Building in Craft:
A Community Founded and Sustained with Industry

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Kimo Griggs, Chair
Robert Corser

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Abstract

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This thesis integrates research of factory-based production and design and building with heavy-timber into the composition of a production facility that serves as a generator and resource for a neighborhood. The "factory", in this conception, is an urban model that engages a community in craft; an origin and a source, which serves first as a producer of building components and systems and endures as a center of information and activity.

Acknowledgments

Kiimo Griggs & Robert Corser

Thank you for helping me line things up & emphasizing the details.

I have benefited from our conversations and am grateful for the time you've offered to me. This project is much stronger as a direct result of your involvement.

My Cohort

Thank you to an inspiring group of students who demonstrated great skill, insight and empathy over the course of over three years. I am so pleased to consider many of you as friends.

My Family

Thank you for supporting this effort and staying with me through this experience.

CONTENTS

"Architects have special skills. They are able to connect the dots between different disciplines, and they're able to communicate ideas to the broader public. We are able to project what something could look like in the future, and we're all about making plans. And that is very useful. I think architects should use these skills more to push issues that they care about for the greater good. I don't know if that's activism or advocacy, but to me it's about moving issues forward that are important to all of us, and using the skills we have to make these things happen."

-Jeanne Gang[1]

1. Introduction

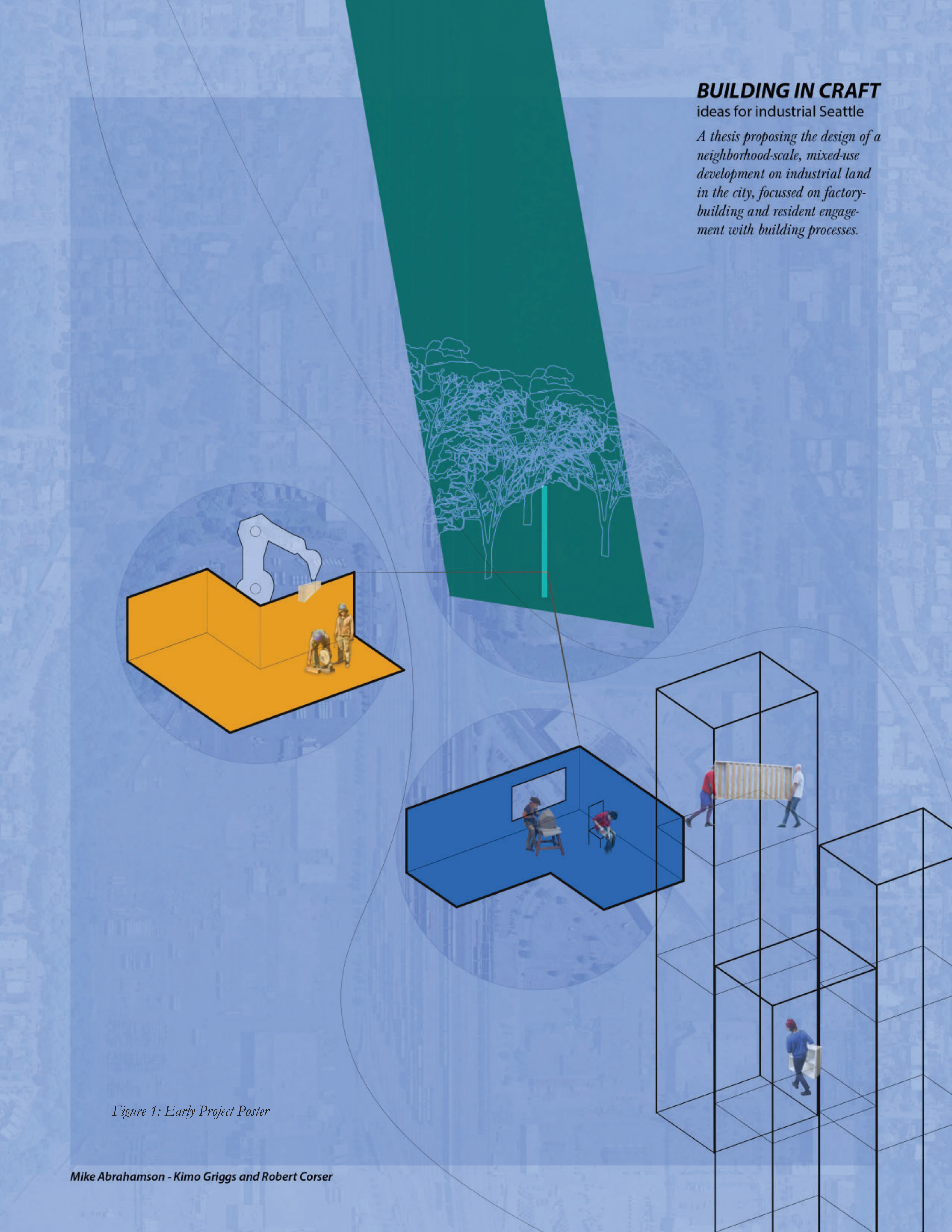


Figure 1: Early Project Poster

Introductory Statement

As architects, we can use our education and skills to participate in the conversation of the contemporary challenges we face and offer possibilities to meet them. While the built work of Architecture is the agency of direct intervention in the built environment, Architectural dialogue can be a space to test ideas and consider approaches to design and constructing that might enhance living conditions for people and address pressing challenges. It is a privilege to participate in the conversation with this thesis.

The current issues of urban-housing affordability and climate change have immediate connections to the work of Architecture. The AIA recently stated that "as a profession, we have the responsibility to prioritize and support effective actions to exponentially decelerate the production of greenhouse gasses contributing to climate change." [2] A challenge for Architecture, then, includes introducing more space for people while at the same time working to mitigate the impact of our work on the environment.

This thesis advocates for the use of processes and materials that address this challenge. The project proposes the use of factory-based production focused on the use of heavy-timber in the composition of a mixed-use urban development in the Interbay neighborhood of Seattle. The goal of the project is to imagine an affordable neighborhood connected to the city and region by industry and economic development with public space anchored by an engagement with making.

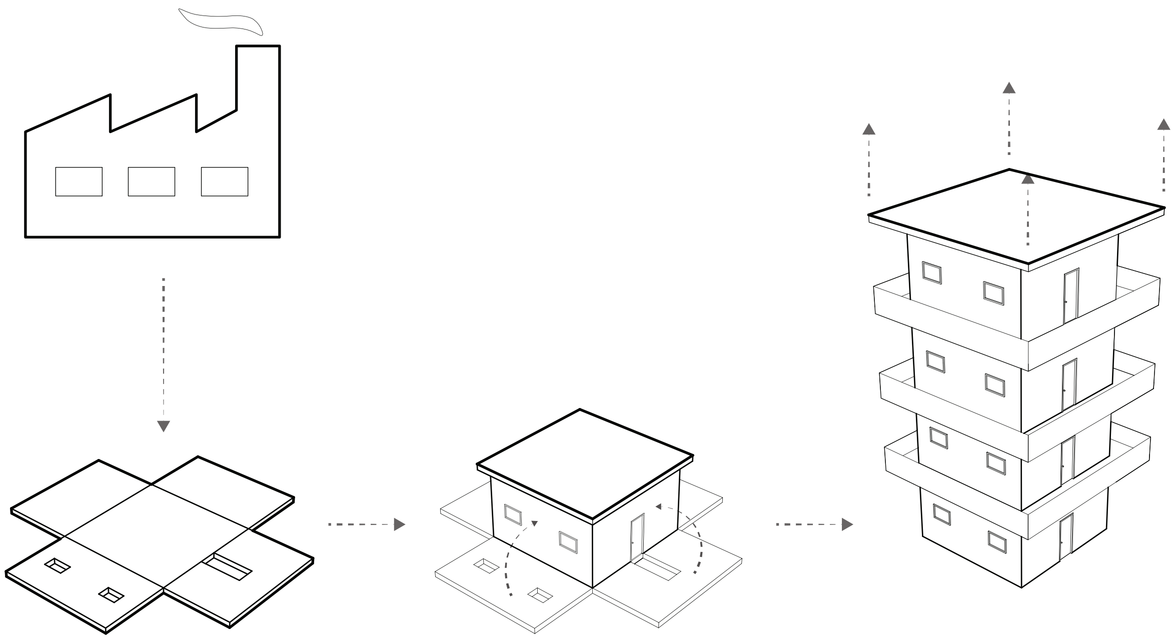


Figure 2.1: Industrial Building Diagram

2. Industrial Building

Making the Case

Industrial building is meant here to describe a manufacturing approach to making architecture. This approach is manifested in prefabricated and modular components, produced in a factory and assembled on site. Site work, including the layering of trade groups executing discrete tasks, is transferred into the controlled environment of the factory or workshop. This environment is an opportunity to coordinate a diversity of knowledge and skills together in consistent and optimized working conditions.

Architectural creation in an industrialized context offers benefits that directly address issues of housing affordability and the environmental cost of construction. The recently published Global Status Report for Buildings and Construction, a joint effort by the International Energy Agency and the United Nations Environment Programme, includes data implicating the building and construction sector in 40% of global energy emissions. The report also estimates an increase in population of 2.5 billion people, requiring a doubling of our current building stock by 2050.[1]

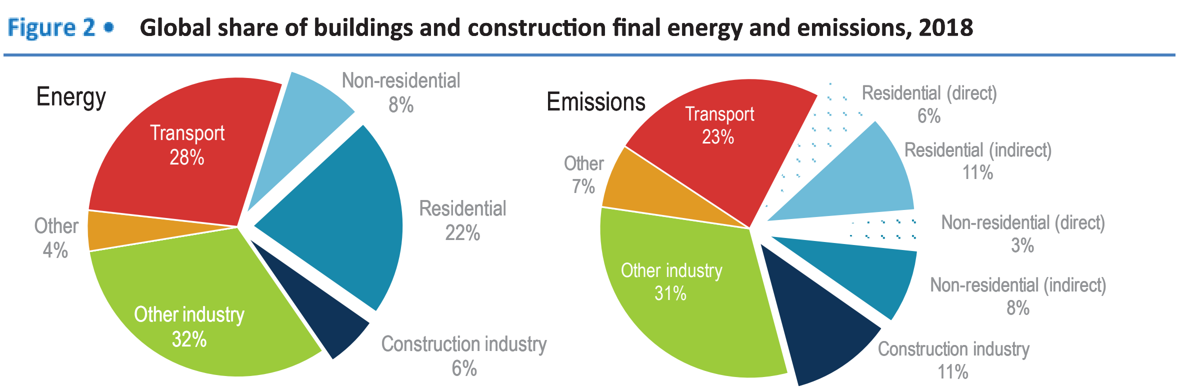


Figure 2.2: Building and Construction share of Global Emissions (UN Environment Programme/International Energy Agency 2019)

These numbers are daunting, but we can make space for a rapidly growing population and make change that helps mitigate the building and construction sector's significant contribution to global energy emissions while we do it. Chris Sharples of SHoP Architects proposes industrialized approaches to building as a strategy for accomplishing this in saying "the principal force bearing on construction is the climate crisis. The imperative to build in such a way that we do not contribute to the continued destabilization of our shared natural environment…prioritizes a host of new problems for which offsite construction has always had the right solutions."[2]

Material use can be organized, processed, tracked and managed in an efficient way in a factory-based environment. The AIA publishes a guidebook for best modular practices, which includes a section describing the benefits of this approach. According to the AIA, "modular construction can also contribute significantly to the environmental sustainability of a project…for example, the off-site production of building components allows for optimal control of material use".[3]

These material efficiencies hold out the promise of less waste and more recycling in the composition of the built environment. Advances in technology, including computational design that can enhance manufacturing capabilities, can be leveraged to further optimize material use and produce housing more quickly and, ideally, at price points that make homes more affordable.

