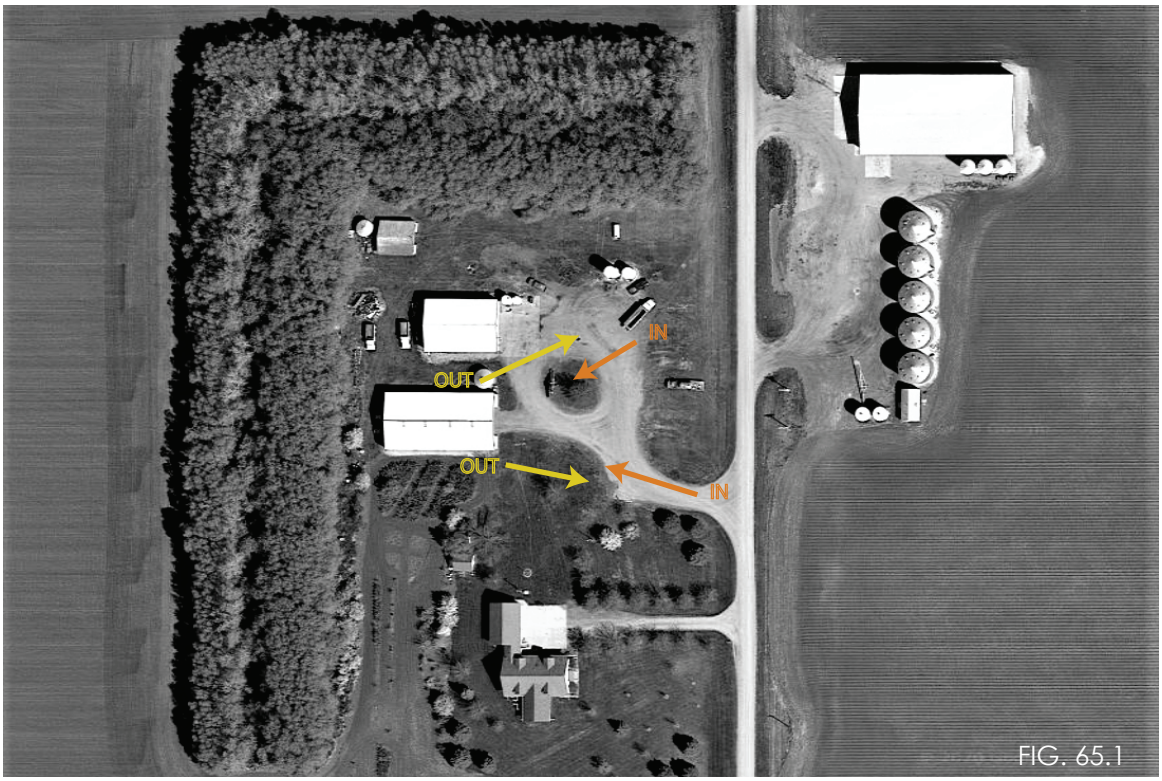


FIG. 65.1


FIG. 65.2


FIG. 65.3


FIG. 65.4


FIG. 65.5

Site Character

The site's character is very occupied. There are several structures on site but it is also a bit stale. It is lacking a piece that may draw you in. This is not necessarily a bad thing as many farmers do not want to draw a lot of attention. They also do not need something flashy, rather they need something that is functional.

Some people may think that the site seems lifeless but this is really a matter of preference. When comparing this yard to typical farm yards it is very nice. Openness and space does not mean it is lifeless in every way. It may more so be a way of showing how much space is needed to run an operation.


FIG. 66.1


FIG. 66.2

Sun Studies

For the studies that I am performing, solar orientation is extremely important. The site is longer east to west but the current building orientation does not reflect the same. When looking at solar heating it will be important to find ways to maximize sun exposure, especially along the south edge. Considering how the vegetation will affect the amount of sunlight allowed into the building will also need to be taken into perspective with the final design. Overall the south side of the building will contain as much glass as possible to allow for passive solar heating and the building will be rearranged to have the longest section run east to west.

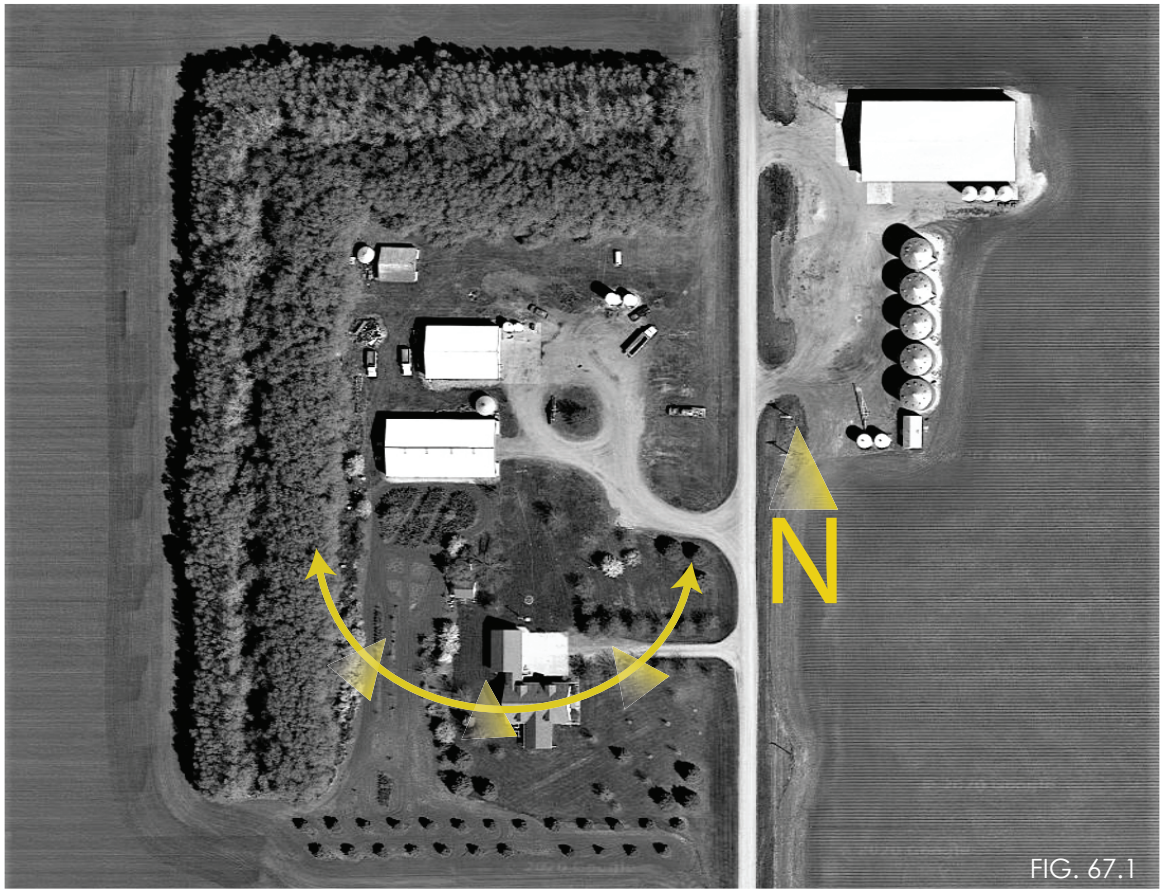


FIG. 67.1

Vegetation

This site is full of vegetation. The yard is mostly grass with different types of trees spread throughout. There is a spread of new deciduous and coniferous trees planted all along the south portion of the site. The West and North edges of the site are lined with shelter belts that consist of deciduous trees. This is to protect the yard from the harsh North Dakota winds. The site is also surrounded by fields where there would be crops from planting season to harvest season.

FIG. 68.1

FIG. 68.2

Water

There is no water on the site but there are several rivers and streams in the area. In the diagram seen below you can see the streams that break off of the Tongue River. The Tongue River runs from Pembina County into Cavalier County in North Dakota.