Considering these advantages, an integrated approach to construction in an industrialized setting offers the possibility of housing more people for less money in a more ecologically responsible way than construction as usual.

Common Approaches

There are many approaches to prefabrication and a few common types most commonly used. The prefabricated building uses strategies of construction typical in any building context. Birkhauser publishes a useful edition focusing on the basics of components and system, which breaks down these strategies into categories that will be recognizable to anyone familiar with the fundamentals of building. Buildings can be created "out of linear, planar or spatial elements. These determine the construction principles characteristic of system building: the frame, the panel and the room module."[4]

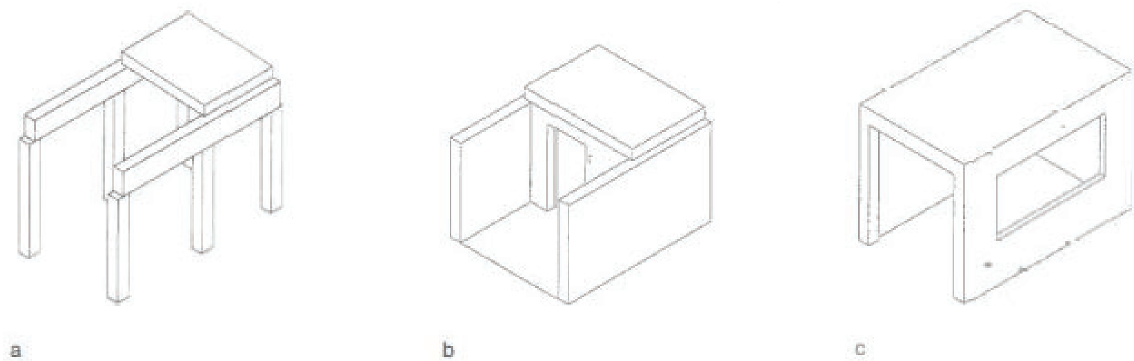


Figure 2.3: *Prefabricated-Building Elements*

The application of one of these basic ideas of constructing are the foundation of any prefabricated building. The images below are illustrative of frame, panel, and room module in action. Moving left to right, the first image shows a frame approach, as floor by floor columns take beams which, in turn, take a floor plate. A panelized strategy is seen in the second photo, as prefabricated wall sections are craned into place on site. The final image shows a factory-built room module being taken by crane for connection to similar modules that ultimately compose the building.

Figure 2.4: *Prefabrication Strategies*
(L: Frame Construction M: Panel Construction R: Volumetric Module)

These approaches can be executed with varying levels of factory vs. site fabrication and assembly. Roger-Bruno Richard articulates three "basic building system categories" in *Offsite Architecture: Constructing the Future*:

1. Site intensive "kit of parts" (assembled on site)
2. Factory-produced volumetric modules
3. Hybrid (complex parts manufactured in factory, while heavy/large-scale tasks are accomplished on site)[5]

The first category describes the assembly of parts from different manufacturers or from one manufacturer's system delivered to a site for assembly. The second "implies that all spaces and all components of the building are entirely made, assembled and finished at the plant as structural 3D modules.[6] The third category is a combination of the first two.

Categories can be broken down further into sub-categories describing the degree of modularity and the relative adaptability of a system. An open approach to prefabrication includes the ability to use parts and components from various sources and manufacturers, while the kit-of-parts approach typically describes a closed modular system that is composed of individual elements that are designed and manufactured to work together.

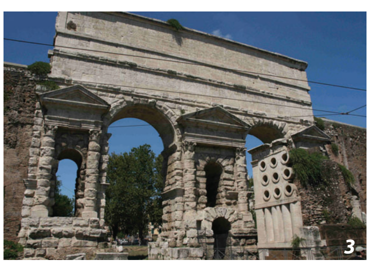
The figure on the following pages describes a broad-strokes history of prefabrication and modular building and offers examples of the categories discussed in this section. An attribution page follows with links to more information for each example.

Tomb chamber of Ur-Nammu, Dhi Qar Province, Iraq (circa 3800 BCE)

The use of pre-fabricated and standardized building components have been used throughout history. We can trace this history back to early urban cultures of the Bronze Age and in the Mesopotamian's use of burnt-clay brick, pictured above.

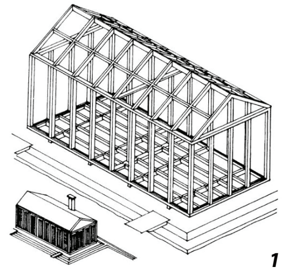
Vatadage Temple, Polonnaruwa Sri Lanka (circa 3000 BCE):

Stone building components prepared offsite, transported and constructed on site.



Porta Maggiore Aqueduct, Rome(circa AD 52):

The Romans used prefabricated stone, introduced moulds to pre-fabricate concrete sections for tunnels and aqueducts and transported pre-fabricated building sections on military expeditions.



Pre-fabricated cottage, London (Henry Manning,1837):

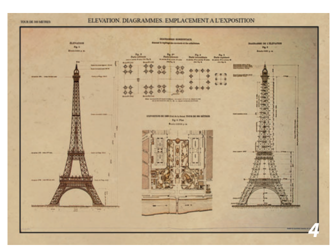
London carpenter Henry Manning builds pre-fabricated cottages for export to Australia.

Gold Rush Imports, California, 1849:

Pre-fabricated homes imported from England, for prospectors during California's gold rush.

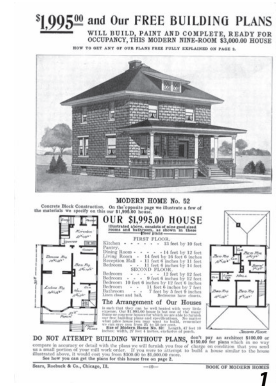
Crystal Palace, London (Joseph Paxton,1851):

Paxton completes the 18-acre Crystal Palace with a pre-fabricated system of wood and iron components, for the Great Exhibition of 1851.



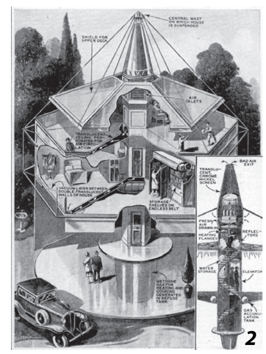
Eiffel Tower, Paris (Gustav Eiffel,1889):

Eiffel (with 50 designers and 150 workers) accomplishes the Eiffel tower from 18,000 pre-fabricated parts for the Exposition Universelle in Paris.



1908-1940: Sears catalogue homes.

Assembly line production techniques lead to the production of 75,000 affordable homes.



Dymaxion house Concept, (Buckminster Fuller, late 1920's)

Early example of sustainable technologies integrated into a mass-production home. Only one prototype built (1948).

"Sectret Cities" Oak Ridge, Tenn., Los Alamos, NM, Hanford, Wa. (SOM, 1940's)

US Govt. hires SOM to construct communities (quickly) from pre-fabricated components, for Manhattan Project sites.

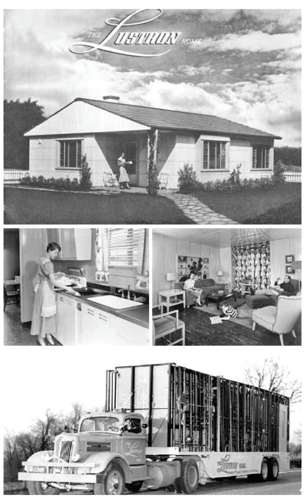
2500 BCE → ***1800's*** ***1900 - WWII***

Figure 2.5: *Prefabrication History Diagram*

Walter Gropius and Konrad Wachs-mann atop a General Panel Home (circa 1950):

Gropius and Wachsmann develop complete modular system for the General Panel company.

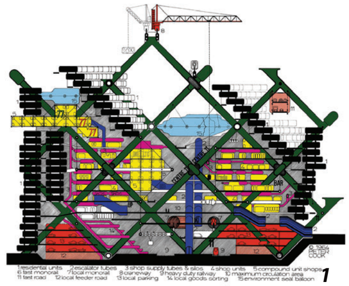
The system is based on a steel "wedge connector" that took wooden panels and required no fasteners or adhesive.



1940's -50's Lustron Co. Poster , USA

Lustron, Gunnison Co', and others develop housing systems based on steel frames and customizable features.

During the post-WWII period in the USA, Pre-fabricated panel system homes were developed to fill the need for affordable housing.



Plug-In City, Archigram,1965:

Peter Cook and Archigram propose speculative concept, with adjustable space and components and a perma-nent working crane.

Habitat 67, Montreal (Moshe Safdie,1967):

Safdie presents a pre-fabricat-ed aprtment complex for the World Expo in Montreal. The 12- story complex is a propos-al for providing space in the city with stacked modules.

Nakagin Tower, Tokyo (Kisho Kurokawa, 1972) :

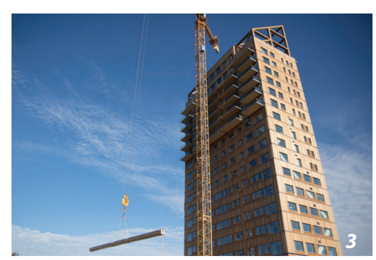
Composed of replaceable modules (never utilized) and connected to the Metabolist movement in Japan.

Garden Village, Berkeley, CA (Saitowitz and Natoma, 2016):

This 77-unit dormitory project is composed of factory-built modules, delivered complete with doors, windows and cabinets installed.

Dortheavej Residence, Copenhagen (BIG Architects, 2019):

BIG completes apartment complex composed of pre-fabricated heavy timber and stacked modules for low-income residents in Copenhagen.



Mjostarnet Tower, Brumunddal, Norway(Voll Arkitekter, 2019)

Constructed primarily with pre-fabri-cated cross-laminated timber parts. At 18-storeys this is the talles timber building in the world.

Post-War (1945-1960)

1960's & 70's

Contemporary - Tomorrow

*citations and links to further information on following page

Prefabrication Timeline Key and attribution

2500 BCE

1. Tomb Chamber of Ur-Nammu, Ur. Digital Image. Accessed 12.13.2019. https://www.britannica.com/technology/construction/Bronze-Age-and-early-urban-cultures.

2. Vatadage Temple, Sri Lanka. Digital Image. Accessed 12.12.2019. http://www.somuchmoretosee.com/2014/05/polonnaruwa-unexpected-delight.html.

3. Porta Maggiore, Roman Aqueduct. Digital Image. Accessed 12.15.2019. https://commons.wikimedia.org/wiki/File:Porta_Maggiore.JPG

1800's

1. Henry Manning prefabricated cottage. Digital Image. Accessed 12.13.2019 https://medium.com/zero-energy-mass-custom-houses/evolution-of-japanese-and-british-housing-industry-d1e57a22e00b.

2. Prefabricated home shipped from England to San Francisco. Digital Image. Accessed 12.13.2019 http://instanthouse.blogspot.com/2011/09/prefabs-before-industrialization.html.

3. Crystal Palace, Hyde Parke London. Digital Image Accessed 12.13.2019.. https://www.ft.com/content/160b03c8-77d2-11e5-a95a-27d368e1ddf7.

4. Eiffel Tower, Paris. Digital Image. Accessed 12.13.2019. https://silodrome.com/eiffel-tower-blueprints/.

1900 – WWII

1. Sears Catalogue home. Digital Image. Accessed 12.11.2019. http://www.searsarchives.com/homes/1908-1914.htm.

2. Buckminster Fuller, Dymaxion Homes. Digital Image. Accessed 12.11.2019. https://www.archdaily.com/401528/ad-classics-the-dymaxion-house-buckminster-fuller/51f0501ee8e44e94e500013b-ad-classics-the-dymaxion-house-buckminster-fuller-image

3. SOM Manhattan Project Homes. Digital Image. Accessed 12.11.2019. https://www.curbed.com/2018/5/8/17328702/secret-cities-national-building-museum

Post-War (1945-1960)

1. Lustron Homes Poster. Digital Image. Accessed 12.12.2019. https://www.busyboo.com/2010/09/05/lustron-prefab-home/.
(See Also: Gunnison Home Poster. Digital Image. Accessed 12.13.2019. https://99percentinvisible.org/article/modularity-modern-history-modular-mass-housing-schemes/)

2. Gropius and Wachsmann, GPC. Digital Image. Accessed 12.13. 2019 .https://idscache.harvardartmuseums.org/ids/view/18743615?width=3000&height=3000.

1960's & 70's

1. Archirgram, Plug-In City Diagram. Digital Image. Accessed 12.13.2019. https://archpaper.com/2019/06/archigram-the-book-review/#gallery-0-slide-0.

2. Habitat 67, Montreal (Moshe Safdie). Digital Image. Accessed 12.13.2019. https://www.dezeen.com/2014/09/11/brutalist-buildings-habitat-67-montreal-moshe-safdie/.

3. Nakagin Tower, Tokyo (Kisho Kurokawa). Digital Image. Accessed 12.13.2019. https://99percentinvisible.org/article/modularity-modern-history-modular-mass-housing-schemes/.

Contemporary - Tomorrow

1. Factory-Built Housing (Garden Village, Saitowitz/Natoma Architects). Digital Image Accessed 12.13.2019.. http://www.saitowitz.com/work/garden-city/.

2. Prefabicated Multi-Family Housing, Copenhagen (BIG Architects). Digital Image. Accessed 12.13.2019. https://www.architectmagazine.com/design/big-builds-prefab-affordable-housing-in-denmark_s.

3. Mjostamnet Tower, Brumunddal, Norway (Voll Arkitekter). Digital Image. Accessed 12.13.2019. https://www.dezeen.com/2019/03/19/mjostarne-worlds-tallest-timber-tower-voll-arkitekter-norway/.

A Prefabricated History

The diagram offers a selection from the history of pre-fabrication as a strategy for developing buildings and is by no means comprehensive. The Production of components offsite in the composition of architecture has a long history that can be read in the building traditions of many cultures. The selections are meant to illustrate a tendency to reach for the promises of efficiency, speed and low cost embodied in the idea of prefabrication.

The principles and strategies of prefabrication can be found throughout these examples. The Sears catalogue homes, and the Lustron and Gunnison building systems were shipped as a kits-of-parts ready to be assembled on site. The General Panel Company claimed that the system developed by Gropius and Wachsmann simplified construction to the point that a small construction crew could erect a 1,000 square foot house in less than a day.[7] Volumetric designs can be seen with Safdie's Habitat 67, the Nakagin tower and contemporary factory-produced room modules like those at the Garden Village in Berkeley.

Economic and social forces have made the adoption of prefabricated housing attractive in many cases throughout history. Examples of both prefabricated successes and failures exist.

The Sears and Roebuck mail order kit homes satisfied a need for affordable housing at the turn of the century in the United States. The need for fast and efficient solutions for housing led to the prefabricated secret cities designed by SOM architects during WWII. The post-war period in the United States was marked by a need for housing, leading to the development of housing systems like the steel panel kits from Lustron. The Lustron home was delivered in a kit of approximately 4,000 parts to site and included everything needed for assembly. The company was backed by the federal government and built over 2,500 houses, though failed to deliver thousands of promised orders as the cost of materials and shipping rose and the company was ultimately forced to declare bankruptcy.[8] The post-war period in Japan also included a severe housing shortage, which led to the introduction of an industrialized housing production boom that remains active today, as 400,000 homes a year (15% of homes produced in the country) are constructed in a factory setting.[9]

The country of Sweden also has a long history of prefabricated housing. Sweden faced a housing crisis in the 1920's, which the government addressed with assistance to factories that produced prefabricated homes. As a neutral state during World War II, Sweden was able to remain industrially active in the production of housing during the period. In the post-war era, Sweden continued to develop their prefabrication infrastructure and adopted aspects of standardization at multiple scales, from urban planning to the sizing of architectural components such as windows and doors. During the 1960's, while faced with another housing shortage, the Swedish government backed the Miljon-programmet (Million-Homes Program), a commitment to build one million homes within 10 years. Multi-family housing blocks were constructed to meet the government's goals, often with uniform floor plans and concrete facades. When a new housing shortage arose in 2010, Swedish designers and construction companies emphasized good design and variation, a move in response to the perception of prefabricated housing as sterile and repetitive. The prefabricated industry continues to develop in Sweden and endures as a major producer of homes, accounting for 50% of multi-family construction.[10]

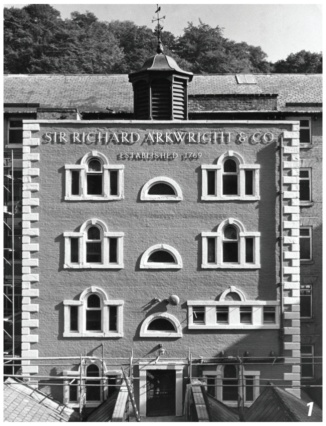
Figure 2.6: *Prefabrication factories; Sweeden (photo: Randek), above and Japan, at right*

Focus on the Factory

These examples mostly share the quality of having been produced in a factory, whether at a distance from the site or, as in the case of Habitat 67, in an adjacent factory. Safdie's project included the construction of an on-site factory that produced the concrete modules used for the apartment units.[11]

The factory building has a long history as a space of production and has had a role in shaping urban life as well. The history of the factory building in America is tied to the deep shifts caused by the Industrial Revolution and the migration from agrarian to urban life. This period is marked by fundamental changes and disruptions for communities, families and individuals. The spirit and energy of production during this time of great transition led to incredible inventions and new ways of living, but also led to the exploitation of workers and the degradation of the environment. As Nina Rappaport discusses in her book *Vertical Urban Factory,* the factory was a place of innovation, though "it also became subsumed by the capitalist who neglected substantial social and environmental consequences."[12] The introduction of industrial space that prioritizes opportunity, equity, and the health of workers and the environment is a worthy challenge for the future of the factory.

I believe in a future industrial space that includes these priorities and a quick trip through the history of factory buildings and culture is helpful when considering how to accomplish these goals. A selection of examples illustrating this history is offered on the following pages:



Richard Arkwright's Cromford Mill (Derby, UK, 1769)

One of the first "factories" and the building credited for ushering the transition of production from small workshops to a centrailized location. (number)

The symmetrical harmony of the facade hid the harsh realities of labor within the factory walls.

The early history of industrialized labor inclues no shortage of examples of the exploitation of the worker.

The Old Slater Mill, Pawtucket R.I. (1790)

Factory and man (Samuel Slater) credited with bringing the Industrial Revolution to America. (number)

Slater was an English emigre who brought his knowledge of the textile industry with him to America, and put it to use in this early mill factory.

Boott's Mill, Lowell, MA (1830's - 1956)

Lowell regarded as the first large-scale factory town in America. The textile factories in the Lowell industrial center benefitted from proximity to nearby water sources for power and the migration of workers from rural areas. This era marked the shift from agrarian to industrial society during the Industrial Revolution. (number)

Pullman's Factory Town, south of Chicago, Ill. (Beman and Barrett, 1879 - 1907)

Responding to labor unrest and a railway strike in the city, the wealthy industrialist George Pullman invests in suburban land and builds a factory complete with 531 worker's houses and ammenities like a school, church and library. (#)

Siemenstaddt, Nonnenwiesen, DE (Janisch & Hertlein, 1914 -1930)

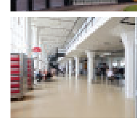
The industrial and corporate headquarters for Siemens that included housing and social services for thousands of workers.

Ford Plant, Highland Park, ILL (Albert Kahn, 1910)

Ford revolutionized production processes through the rationalzation of work in the form of the assembly line and mass production; approaches that led to rapid gains in efficiency and also monotonous working conditions.

Fagus Factory, Alfeld an der Leine, Lower Saxony (Walter Gropius, 1910)

Representative of modern industrial functionalist architecture. Notable for treatment of light (with the introduction of large bands of windows and skylights) and humanistic approach to the creation of space for the workers within. (#)



Van Nelle Factory, Rotterdam, NE (Brinkmand and Van der Vlught, 1931)

Tobacco, tea, and coffee production and administration facility with open social spaces and emphasis on transparency with access to light and fresh air.

The First Factories →

The Factory Town

Modern Factories

Figure 2.7: Factory-History Diagram

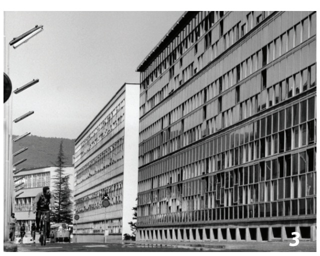
Garden Cities of Tomorrow, Ebeneezer Howard (1902)

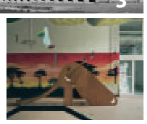
Howard composed plans for cities that included the careful organization of citizen needs, arranged (in plan) with concentric circles representing specific activites.

The center of each city would be a park, while the outer perimeter would be devoted to railways and industry.

Cite Industrielle (Tony Garnier, 1917)

Garnier's vision focussed on the industrial city, dividing city space into four distinct zones: housing, work, leisure, and health, while emphasizing access to nature and light.





Olivetti Factory, Ivrea, Italy (Figini & Pollini, 1939 - 1962)

Adriano Olivetti develops an industrial model that includes housing, free child care, on-site education and care through retirement.

Cankun Factory, Zhangzhou, China

De-industrialization is complicated difficult to attribute with a simple description.

One thing for certain, patterns of industrial activity have shifted, as technological and economic forces have resulted in the removal of many industrial jobs in the United States.

"In 1960, about one in four American workers had a job in manufacturing. today fewer than one in 10 are employed in the sector." (number)

Much of this industrial work now happens overseas, and consumer goods are often shipped back to the US from factories like the Cankun pictured above.

Hong Ho Factory, Valladolid, Mexico

In some cases, manufacturers use Fair-Trade Practices for workers who make their products overseas. These practices are an attempt to ensure safe and equitable working conditions and include measures to encourage environmental sensitivity in production.

The factory above produces clothing for Patagonia. Each product sold that originated in the factory includesa a premium that goes directly back into an employee-managed fund.