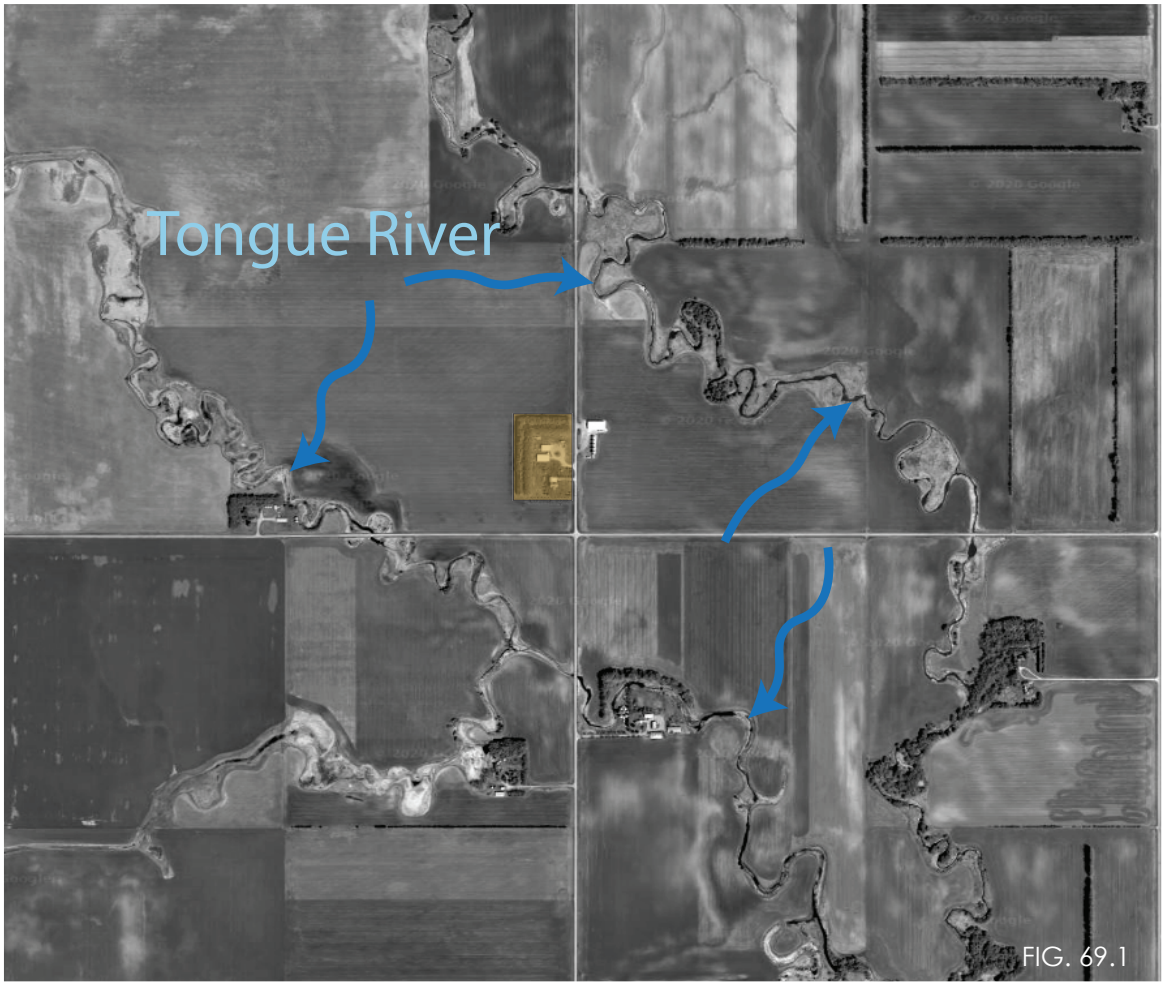


FIG. 69.1

Wind

Wind in this area most commonly comes from the North West. This means that the shelterbelt location was placed perfectly in order to protect the yard from wind. It is very typical to see wind speeds between 10 to 20 mph. The average wind speed is 10.9 mph. The wind speed and direction like anywhere in the country, changes depending on the weather patterns.

FIG. 70.1

Soils

87 percent of the area is made up of Rolling, Loamy and Silty Soil. This is soil that is formed from glacial till and deposits. This is very good soil for cultivated crops so it makes sense why agriculture is so dominant in the area. The biggest concern with this soil is controlling soil blowing and water erosion.

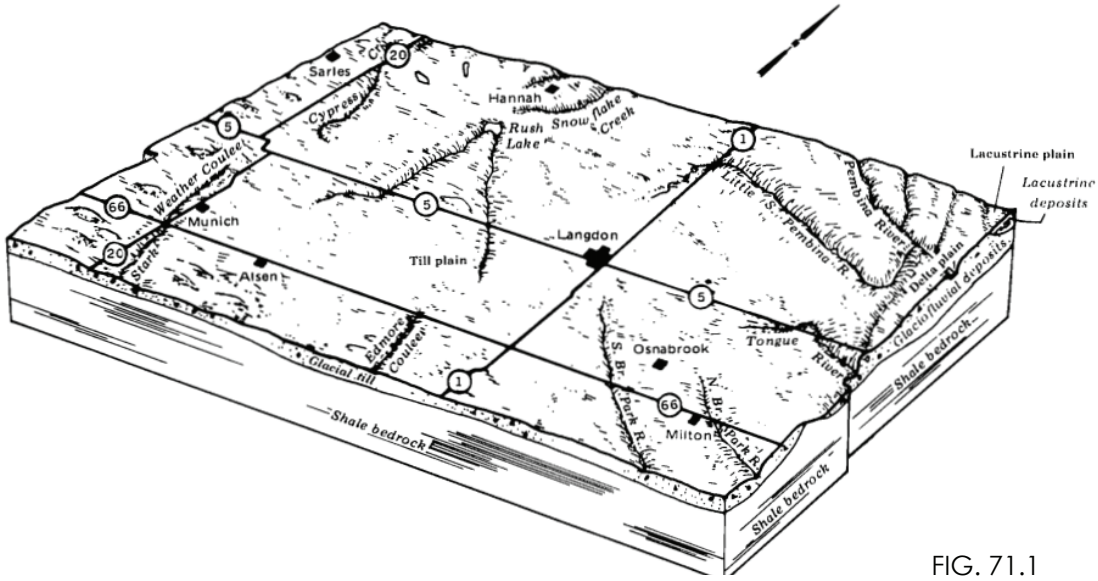


FIG. 71.1

Climate

The site is in what is a humid continental climate. This means that summers here are not and the winters are very cold. There is a large variance in the amount of precipitation and temperatures in the area. The average temperature ranges from 77 degrees to 87 degrees on average in the middle of July. Temperatures during the winter typically drop to be below zero for an average of 40 to 70 days. Even with the fluctuating temperatures and precipitation we are still able to calculate that they receive 14" of precipitation on average.

FIG. 72.1

FIG. 72.2


BIG TOP
Bullet Rotor
4
9870 STS
JOHN DEERE
6350

Performance Criteria

Code Compliance

My project will meet all of the local code requirements. That means that all International Building Code Standards will be upheld. This also means that all of the local ADA codes that are in place will be met. I want the building to be able to be used by all users and I believe that this is the right thing to do. It is also required by local building and code officials. I do not want to push code officials to believe that anything in the building is out of place and not up to code.

Performance Analysis

The structure shall receive approval from the farmers that have been researched. If the desired cost increase is only 10 percent and it needs to pay that 10 percent back within 10 years then that will be the standard for success. These numbers are still being acquired as I do not want to have a small sample size that skews the numbers. I want this to be valid and that is why extra time is going into this area. It was considered meeting LEED Platinum but this project is more about the cost analysis of passive design in our climate so the ROI is the most important number to the validity of the project.

Example Placeholder: Farmers on average have said that they have spent an average of 200,000 dollars on new shops that have a bathroom and office space. They have also said on average that they are willing to pay an extra 10 percent, but that extra 10 percent needs to be paid off within 10 years. That way if the structure will stand for 60 years, the next 50 years of its life will be cheaper for them. If the structure can not meet these numbers then it will be considered a failure on the performance side of things.

Summary

Local codes will be met and will be taken into the highest regard. There will be no stretching of code officials. The project will be completed with the highest ethical standard. The project will also be considered a success or a failure based upon the farmers collective ROI that is needed. These numbers will be carefully calculated and applied to the form of the structure. This is an important place to start. If the ROI can reach a reasonable number then visual design changes can be considered.

Tools For Further Development

Climate Consultant by UCLA

Revit: Energy Modeling

AutoDesk Green Building Studio

Space Allocation

These diagrams show the simplicity of the shop design. However having these spaces closely designed is crucial. We could see that in the literature that discussed shop designs. Every space is placed adjacent to another for a reason and there are subspaces that will be designed even further than what is shown in these diagrams.

ALLOCATION OF FINISHED FLOOR SPACE IN SHOP SPACES

	SMALL		AVERAGE		LARGE	
SHOP	900	55%	1,500	58%	2,500	63%
STORAGE	500	30%	750	29%	1,000	25%
BATHROOM	50	3%	50	2%	50	1%
OFFICE	200	12%	300	11%	400	11%
TOTAL	1,650	100%	2,600	100%	3,950	100%

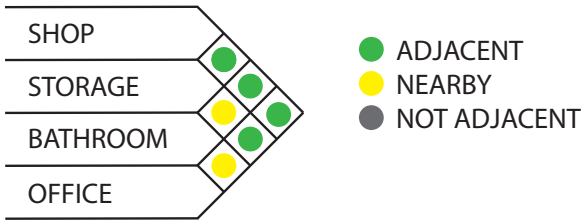


FIG. 76.1

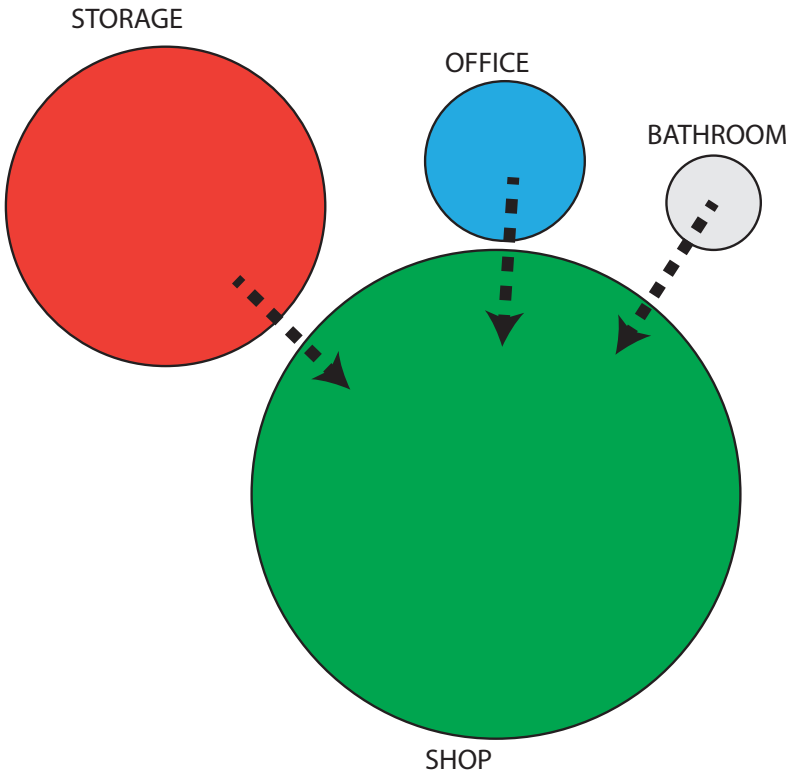


FIG. 7.1

FINAL DESIGN

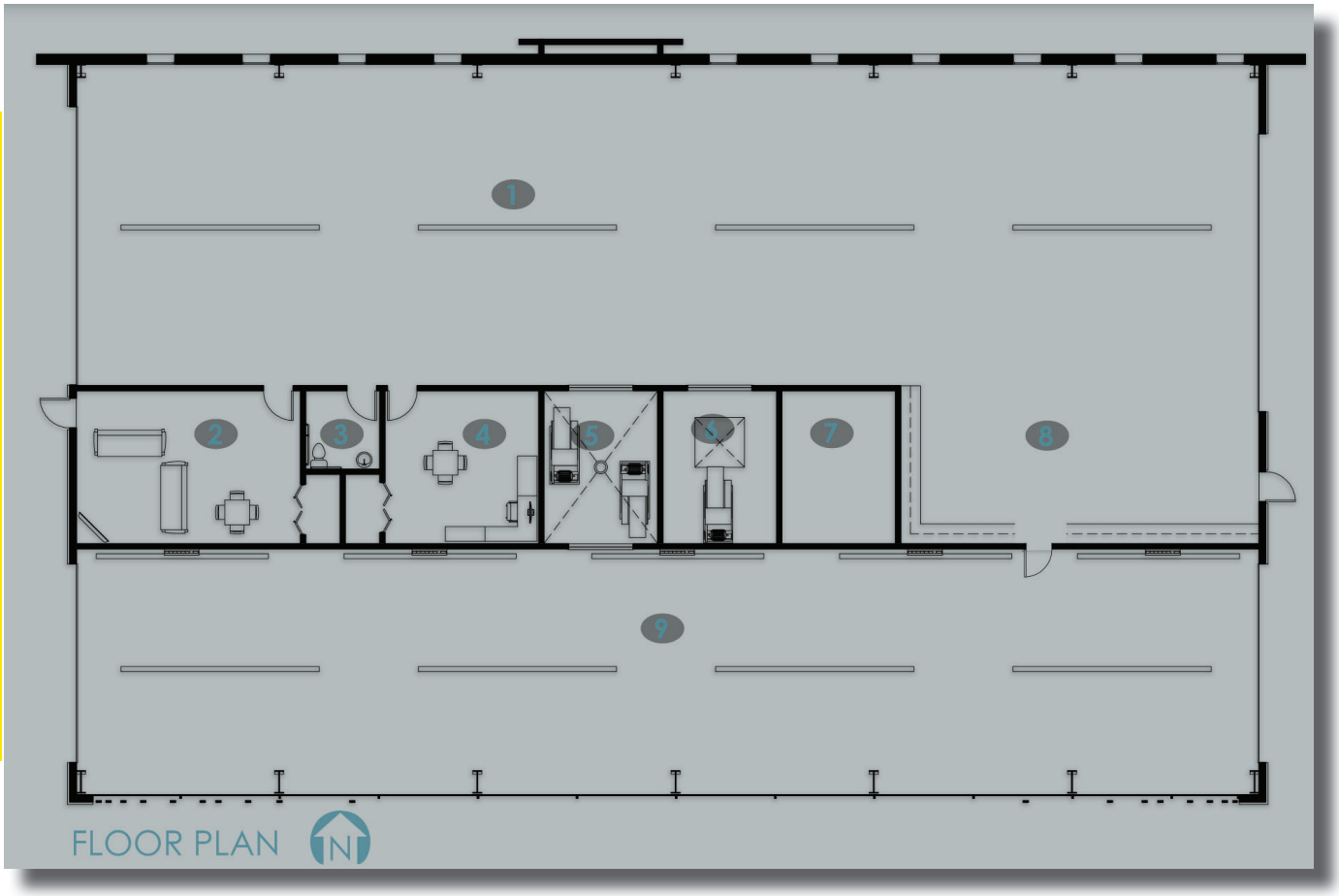
AG ZERO

SITE LOCATION

The site is located near Cavalier, North Dakota. It is owned by Thomas Shepherd who is a farmer who is looking to build a shop space for the future. The site is near the Red River Valley, where Thomas Farms with his family. The site is close to where my family grew up farming which increases the value of the site to me in a sentimental way. It is crucial that the location is closely studied and evaluated in order to get the best design.