Factory Building, Weil am Rhein, Germany (Frank Gehry, 1989)

Holmen Industrial Area, Sortlandssundet, Norway (Snohetta, 2017)

Contemporary industrial structures with expressive forms and material: the factories on the Vitra Campus and the programmatically distinct volumetric forms of the Holmen industrial complex in Northern Norway (both above).

Vitsoe Factory, Leamington Spa, UK (Waugh Thistleton, 2017)

Princeton Embodied Carbon Lab, Princeton, New Jersey (The Living, 2018)

A recent factory and an academic facility built for manufacturing research above; both take advantage of heavy-timber construction, while providing adaptable space for both production and administration.

Utopia!

Globalization

Contemporary - Tomorrow

*citations and links to further information on following page

Factory Timeline Key and Attribution

The First Factories

1.Richard Arkwright's Mason's Mills, Cromford UK. (1771) Digital Image. Accessed 12.15.2019 .https://www.architectural-review.com/essays/typology/typology-factories/8691159.article

2. The Old Slater Mill, Pawtucket R.I. (1793). Digital image. Accessed 12.15.2019. http://library.providence.edu/encompass/rhode-island-and-the-industrial-revolution/primary-sources/slater-mill/

Factory Towns

1. Boots Mill, Lowell, MA (1830's). Digital Image. Accessed 12.15.2019. https://libguides.uml.edu/textile_mill_images
(See Also: https://www.atlasobscura.com/places/old-slater-mill-historic-site)
https://www.nps.gov/lowe/learn/historyculture/the-mill-girls-of-lowell.htm)

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3. Van Nelle Factory, Rotterdam, Netherlands (Brinkman and Van der VLugt, 1931) http://dutchdesigndaily.com/architecture/van-nelle-factory/)

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2. Cite Industrielle, Vision for Industrial City (Tony Garnier, 1917). Digital image of original Painting, Museum of Fine Arts of Lyon [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)] Accessed 12.15.2019. https://commons.wikimedia.org/wiki/File:GARNIER-tony_La-cite-industrielle-centre-vue-perspective.jpg

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2. Hong Ho Factory, Valladolid, Mexico (Fair Trade Certified Factory, Patagonia Clothing). Photo Keri Oberly. Accessed online 12.15.2019. https://www.patagHonia.com/blog/2017/10/partnering-with-the-people-who-make-our-clothing/

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3. Vitsoe Factory, Leamington Spa, UK (Waugh Thistleton Architects, 2017). Digital Image. Accessed 12.15.2019. http://waughthistleton.com/vitsoe/

4. Princeton Embodied Computation Lab, Princeton, NJ (The Living, 2018). Digital Image Accessed 12.15.2019. https://www.architectmagazine.com/project-gallery/embodied-computation-lab_o

A Historical Trip to the Factory

The Industrial Revolution marked a shift from traditional craft production to machine manufacture in a centralized location. In America, factory-based production during the early stages of the industrial revolution consisted of mills and textile-manufacturing facilities, dependent on water for power and necessarily sited near rivers. Lowell, Massachusetts is a prime example of the connection between water-power and early factories. Advances with steam power led to the ability to site the factory workspace in any location.

In 19th century, the population in America shifted from rural to urban areas as workers relocated for employment opportunity. The trend continued throughout the century, until the 1880's marked the first decade in the United States when the urban population increased more than the rural.[13] As Charles Hirschman and Elizabeth Mogford explain in their article Immigration and the American Industrial Revolution From 1880 – 1920, "the development of commercial electricity at the end of the 19th century allowed industries to take advantage of the labor supply in large cities."[14]

During this period, factories proliferated in cities. The factory contained the space for production and would also come to contribute to the cityscape and the urban image. Cities and regions had become centers for specific industry, which in turn helped shape the culture in those cities; "London was known for textiles; Hamburg for shipbuilding; Boston for grain exports, Chicago for machinery and meat processing; and Philadelphia was referred to as the 'workshop of the world" for machinery."[15] Rappaport describes the foundational elements of the relationship between city and factory in saying "the city is home to labor, resources, and consumers, activating a chain of production, consumption, and reproduction. The factory served as a conduit for these cycles, with workers and owners in proximity to innovation and creativity."[16]

Rappaport goes on to consider the dynamic energy that exists between city and factory; the history of engineering and architectural creation that supports industry in urban areas and the role of these spaces in the creation of culture and the shaping of the urban landscape. Issues of equity and sustainability are deeply considered again, as in these industrial regions, zones and buildings "places of innovation become subsumed by the a capitalist drive and, with all roads leading to the company's bottom line, [profits] push the social and environmental consequences to a secondary consideration."[17]

In the early 20th Century, Rappaport describes the "sequestration" of industrial life from the daily life of the city. Zoning rules had come to allow industrial uses and residential uses in the city, though the two were now considered separate and, as Rappaport argues, manufacturing was "relegated to the edges, leaving fewer and fewer factories in the city."[18]This process of de-urbanization of industrialization continued during the World War II period, as factories and supply chains moved to the outskirts of cities.

This dispersal also occurred on coast lines, as industrial population concentrations were moved inland for security in case of attack. War-time production facilities took advantage of available land outside of cities and spread production among multiple buildings; the scale and volume of war-time production required large spaces and spreading these spaces out helped to avoid providing a single target for attack. The products of war-time industry were also considered safer from industrial espionage in these locations.[19]

The new suburban reality of post-war America included the further decentralization of the industrial workplace. The interstate highway system contributed to the expansion of suburban life for communities and for industry.[20]A connection can be drawn to the suburbanization of prefabricated housing during the same period, noted in the previous section of this work. One of the consequences of this movement of production to the suburbs was the loss of the visibility of the work that goes into the creation of products. The traces of how things are made and by whom is abbreviated in this suburban scenario. By extension, the connection between the conditions of the work and the final product is easily lost.

In the second half of the 20th century companies began to seek overseas production opportunities to reduce labor cost and this connection was further damaged. This trend continues into the contemporary reality of production, as our economic system is changing rapidly and many of the actual production processes [are] now taking place in Asia." [21]

The push for lower prices has led to consequences beyond the loss of transparency of manufacturing processes. The reduction of prices is facilitated by unregulated factory production, including a lack of safeguards for workers and the environment. Rappaport points out that the global factory "is highly dependent on robust supply chains to bring its products from one country to the next without the barriers of taxes, and requirements for health and safe work environments."[22]

Figure 2.8: *Global Factory Conditions; Maquiladora factory Mexico, left (photo, Guldhammer) and Yangtze River factory, right*

These problems related to the production of consumer products in factories overseas can be compared to issues more closely related to architectural production. A building is no static object, but the product of processes that take place all over the world; systems of extraction, processing, transportation and assembly combine to manifest in structures on site. As architects, our work is affected by, and can affect, these processes…and where they take place. The editors of a *Climates: Architecture and the Planetary Imaginary* frame this idea by considering the concept of a building's "footprint" and encourage an expanded idea of this concept as "the outline of a building is redrawn to include economies of material extraction and the vast amounts of energy…that give it physical form and allow it to be occupied in comfort."[23]

The field of Architecture has work to do in this context. The processes of designing and making can include deep connections between place and the use of material. These material geographies can help us choose how to build and what we build with. Sourcing, processing, labor…these categories of industry can be designed along with the buildings. "Architecture participates in the systems if labor, resource extraction, and wealth accumulation…Architecture has the agency to make direct interventions into the negative effects of capitalism."[24]

An opportunity for intervention worth looking at includes establishing a new industrial presence in the city that includes sustainable factory production. One of the primary aims of this thesis is to suggest a model of a community development, in the city, that is enriched through a connection with industry. The lessons learned from our industrial history offer examples of the potential for architectural space to make this connection and emphasize the importance of considering the impact of our industrial buildings and materials on the environment while keeping the experience of those who use these spaces at the forefront of the design process.

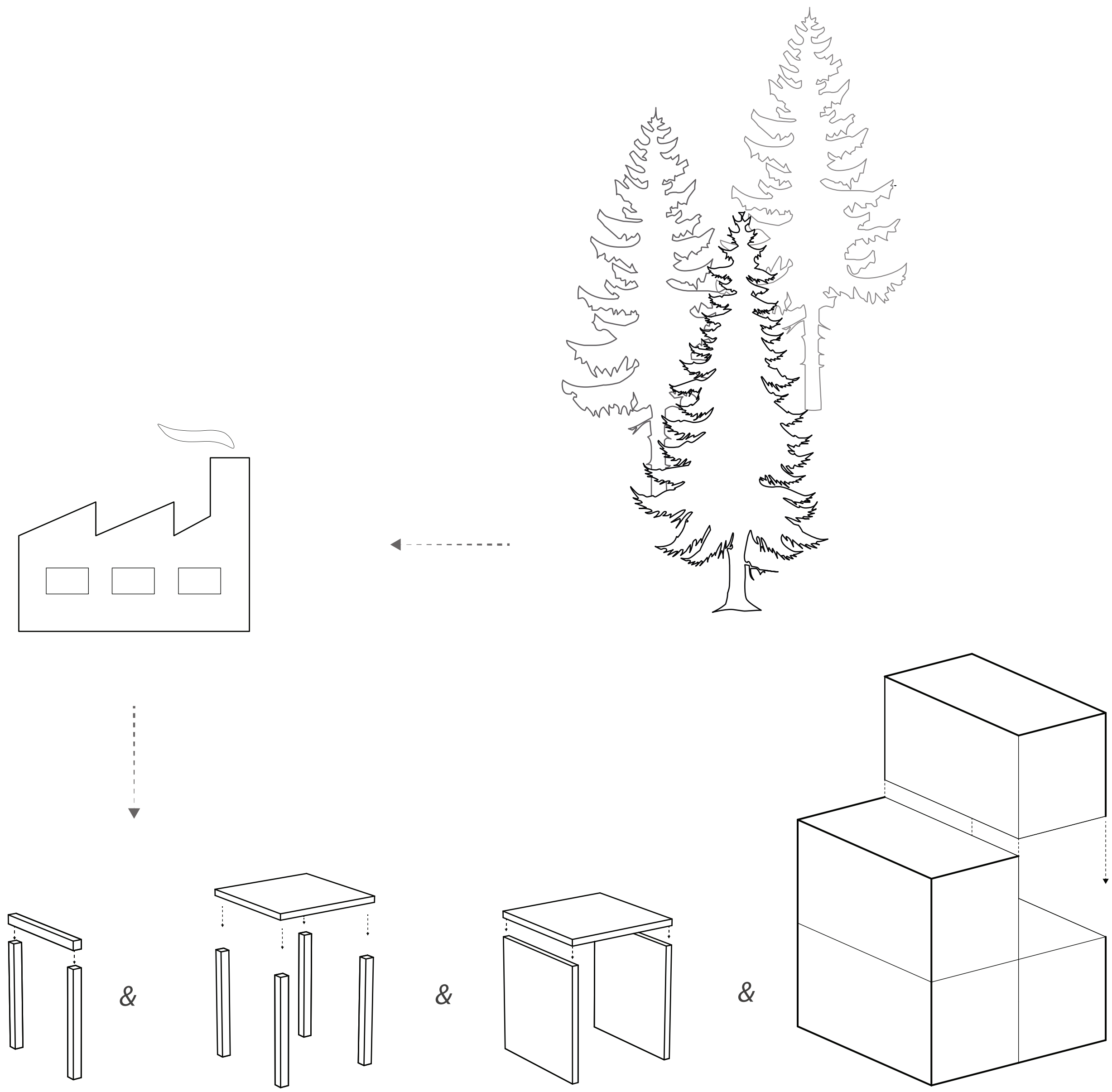


Figure 3.1: Timber-Building Diagram

3. Timber!

"Selection of Materials should involve not only tangible qualities – such as type, color, grade, strength, and finish – but also invisible features, such as amount of embodied energy, source of embodied energy, quality of human labor involved, and life-span of material."