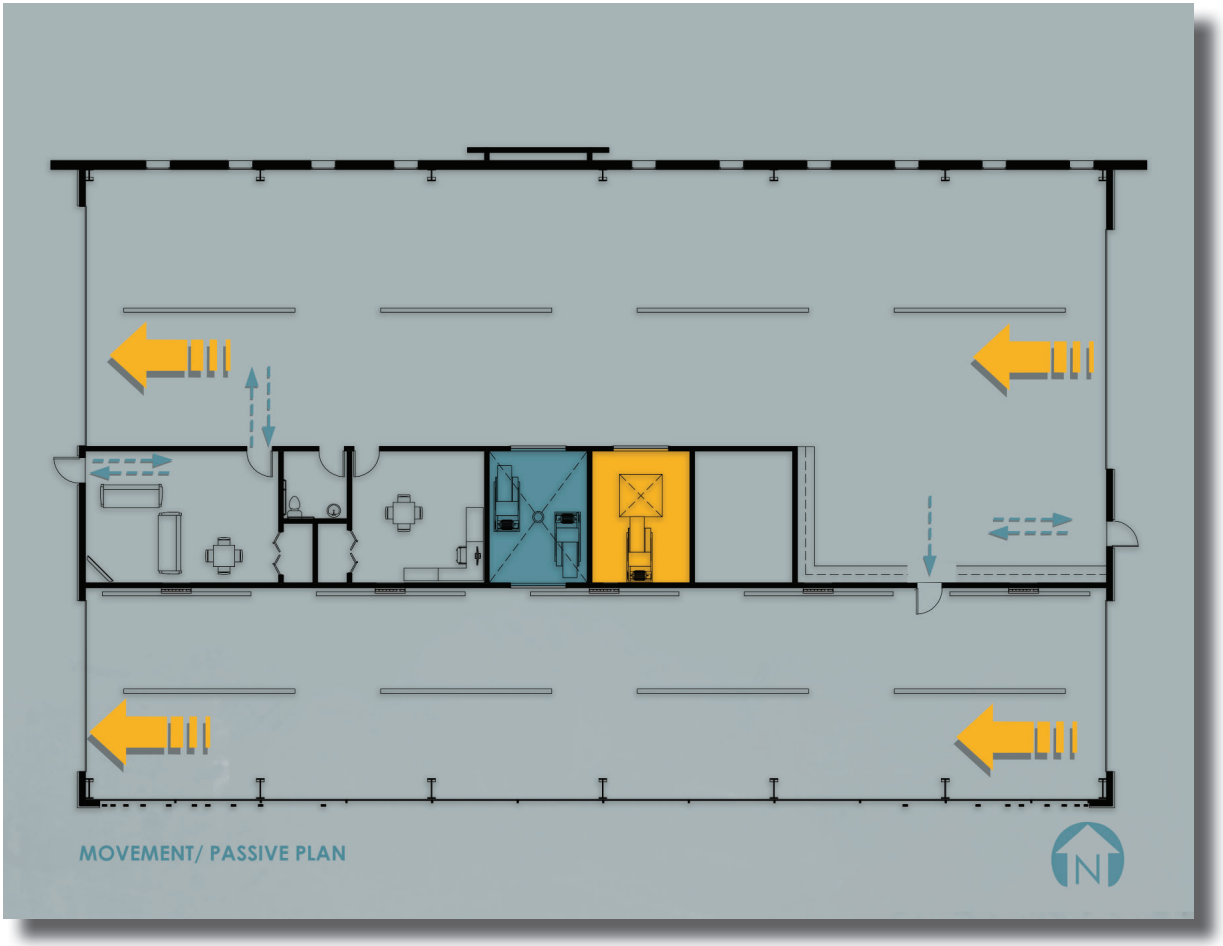
SITE PLAN

FLOOR PLAN



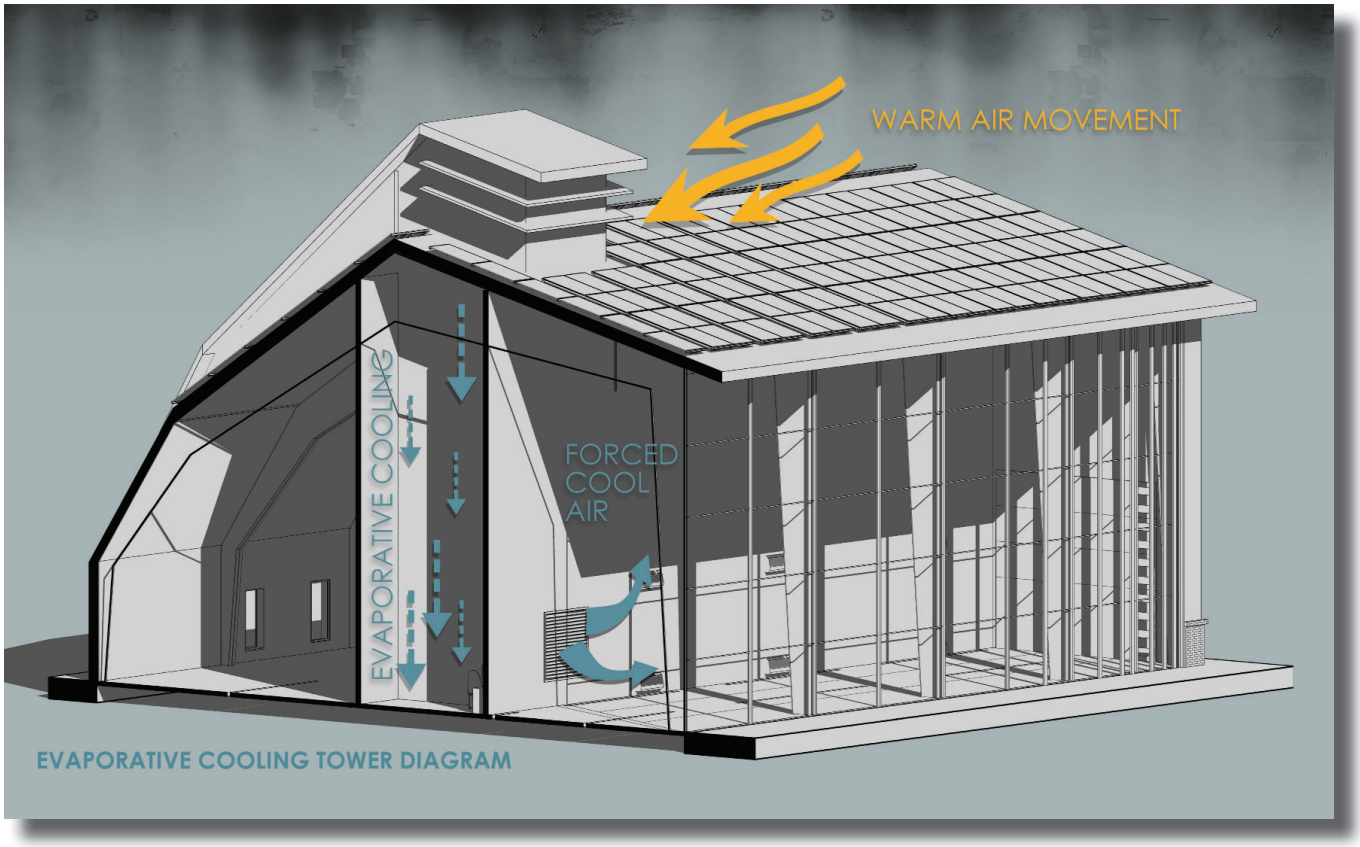
1 SHOP SPACE
2 BREAK ROOM
3 BATHROOM
4 OFFICE
5 COOLING TOWER
6 ROCK BED VENTILATION
7 MECHANICAL ROOM
8 WORK BENCH/ CABINETS
9 STORAGE/SHOW ROOM

MOVEMENT PLAN



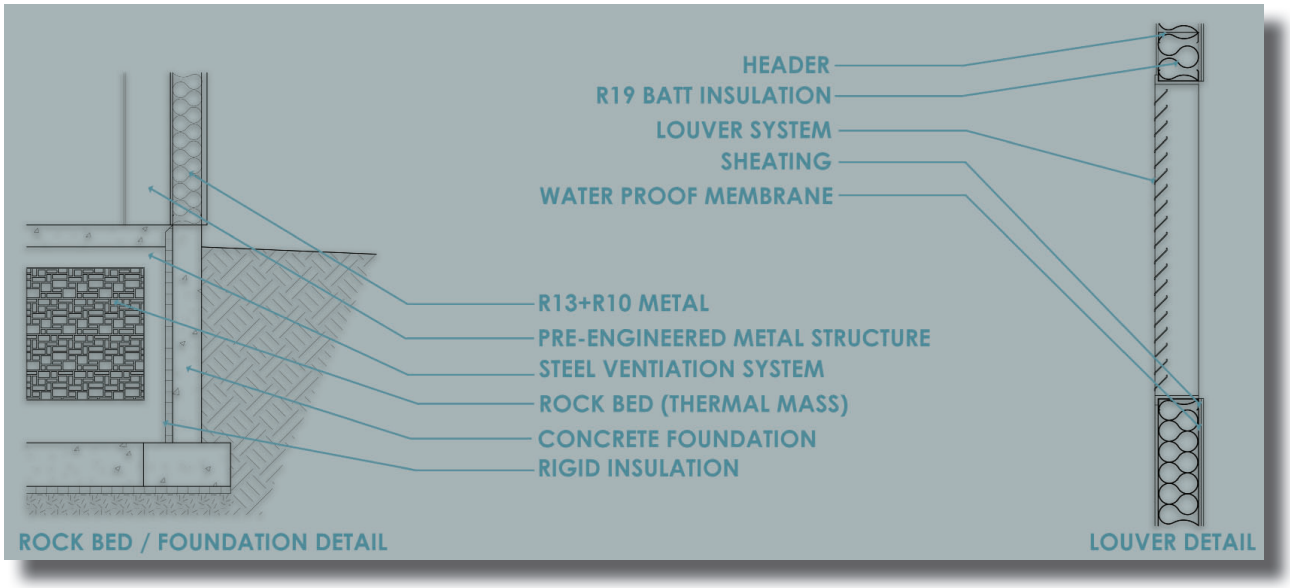

EQUIPMENT MOVEMENT
PEOPLE MOVEMENT
ROCK BED VENT (HEATING)
EVAPORATIVE COOLING TOWER

SECTION/PASSIVE DIAGRAMS

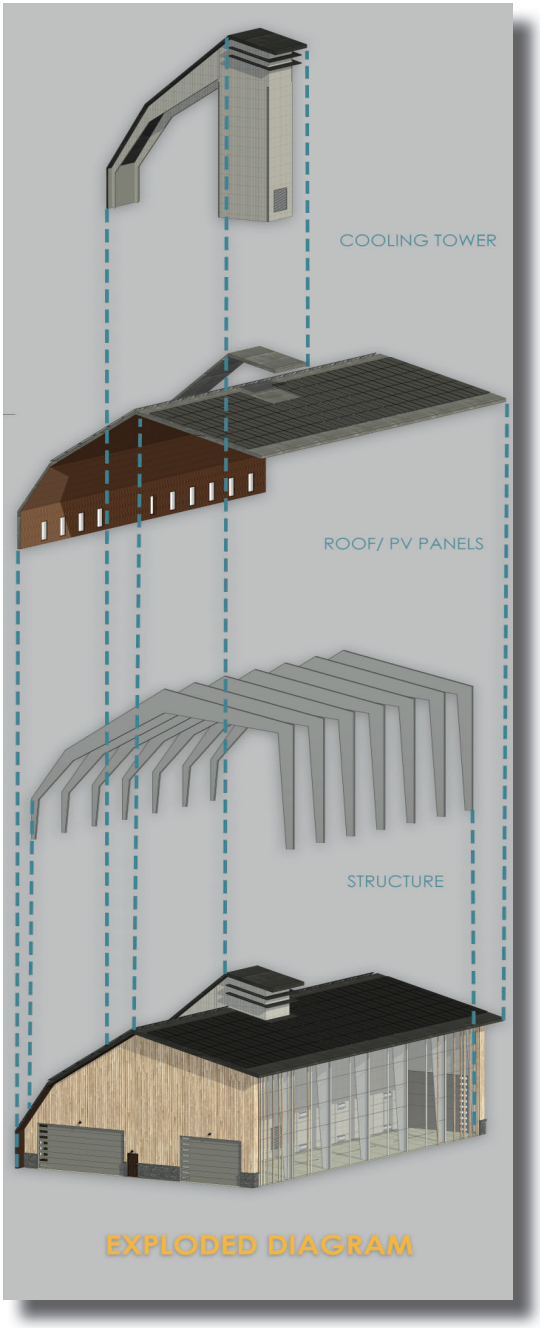



SOLAR HEATING
FORCED AIR
INTO VENTS
HOT AIR FOCED
INTO COOL SPACE
ROCK BED / THERMAL MASS DIAGRAM

DETAILS

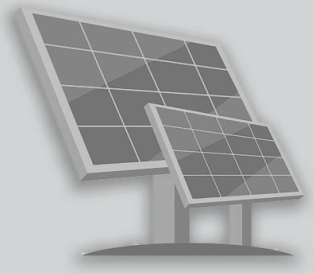

HEADER
R19 BATT INSULATION
LOUVER SYSTEM
SHEATING
WATER PROOF MEMBRANE
R13+R10 METAL
PRE-ENGINEERED METAL STRUCTURE
STEEL VENTIATION SYSTEM
ROCK BED (THERMAL MASS)
CONCRETE FOUNDATION
RIGID INSULATION
ROCK BED / FOUNDATION DETAIL
LOUVER DETAIL

EXPLODED DIAGRAM

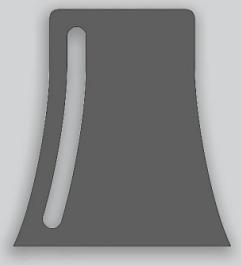


PASSIVE DESIGN STRATEGIES

THERMAL MASS: A ROCK BED BELOW THE FLOOR IS USED TO HEAT THE BUILDING PASSIVELY

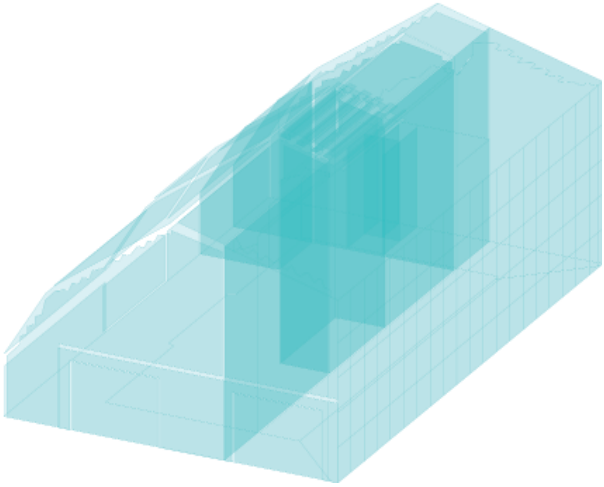


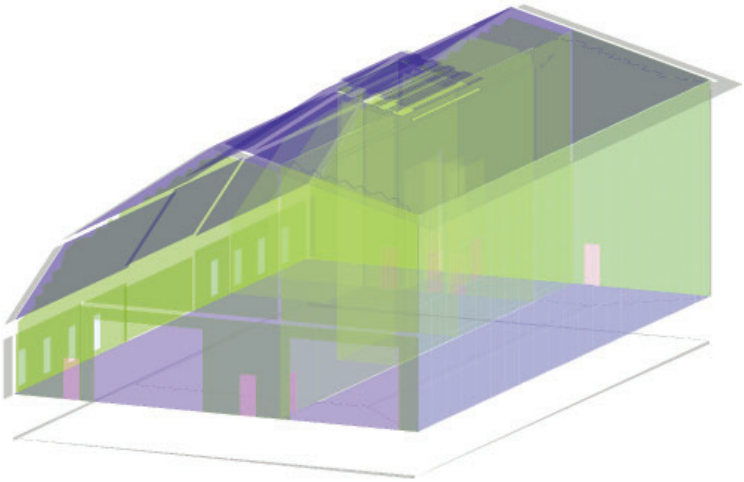
SOLAR PANELS: PV PANELS ARE USED TO COVER NEARLY THE ENTIERTY OF THE ROOF TO CREATE ENERGY.



COOLING TOWER: AN EVAPORATIVE COOLING TOWER IS USED TO PASSIVELY COOL THE STRUCTURE.

ENERGY MODELING





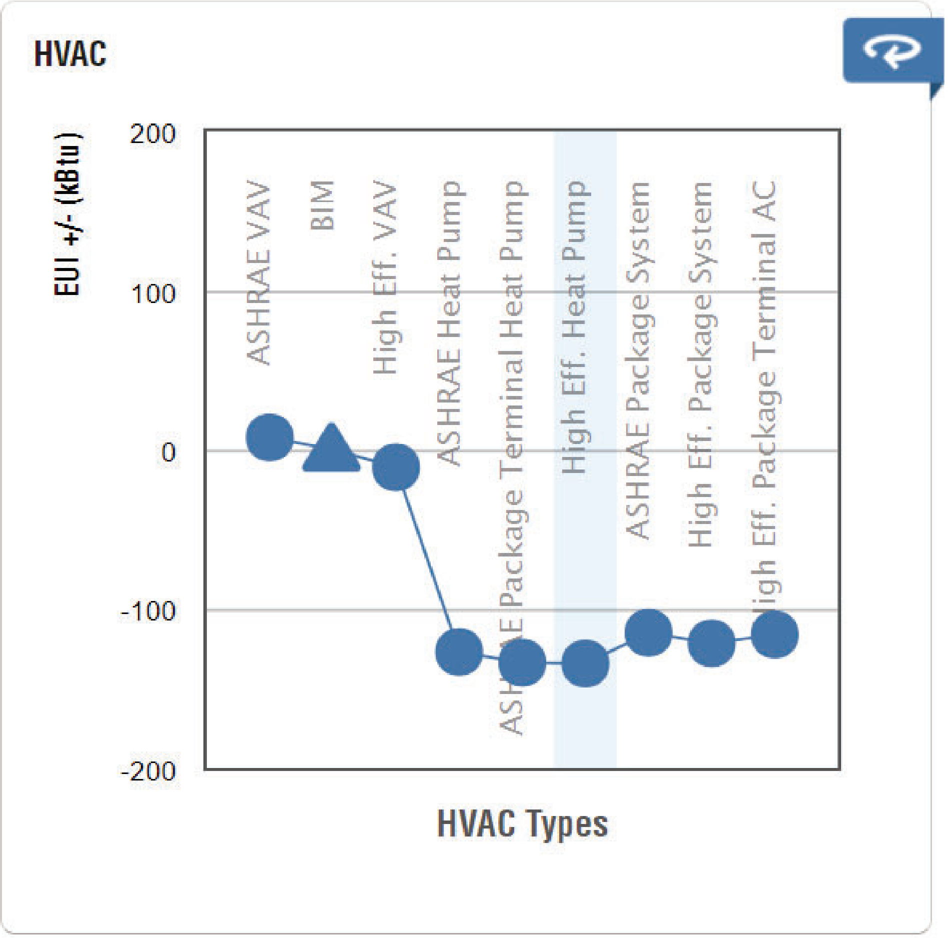
NET ZERO STRATEGIES

HVAC

Represents a range of HVAC system efficiency which will vary based on location and building size.