-David Benjamin[1]

Part of the solution

In several of the housing and factory examples above, heavy timber is used as a primary material. While researching industrialized building, it became clear that wood is a natural fit for prefabricated and modular manufacturing and the best candidate as the primary material for composing our buildings as we work to meet challenges faced by society today. If we produce building components from wood in factories in our cities, all the better! The appropriate material (be it wood, concrete, or steel) should be considered for any given context…and the appropriate material should be used (in a way that continually seeks to reduce the amount of embodied carbon in our buildings). However, a comprehensive approach to the use of wood, including responsible forest management and low-carbon intensive manufacturing and construction practices, works in an increasing number of contexts today.

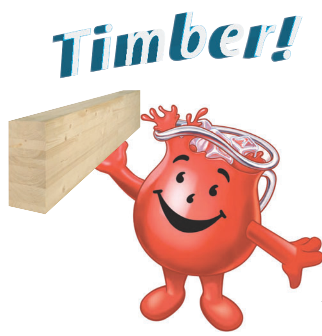


Figure 3.2: Timber Kool-Aid®

Timber benefits

The population growth projections from the UN noted earlier are general. When we consider the growth of urban areas in the context of population growth, it becomes clear that most of the construction activity in the future will take place in our cities. The World Bank Group states that "today, over 4 billion people around the world – more than half the global population – live in cities. This trend is expected to continue. By 2050, with the urban population more than doubling its current size, nearly 7 out of 10 people in the world will live in cities." [2]

As we plan to accommodate the rapid growth in population within expanding cities, the processes and materials we use will have great impact on the environment. ARUP offers the estimate that 2 *billion* sq. meters of new building stock would be necessary to provide adequate housing for global population growth, in the near term, between 2019 – 2025.[3] The use of timber, within a system that includes the responsible management of forests, offers clear advantages to meet this demand when compared with materials that are more fossil-fuel intensive in their production such as concrete and steel.

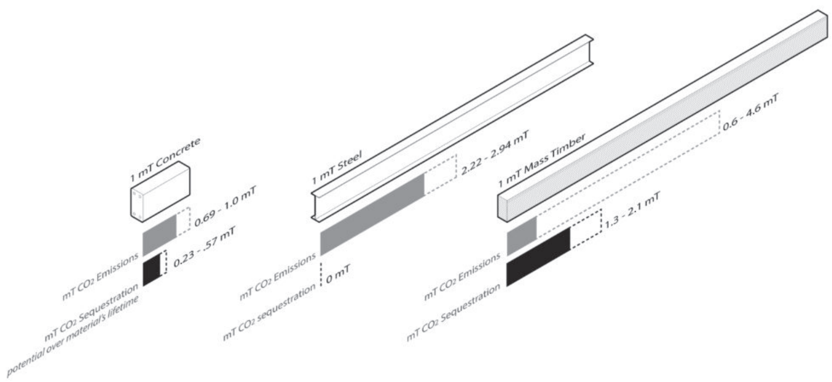


Figure 3.3: Relative Benefits of Timber (Gray Organshci Architects)

The use of wood is a carbon sink and includes the critical benefit of sequestering carbon rather than emitting carbon into the atmosphere. Gray Organschi, an architecture firm and timber advocate that has published excellent information from analysis of timber use, claims that in "a typical mid-rise commercial project with concrete and steel vs. mass timber" a timber building saves 100 terajoules of carbon emissions, "roughly equivalent to saving 17,300 barrels of oil."[4]

Timber building also offers favorable structural properties and is recyclable, reusable and adaptable to different uses; "in comparison to steel, timber is distinguished by great strength with a low weight, and a high resistance to thermal transmission; it can be employed for structural systems, internal fit-out and facades", and "industrial lamination and pressure techniques enable numerous building materials to be made from timber fibers and chips. These can also be produced by simple recycling processes using timber waste products."[5]

The argument for wood construction grows stronger when the health benefits are included in the conversation along with the relative environmental benefits. The numbers cited in this work represent the real people who will live and work in the structures we build. The introduction of timber surfaces provides a link to nature, which has been shown to have health benefits for people. A recent study by researchers from Norway offers a summary of findings in this regard:

"As mentioned in the Introduction, visual access to nature can promote positive feelings and reduce negative feelings such as anxiety and anger. Findings from several studies also suggest that simply looking at everyday nature, compared with built scenes that lack nature, is significantly more effective in promoting restoration from stress as reflected in outcomes such as reduced blood pressure, heart rate, skin conductance, muscle tension, and increased electrical activity in the brain…"[6]

The connection between managing the process of wood manufacture and designing buildings with wood is important to emphasize. The logging industry, including extraction – processing – transportation, is also responsible for carbon emissions. An expansion of timber building can, and should, drive sustainable forestry management. Mark Wishnie, the director of forestry and wood products at The Nature Conservancy, emphasizes the importance of this aspect of timber building by saying "we must ensure that mass timber drives sustainable forestry management, otherwise all of these benefits are lost."[7]

Developing sustainable forestry management is the foundation of the connection between rural wood-producing communities and urban manufacturers. Reciprocal benefits are possible as rural communities harvest and process material and urban sites have the capacity to detail and construct components in the city.

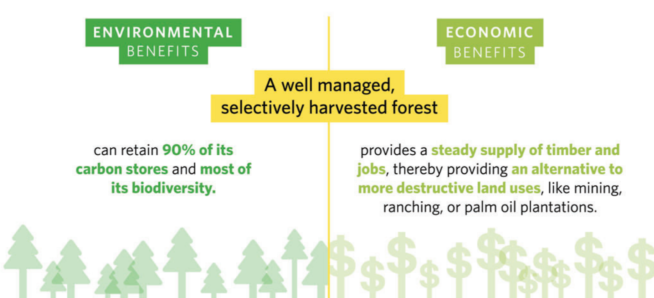


Figure 3.4 (l.) & 3.5 (r.): Environmental Benefits of Well-Managed Forests (The Nature Conservancy) / Forest Harvesting (Gillian Flaccus)

A joint study from 2014 between researchers at Harvard University and the University of Washington in the *Journal of Sustainable Forestry* concludes that engaging in wood construction (and limiting the removal of global forest lands for development to no more than the rate of growth annually– rather nurturing these forest lands through responsible harvesting) could realize the dual benefits of carbon sequestration and reduced emissions to the point of eliminating the total current level of construction emissions.[8]

Our Forests are renewable. Thinning forests, on a reasonable rotation schedule that doesn't rapidly deplete the resource, helps prevent wildfire. The use of timber helps reduce carbon emissions and is the best candidate as a primary building material as we house a growing number of people while, at the same time, pursue environmental goals such as those laid out in the Paris Agreement of 2015 of keeping global temperature rise below 2 degrees Celsius. Todd Myers (director of the Center for the Environment at Washington Policy Center), writing in the local news outlet Crosscut, cites University of Washington scientists who have come to the conclusion that "the most effective use of forests to mitigate carbon is to produce wood products that displace the most fossil fuel emissions from sustainable forest rotations … not saving the carbon in the forest."[9]

The Washington Forest Protection Association has also taken a strong position of advocacy for mass timber products from managed forest. The council finds that wood products are a renewable material and also energy efficient, for the following reasons:

> *-Wood building materials produce less air and water pollution, require less energy and generate less CO2 emissions than other common building materials.*
>
> *-Concrete creates 51% more solid waste than using wood to build a typical house.*
>
> *-Steel requires 400% more water than using wood to build the same structure.*
>
> *-Two tons of carbon emissions are offset for every dry metric ton of wood.*
>
> *-WFPA*[10]

As stated earlier in the work, the UN estimates that roughly 40% of CO_2 emissions in 2018 are attributable to the building industry…11% of this figure is the result of the production of building materials.[11]. Also, emissions rose by 2% from 2017-2018. The UN finds that "increases were driven by strong floor area and population expansions" and that "efficiency improvements continued to be made, [though] they were not adequate to outpace demand growth."[12]

The trend of floor area growth will necessarily continue – and likely rapidly increase – in the years to come. We will need to face this with more responsible material choices in the design and manufacture of our structures. The cycle of sustainably growing, harvesting and using wood as a primary material makes sense as we plan for the future.

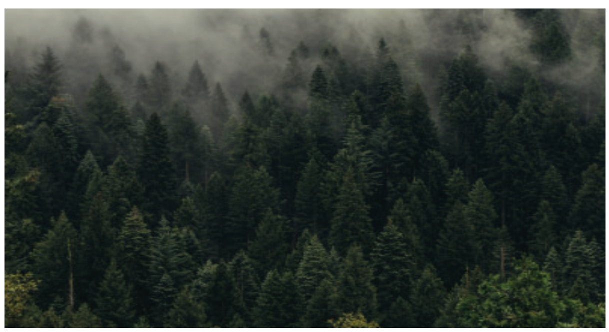


Figure 3.6: Sustainably Managed Forest (Dan Otis)

The Basics and Precedent Examples

"Despite the extraordinarily diverse range of potential applications and its proven track record as a building material over thousands of years, wood got pushed aside during the age of industrialization The manual working processes of timber were too slow and hence too expensive when compared with the industrialized production methods of steel and reinforced concrete."

-Rainer Hascher[13]

Wood has been used in building systems for centuries and technological advances in wood production have started to reverse the trend described in the quote above. The use of glue-laminated columns and beams and cross laminated wood panels have provided an efficient and cost-effective alternative to concrete and steel. A contemporary increase in the use of wood is not limited to new processes. Realizing the benefits of wood manufacturing, companies such as Structurecraft are offering adhesive-free wood panels composed of dowel-laminated boards "a classic German technique for structural, load-bearing walls made exclusively from timber."[14]

The basics of heavy-timber construction mirror the basics of prefabrication described earlier in this document. Post and Beam, Post and Plane, Panelized construction are found in heavy timber building and full volumetric module construction can be added to the mix as well.