Current Setting:

High Eff. Heat Pump

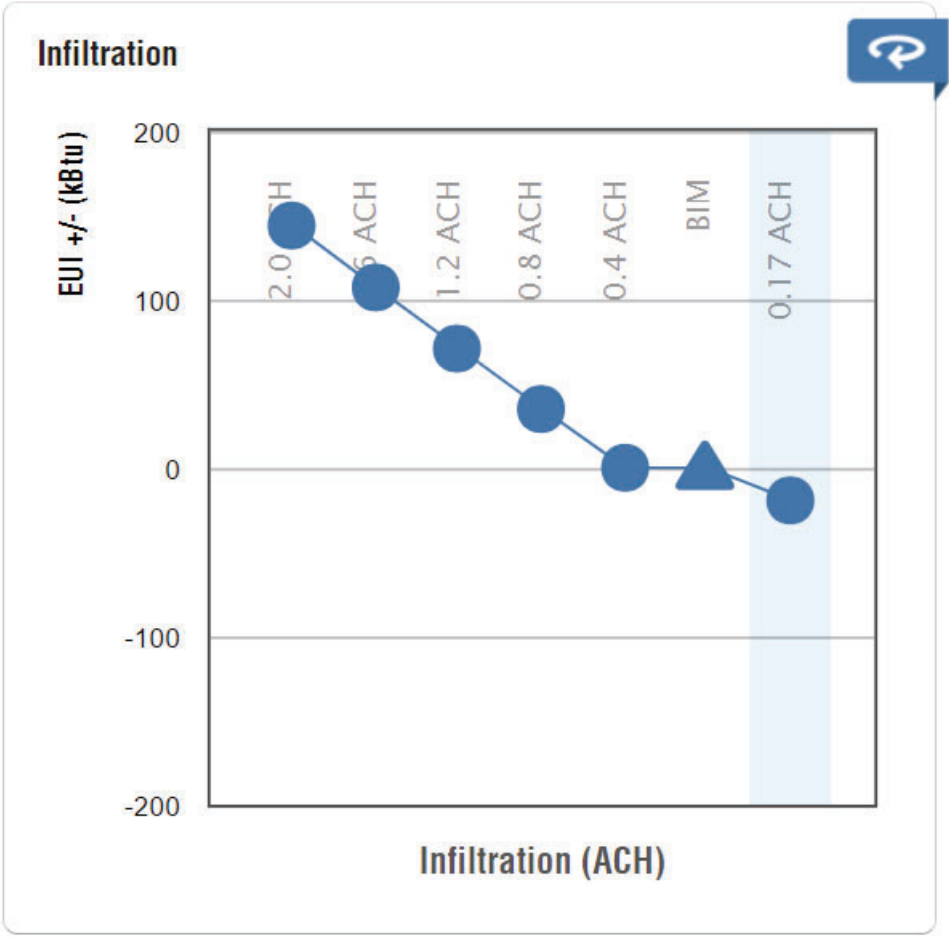

HVAC
EUI +/- (kBtu)
200
100
0
-100
-200
ASHRAE VAV
BIM
High Eff. VAV
ASHRAE Heat Pump
ASHRAE Package Terminal Heat Pump
High Eff. Heat Pump
ASHRAE Package System
High Eff. Package System
High Eff. Package Terminal AC
HVAC Types

Infiltration

The unintentional leaking of air into or out of conditioned spaces; often due to gaps in the building envelope.

Current Setting:

0.17 ACH

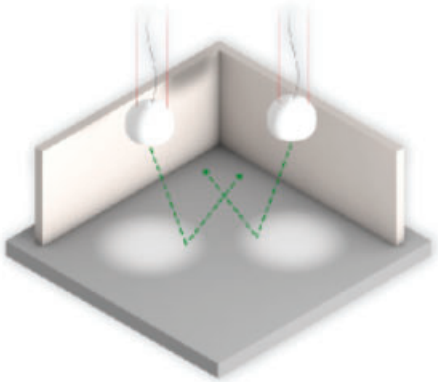

Infiltration
EUI +/- (kBtu)
200
100
0
-100
-200
2.0 ACH
1.2 ACH
0.8 ACH
0.4 ACH
BIM
0.17 ACH
Infiltration (ACH)

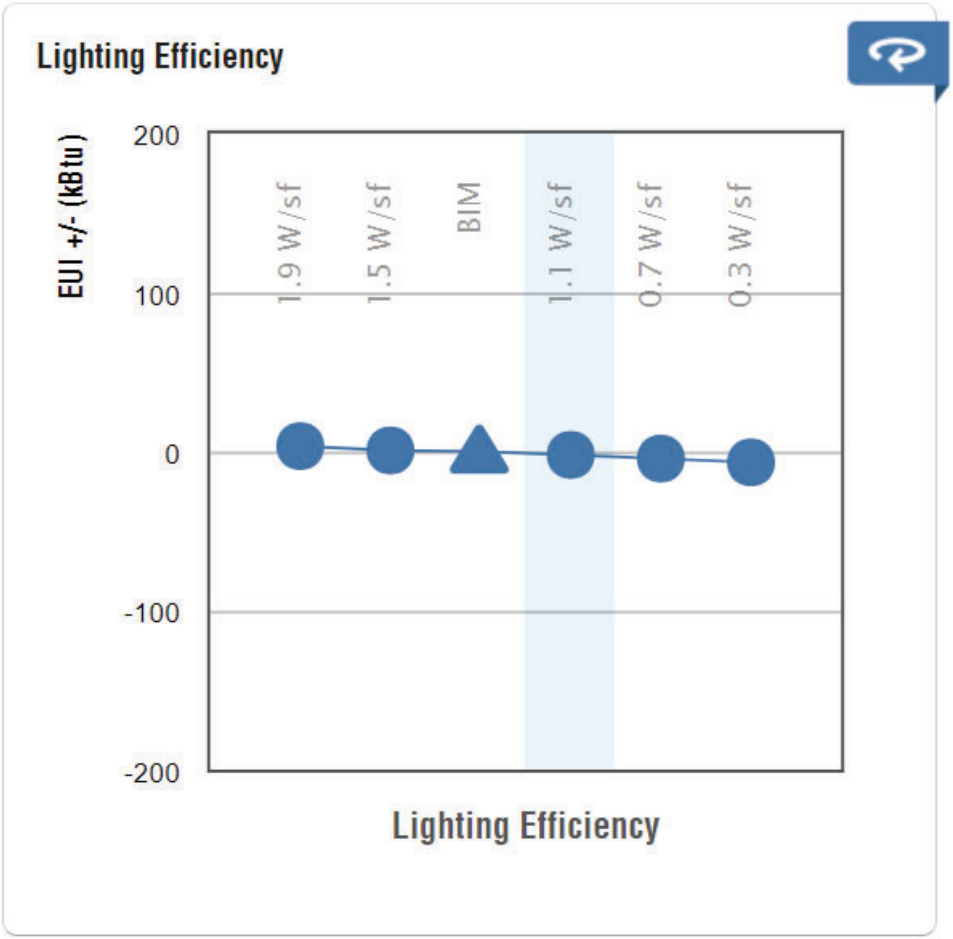
Lighting Efficiency

Represents the average internal heat gain and power consumption of electric lighting per unit floor area.

Current Setting:

1.1 W/sf



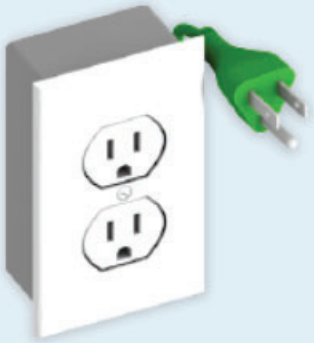

Lighting Efficiency
EUI +/- (kBtu)
200
100
0
-100
-200
1.9 W/sf
1.5 W/sf
BIM
1.1 W/sf
0.7 W/sf
0.3 W/sf
Lighting Efficiency

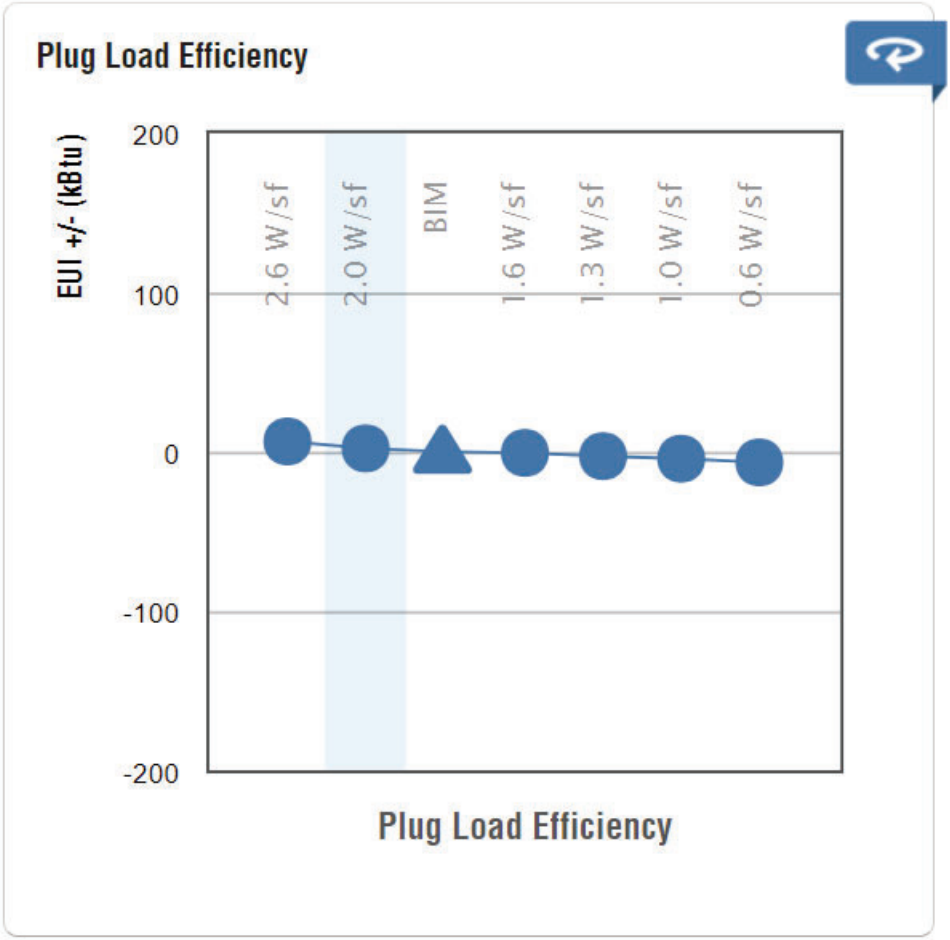
Plug Load Efficiency

The power used by equipment i.e. computers and small appliances; excludes lighting or heating and cooling equipment.

Current Setting:

2.0 W/sf



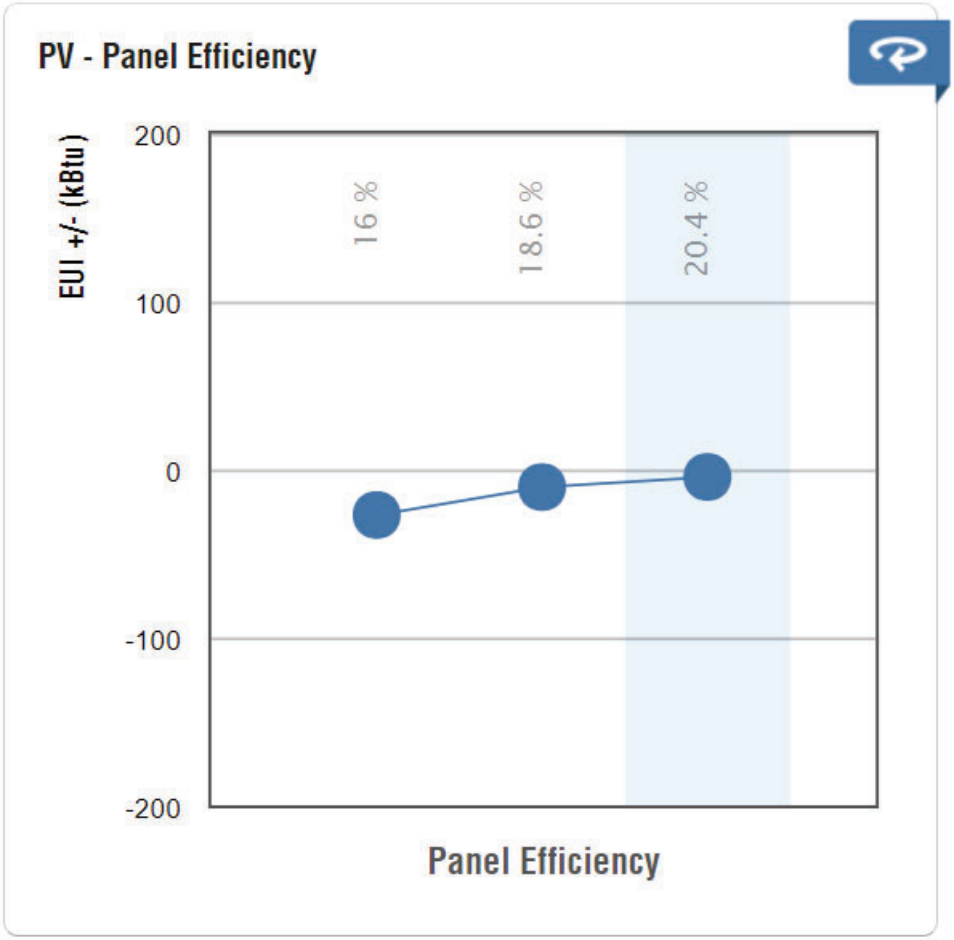

Plug Load Efficiency
EUI +/- (kBtu)
200
100
0
-100
-200
2.6 W/sf
2.0 W/sf
BIM
1.6 W/sf
1.3 W/sf
1.0 W/sf
0.6 W/sf
Plug Load Efficiency

PV - Panel Efficiency

The percentage of the sun's energy that will be converted to AC energy. Higher efficiency panels cost more, but produce more energy for the same surface area.

Current Setting:

20.4 %

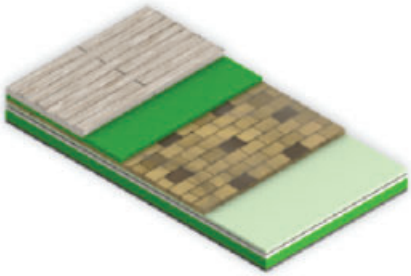

PV - Panel Efficiency
EUI +/- (kBtu)
200
100
0
-100
-200
16 %
18.6 %
20.4 %
Panel Efficiency