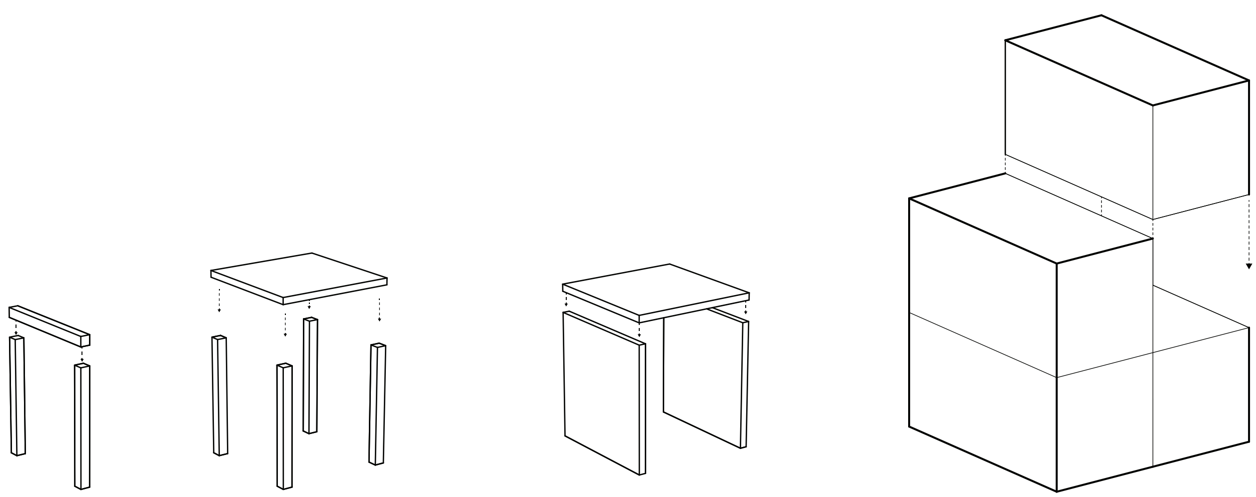


Figure 3.7: Timber-Building Diagram Fragment

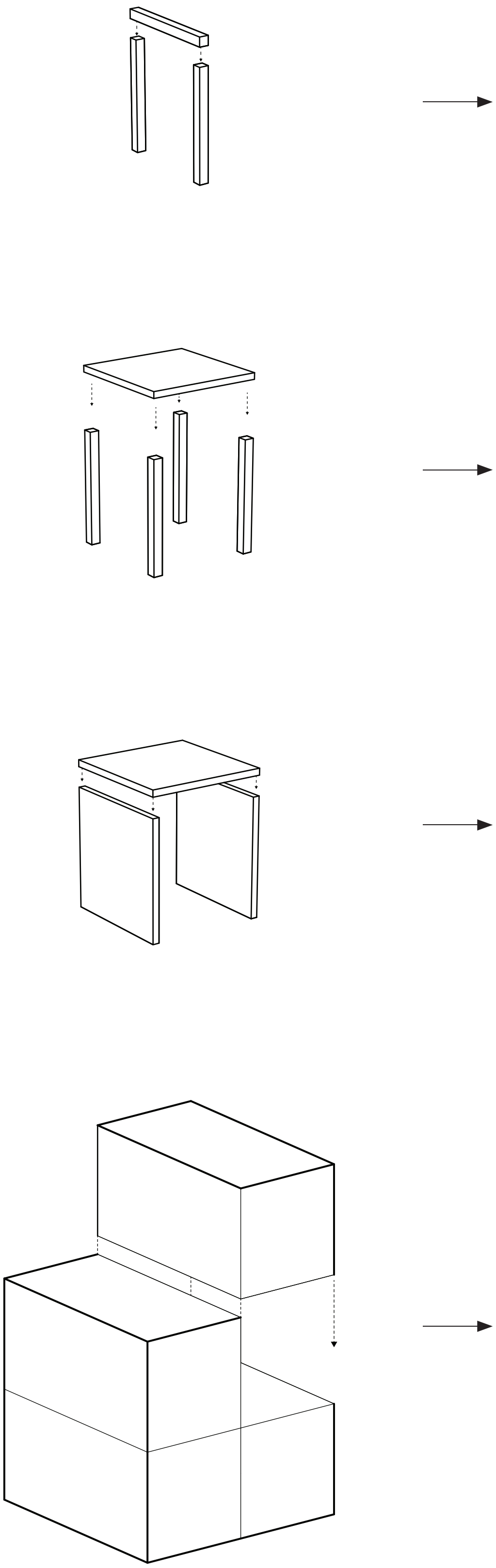


Figure 3.8: Timber-Building Diagram Fragment

Figure 3.9: 111 East Grand (2018 Des Moines, IA, Neumann Monson Architects)

Figure 3.10: Brock Commons (2017 Vancouver, BC, Acton Ostrey Architects)

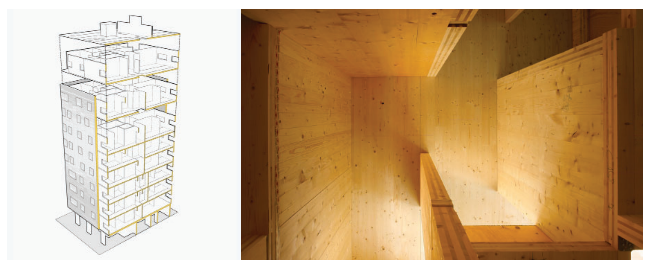


Figure 3.11: Murray Grove (2009 Hackney [London], Waugh Thistleton Architects)

Figure 3.12: Watts Grove (2019 [construction] London, Waugh Thistleton Architects)

The first image to the left, 111 East Grand (Des Moines, IA, 2018, Neumann Monson), a commercial office building with retail space at the street level, is an example of a post and beam construction with glulam columns supporting glulam beams, which in turn take the dowel-laminated timber floor plates.

The second example, Brock Commons (Vancouver, BC, 2017, Acton Ostry Architects) a student residence on the campus of the University of British Columbia, uses a post and plane method which removes the beam from the equation; steel connectors between column and cross-laminated timber panels allowing the transfer of loads directly from panel through column, and down.[15]

The third example, Murray Grove (London, 2009,Waugh Thistleton), offers a look at panelized construction with CLT. Waugh Thistleton considers this building "constructed entirely from prefabricated solid timber."[16] According to KLH, the manufacturer of the CLT panels used in the project, the use of wood saved 1,150 total tons of CO_2 from being emitted into the atmosphere (a number which includes the carbon cost of transporting the panels from factory to site).[17]

In order to contextualize this savings, it is helpful to look at the typical carbon emission for automobiles and single-family homes. The Environmental Protection Agency (EPA) publishes emissions statistics for a typical car (4.71 metric tons of emissions/yr.) and for the electrical use of a typical home (5.734 metric tons/yr.) in the United States.[18] A couple simple calculations shows us that Murray Grove saved the equivalent of a year's worth of emissions for 244 cars or 200 typical homes.

The final example, Watts Grove – also by Waugh Thistleton (Tower Hamlets, UK, under construction) – is composed of room modules, constructed with CLT, fully fitted out with kitchens, bathrooms, and cabinetry in a factory setting.[19] The modules will be transported to site and stacked together to form a series of buildings that total 65 affordable-housing units.

These approaches can all be accomplished with a variety of wood products available today. Coupled with industrialized prefabrication, building with timber also allows for an increased pace of production and assembly of housing units at a reduced cost. According to a study performed in 2019, Toronto-based Sidewalk Labs determined that engaging a factory-based model of prefabrication with heavy timber, based on a library of building parts, would fulfill the promise of these benefits:

"Off-site timber construction can accelerate project timelines by 35 percent, reduce costs, and greatly improve overall productivity"

-Sidewalk Labs[20]

Considering these advantages against the need for more housing (and more quickly) and environmental innovation in the building sector, it is welcome news that code hurdles that have held mass timber back from general use and acceptance are being removed.

Progress on the Local Scene

While researching the use of manufactured timber components in buildings, many examples are available to study in Europe, England and Canada with a relative paucity in the United States. There does appear to be a new momentum for building more and higher with these systems in the United States and Canada. Concerns about the structural integrity and fire safety may have held back adoption of timber, though these issues have been addressed with numerous studies.

A local example, the Miller Hull designed Bullitt Center in Seattle, uses manufactured timber components throughout. The Bullitt Foundation offers plentiful information and lessons learned from the design and construction of the building. Writing on the bullitcenter.org site, Brian Court of Miller Hull describes the choice of wood for the Bullitt Center's main structure and points out that "we all know that wood burns, but it does so at a relatively slow and predictable rate. So, if there were ever to be a fire in the building, the timber chars and burns slowly allowing plenty of time for occupants to vacate". [21]

A block of laminated wood used as a stair tread, for example, will char on the outside when exposed to fire, though the core remains stable longer than an equivalent piece of steel. According to Joseph Mayo, whose book *Solid Wood: Case Studies in Mass Timber Architecture, Technology and Design,* which is highly recommended to any interested reader, this advantage means that "[steel] must be fire protected by additional materials whereas timber does not. Because of their strength, even in multi-story designs, mass timber will generally only be loaded to a fraction of their serviceable capacity, adding additional structural robustness and safety."[22]

Several recent proposals have demonstrated a positive outlook toward the expansion of timber. Plans for a 21-storey timber tower in Milwaukee recently received planning commission approval and Perkins and Will has a proposal in the works for a 35-40 story tower in British Columbia. Several recent local studies investigating the viability of timber in the city are also encouraging signs. The DLR group and Callison have published analyses of building with timber in Seattle and the Carbon Leadership Forum at the University of Washington engaged in a mass timber optimization study published in 2018. Both studies appear in the Appendix for this work.

The City of Seattle now publishes these benefits for building with CLT on the seattle.gov website:

- Carbon negative construction
- Sustains local materials and industries
- Reduces construction time
- Cost competitive with concrete and steel
- Clean and quiet construction process
- Ideal for tight urban sites [23]

Recently this interest has manifested in a change to the building code. In 2018, Washington state became the first state to allow timber buildings up to 18 stories, without the requirement to pursue an alternate method.[24] And in Seattle, which can expect to see an increase of 600,000 people in the next 20 years[25] , the city council now accepts building applications for up to 18-story timber buildings. According to multiple sources, most new timber buildings will likely be in the 8 -10 story range, though we can expect to see that change as more building occurs, technological advances continue, and prices go down. The new code options come with new building types that are specific to timber and regulate the percentage of wood material that must be covered relative to building height and other structural considerations. A presentation given to AIA Seattle from July 2019, that includes the relevant information, is included in Appendix of this work.

There is strong interest and a recent increase in the use of both factory-based building and the sustainable use of wood for architectural components. This thesis proposes a model for urban development that includes both.

There is also strong contemporary interest in the industrial neighborhood of Interbay in Seattle. The Interbay Site is the focus of attention as potential land in the city that will be available for development in the coming years. This project considers the Interbay site as ideal for developing a community founded and sustained by industry.