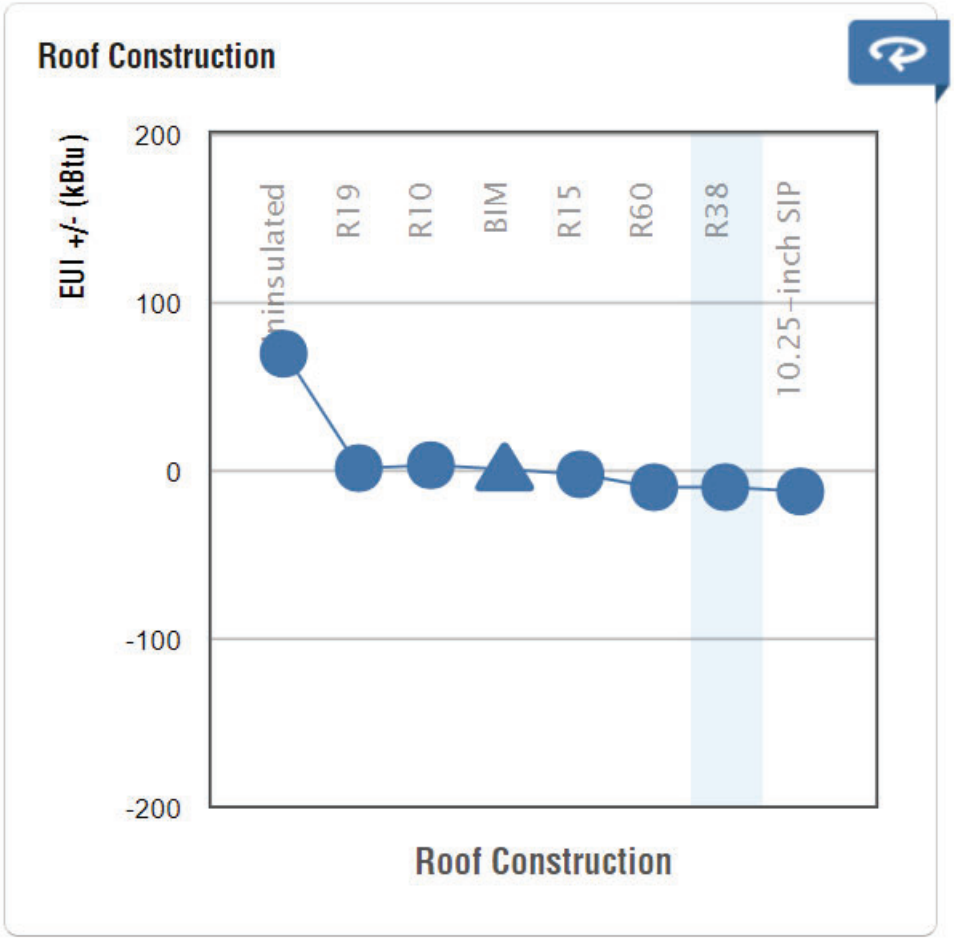
Roof Construction

Represents the overall ability of roof constructions to resist heat losses and gains.

Current Setting:

R38



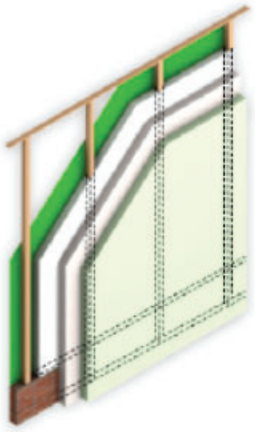

Roof Construction
EUI +/- (kBtu)
200
100
0
-100
-200
Uninsulated
R19
R10
BIM
R15
R60
R38
10.25-inch SIP
Roof Construction

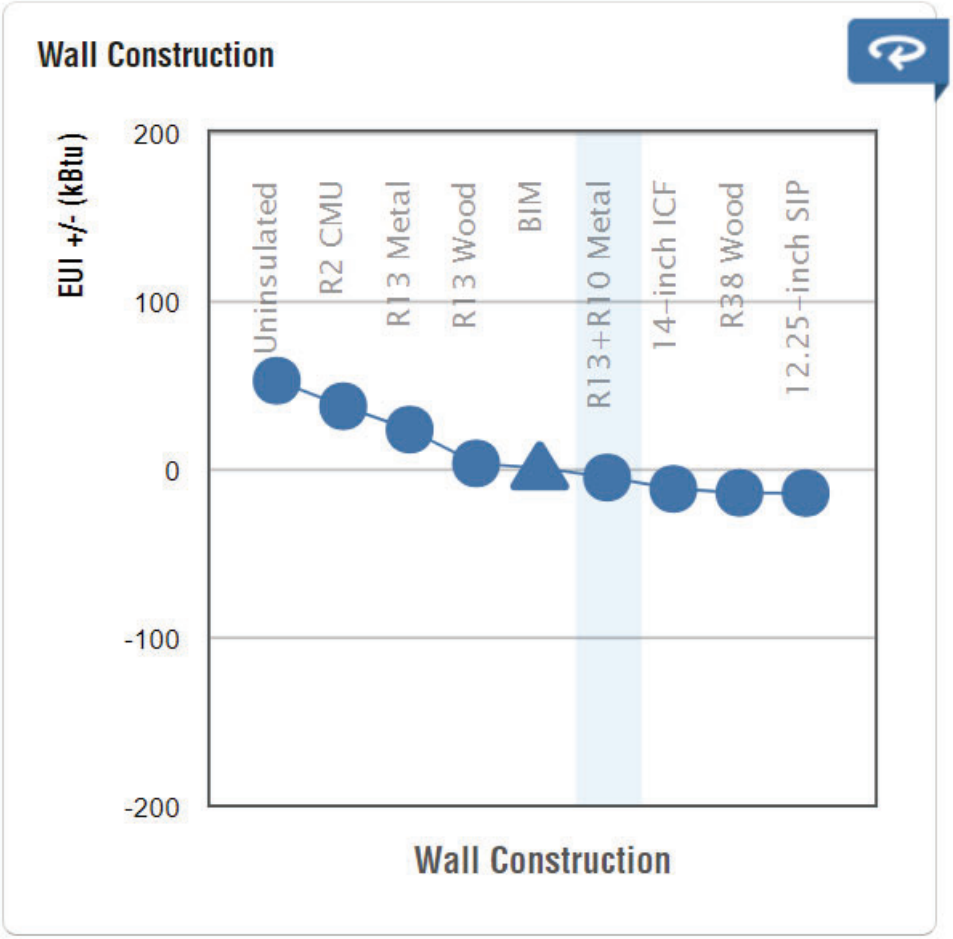
Wall Construction

Represents the overall ability of wall constructions to resist heat losses and gains.

Current Setting:

R13+R10 Metal




Wall Construction
EUI +/- (kBtu)
200
100
0
-100
-200
Uninsulated
R2 CMU
R13 Metal
R13 Wood
BIM
R13+R10 Metal
14-inch ICF
R38 Wood
12.25-inch SIP
Wall Construction

FINAL RENDERS


AMAZONE
Cenios 70

APPENDIX

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PREVIOUS STUDIO EXPERIENCE

2nd YEAR

Charlott Greub

Projects:
Tea House | Fargo, ND
Boat House | Minneapolis, MN

Charlott taught me a lot about how to use case studies and apply them to your style. She also let me push the boundaries of what is possible, which was unique for me.

Cindy Urness

Projects:
Marfa Single House | Marfa, TX
Multi-Use/Multi-Family Living | Fargo, ND

Cindy taught me to think outside of the box. Don't only design what you know but get out of the box and consider using new materials or forms that you never have before.

3rd YEAR
Paul Gleye

Projects:

Fargo Visitor Center | Fargo, ND
Downtown Multi-Use Center | Fargo, ND

Paul taught me how to simplify things to create a dynamic form that stays true to what you want to design. At the end of the day it is about taking an idea from you head and making it happen.

Regin Schwaen

Movable Structure | Fargo, ND
Native American Museum | Moorhead, MN

Regin taught me to dream up new ideas while having an order and a reason for everything that you do. Ratios matter, layouts matter.

4th YEAR
Mark Barnhouse

High Rise | Miami, FL
Green City | Miami, FL

Mark taught me so much about how to approach design from a practical sense. It is vital to have layouts that will actually work, and have materials that can be well detailed and implemented properly.

5th YEAR
Lance Josal

Fenway Park Redesign/ SURGE Design | Boston, MA

Lance has taught me that the best idea always wins. This is a process. You need to think, think, and rethink and then execute.

ABOUT THE AUTHOR

Chandler Dick

The project was formed from his love for the Agriculture Community and the Design of Architecture. Chandler grew up in Devils Lake, North Dakota. A community that is consumed by the agricultural industry. His family farmed up until he was born, but he still has several family members that farm or are involved in the agricultural community.

Chandler has been torn as he has entered the architecture industry because his heart for the agriculture community is so big. There has been such a large disconnect between the two. That is why he has tried to create a solution to tie the two together. In another sense this is a chance for him to use the practical sense that he has in him by creating a physical and tangible solution.

Another piece about Chandler is that he has found a great love for creating video content that is cinematic and creates an emotional experience for viewers. This is something that has translated into a greater desire to create architectural presentations that evoke an emotion within the viewers. A lot of times he wants this to be the emotion of excitement. Overall he wants that emotion to be created while also having the building be effective and perform well.

In May of 2020 Chandler will be graduating with his Masters of Architecture from NDSU.