Figure 4.1: Interbay Overhead Photo (Port of Seattle)

4. Interbay

Figure 4.2 & 4.3: Interbay Overhead Photo immediately above (UW14461) / Interbay Area Map above

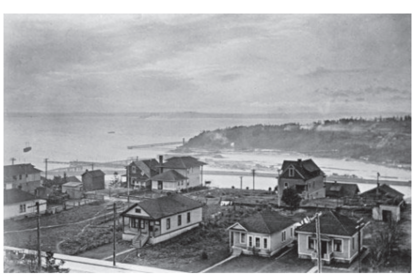


Figure 4.4: Historical Interbay Photos (l, m & r Seattle Municipal Archives)

Introduction and History

The Interbay neighborhood in Seattle is part of the Ballard-Interbay Industrial Center, one of the two main centers designated as primarily industrial land in the city. The area is composed of a filled tidal flat between the established residential communities of Queen Anne to the East and Magnolia to the West, ascending from either side of Interbay in tree-lined streets and single-family homes. The physical shape of the place, visible in the contour lines of the map to the left, is the result of the deep and cold carving work of the Vashon Glacier more than 10,000 years ago. The area was home to the Native American Shilshole tribe for thousands of years. According to History Link, the Shilshole made a settlement here with cedar long- houses and hunted and fished for food along the shores of what we now know as Interbay.[1]

Euro-Americans arrived in 1850 and staked claim to the land. Various settlements and prospects operated in the area, and a terminal for the Great Northern Railway was introduced circa 1892. The Ballard Locks were completed in 1917, which channelized the connection between Lake Washington and the Puget Sound and flooded the low-lying area of Interbay. Dredged earth from the project was used to fill the site, which became an industrial area bookended by busy piers to the North and South.[2] Pier 91, to the South, was owned by the US Navy after 1942 and used as a port of embarkation during WWII. The Port of Seattle reacquired the area in 1976 and replaced war-time warehouses and barracks with modern industrial facilities.[3]

Figure 4.5: Interbay Industrial Photos (author)

Figure 4.6: The Ballard-Interbay Industrial Center

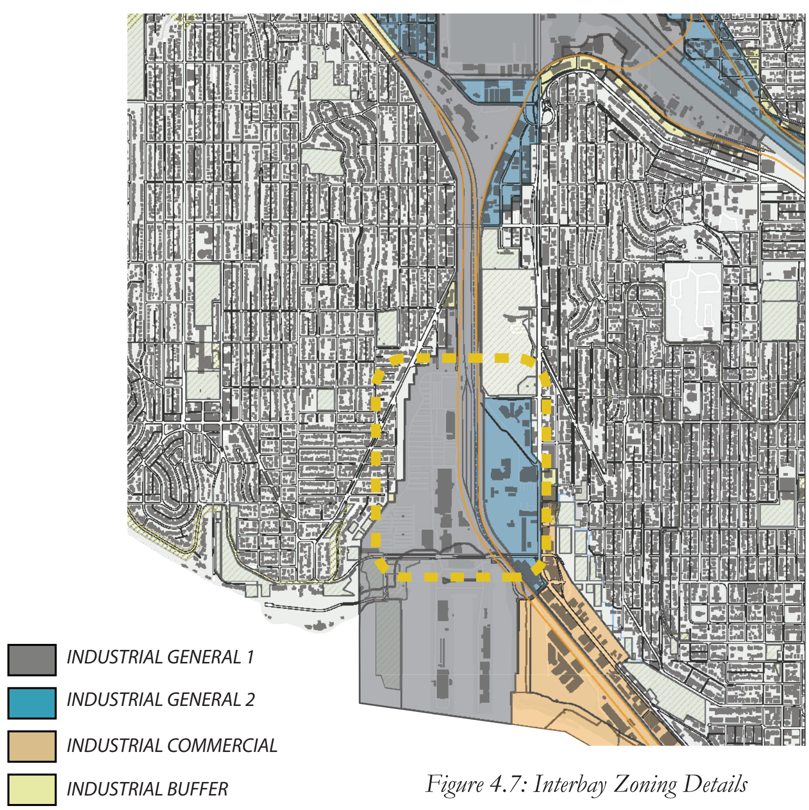


Figure 4.7: Interbay Zoning Details

Current Events - The Future

Today, these lands support the region's industrial sector, which the City of Seattle estimates as "representing 18% of total employment [in Sthe city]."[4](#) This activity and these jobs are worth celebrating, as they add a layer of economic and social diversity to the mix of life in the city. Interbay, which includes 879 acres (617 acres [70%] zoned industrial) accounts for 10,400 industrial jobs.[5]

This project focuses on a 25-acre site in Interbay which is currently home to Seattle's National Guard Armory and Readiness Center and the Northern-most portion of the former Navy-operated Port 91, adjacent to the Guard site, across the rail tracks to the West (encircled in yellow on maps to the left). As mentioned above, the site lies at the intersection of established residential neighborhoods and is connected to downtown Seattle by a major arterial. The Great Northern is extant as a working rail yard, and the neighborhood will realize additional activity and connection with the introduction of a light-rail line (and adjacent stations), scheduled to begin operation in 2035.

The site is an urban industrial zone. Industrial zoning in the City of Seattle includes four designations. The Port site is zoned Industrial General 1 while the Guard site is zoned Industrial General 2.

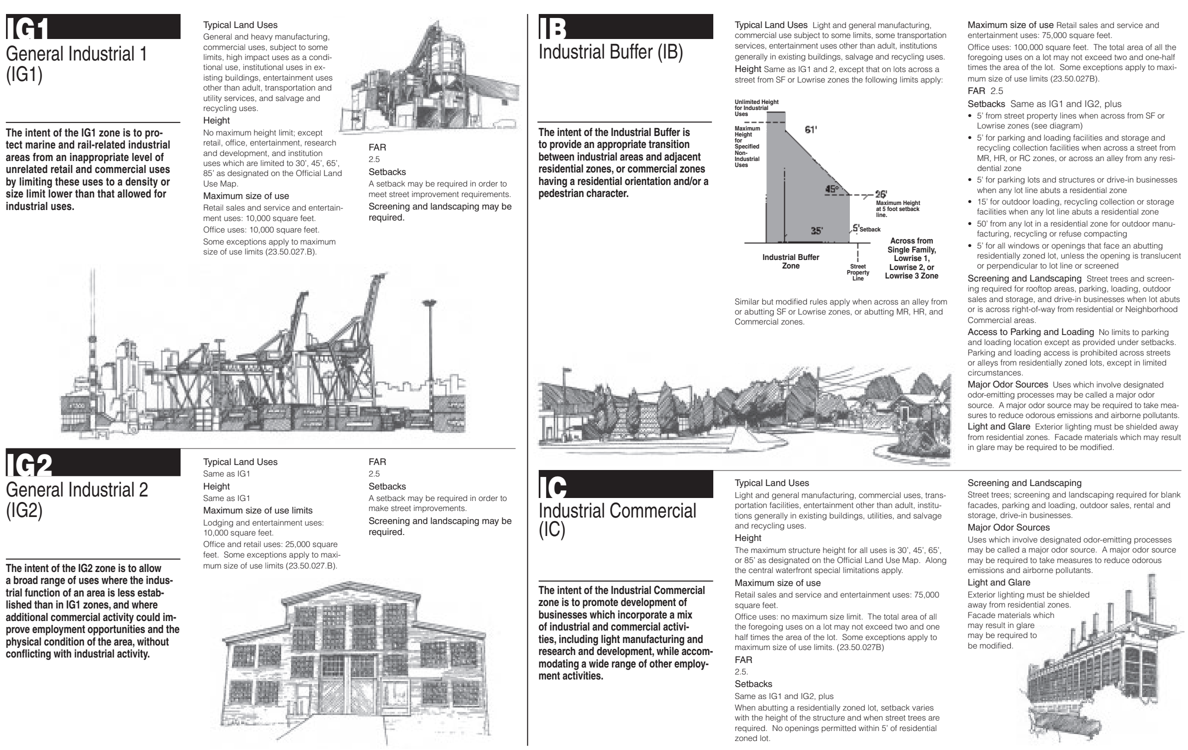


Figure 4.8: City of Seattle Industrial Zoning Summary

Figure 4.9: Interbay Circulation Area

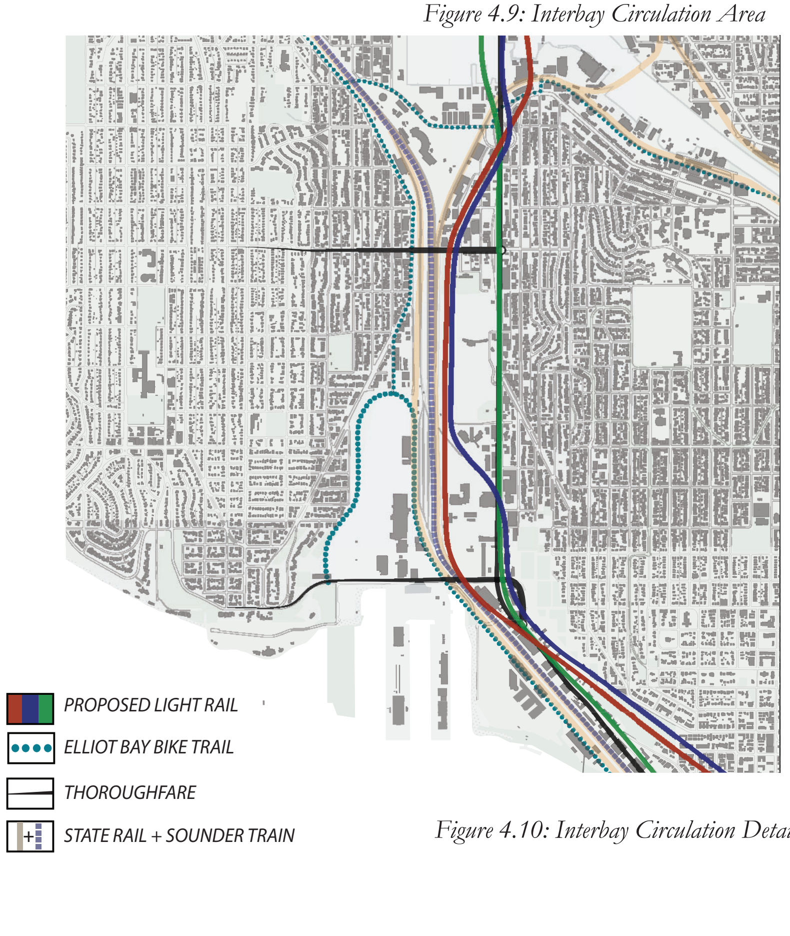


Figure 4.10: Interbay Circulation Detail

The zones describe varying degrees of allowable non-industrial uses, but they share a prohibition on housing, which has led to questions as the nature of manufacturing changes and the city's population increases rapidly. As author Erica C. Barnett writes "in recent years, though, the city's housing shortage has led developers to take a new look at the city's previously sacrosanct industrial area and ask: Why couldn't people live there?"[6]

The City has an active recent history of conversation regarding these lands. Industrial use was formalized as primary when Ballard-Interbay northwest Manufacturing and Industrial Center (BINMIC) was created in 1998, the City Council passed an amendment to further limit non-industrial uses in 2007 [7], and in 2016 then mayor Ed Murray launched an Industrial Lands advisory panel with the aim to "further safeguard industry."[8] The City recently published information that supports the further protection of industrial uses, but also suggests that it is time for an update to Land Use policy.[9]

The area is the topic of conversation for many reasons, though there is a clear interest in maintaining industrial culture here. The quote from Erica C. Barnett above reflects the notion that this industrial use could persist along with a possible future residential use. This mixed use is necessary to consider, as the city grows. Interbay is a good candidate as a dynamic future hub; well connected to the city (by auto, mulit-use trail, and ultimately light rail) and to the state (and beyond) by freight rail.

Figure 4.11: Interbay Neighborhood Photos

The Interbay Project provides a contemporary context for exploring the ideas of this thesis and building a model for future urban developments. The opportunity to consider new uses for these lands had recently come up with the news that the National Guard Readiness Center would likely be moving out of its location in Interbay. The Guard was making preliminary plans to move out of the city and build a new center in North Bend, WA. The state of Washington owns the 25-acre Interbay property and, through the Department of Commerce, set up the Interbay Public Development Advisory Committee to study the situation and determine what opportunities existed for this land.

Figure 4.12: National Guard Readiness Center

Figure 4.13: Interbay Project Diagram

During 2018 and 2019, several open houses and advisory panel meetings were held, allowing for public comment and panel discussion regarding these opportunities.

Several economic and political factors would determine the eventual use, including the need to financially support the Guard's relocation, and the zoning considerations discussed above. The advisory panel was tasked with studying these issues and stated that in any future scenario, "the committee will make recommendations regarding the highest public benefit and future economic development uses for the Interbay site, and will make recommendations to assist the Washington national Guard in their relocation."[10]

There are differing, and sometimes competing, perspectives on how to acheive "the highest public benefit"; as mentioned above, this land is the topic of much debate. There are proponents of maintaining Interbay for industrial use and advocates for opening the area to housing and a mix of uses. Considering all perspectives, the possibilities of this land and the challenges we face looking into the future of the city of Seattle, the highest public benefit for this land will include a mix of housing and industrial uses.

The advisory panel ultimately has chosen to include a redevelopment scenario with a mix of housing and industrial uses as an option. In early December 2019, the panel's work was summarized in a report that was forwarded to the Governor and the Legislature. The report identifies an "industrial only" option but also articulates several redevelopment concepts that include housing and states that "the following land uses will be the primary elements of the redevelopment concepts: Industrial, Mixed-income housing, flexible civic space."[11]

Precedents exist for development with these mixed uses. Part of the panel's report includes take-aways from a case study performed by Maul Foster & Alongi focusing on mixed-use industrial residential development. The panel identified Strathcona Village in British Columbia, the Manufacturing Incubator in Toronto, ON, and Port Covington in Baltimore, MD…all developments that include light industrial uses with housing, in either a vertical integration (housing atop industrially-activated ground floors) or horizontal integration (housing units adjacent to buildings used for industry).

Redevelopment Concepts

Informed by the adopted guiding principles, input from the public, and project team analysis, the advisory committee identified three redevelopment frameworks and six redevelopment concepts for evaluation. These appear in Table 6. The advisory committee established that the following land uses will be the primary elements of the redevelopment concepts:

- Industrial
- Mixed-income housing
- Flexible civic space

Each of these elements helps create the highest public benefit and future economic development opportunities within the existing context of the Interbay neighborhood and considering major public investments planned for the area. It is important to note that **the focus of the advisory committee was not to seek concepts that maximize return to the state in supporting the Guard's relocation costs, but rather to create the highest public benefit and economic development opportunities.**

Industrial land uses that produce family-wage jobs are consistent with the current city policy and zoning. Mixed-income housing, while not currently supported by policy or the land use code, would create needed affordable housing units in a mixed-income neighborhood and leverage the region's investment in light rail. Supportive retail in the mixed-income neighborhood would provide access to basic goods and services and may provide space for community

Table 6: Redevelopment Concepts

Concept	[illegible]
Mixed use commercial/residential with mixed-income housing framework	
(1) High-Rise Concept	
(2) Mid-Rise Concept	
Industrial framework	
(3) Industrial-Only Concept	
Mixed use light industrial/residential with mixed-income housing framework	
(4) Housing Next to Industrial (mid-rise) (5) Housing Next to Industrial (high-rise)	
(6) Housing Above Industrial	

THE INTERBAY PROJECT 47

Figure 4.13: Interbay Advisory Committee Redevelopment Concepts

Light-Industrial uses in this context include boutique manufacturing, small-scale food and beverage, advanced manufacturing (3D printing, research and development, Software), and skilled trades.[13] These opportunities could manifest into buildings that house people only when, and if, the Guard realizes the necessary funds to move operations and the City of Seattle adjusts the Industrial Zoning Code. Ultimately, the panel recommended that the state appoint an additional new authority to manage future development when the time comes. The recommendations of the current panel's work, though, have provided a foundation that include the possibility for a new neighborhood that includes industrial and residential uses.

During one of the advisory panel meetings, the adjacent industrial site managed by the Port of Seattle was discussed. Could this land play any part in a future Interbay redevelopment scenario? The site is home to several industrial buildings, but also includes a surplus of open space currently used for parking.

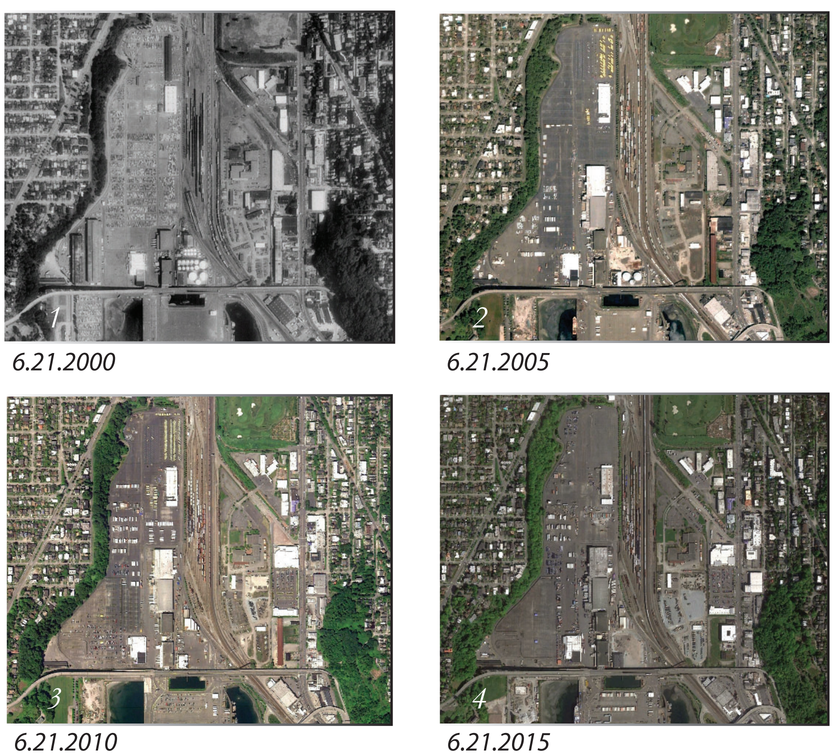


Figure 4.13: Port of Seattle, Pier 91 Parking Lot (Google Images)

The site is also involved in redevelopment plans, managed by the Port. The plans include the addition of 100,000 square feet of light industrial space that "will support fishing and maritime supply chain companies needing to expand within the Ballard/Interbay Manufacturing Industrial Center."[14]

This area and the people who live and work nearby will benefit from further development. Further, there is room to include additional industrial capacity here that could have a strong connection to possible future development across the tracks at the Interbay Project site. This site is well positioned to include the additional industrial resource of timber manufacturing. Considering the advantages of the material and the recent interest in using it, the time is right to introduce this production resource in the city.

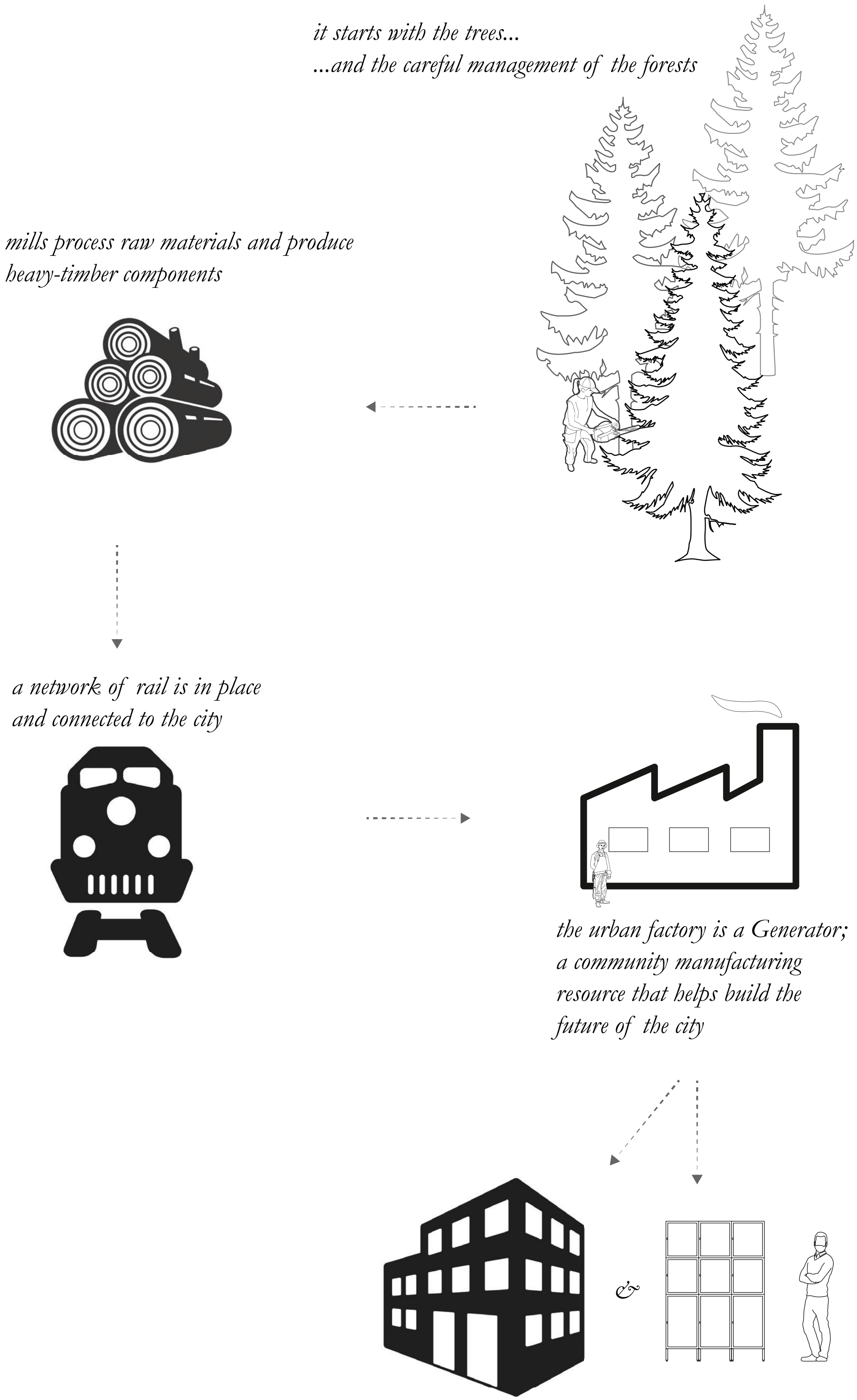


Figure 5.1: Urban Factory Process Diagram

5. Generator

Concept

Another industry, deeply connected to the cultural history (and future) of the region could play a major role in the BINMIIC. Research suggests that factory-based production, especially using timber as primary material, would be an appropriate use for this site.

The concept for this thesis is based on the factory as a generator for a new mixed-use neighborhood in Interbay. The factory will be erected on the Pier 91 site, adjacent to the Interbay Project. This production facility has the capacity to manufacture the components that will compose the initial buildings of the new neighborhood. Once the buildings are constructed and occupied, proximity to the manufacturing center will be an enduring benefit to the new community. Making production processes visible and available with community shop space is a strategy for creating craft-based place. The diagram below describes a broad diagrammatic overview of the opportunities that exist here. The Generator is the focus of the design project and is responsible for the creation of the multi-use neighborhood proposed for the Interbay Project site.

The land directly north of this site is currently used as a municipal golf course. This thesis proposes a light rail station and transportation hub will assume part of this space. The long-term planning for a light-rail line in this neighborhood includes several options (illustrated in a previous map); this project prefers the option that runs along the rail tracks and directly above the Interbay Project, before turning to the East and continuing south on 15th Ave toward downtown. This thesis also introduces a rail station adjacent to the Interbay Project.

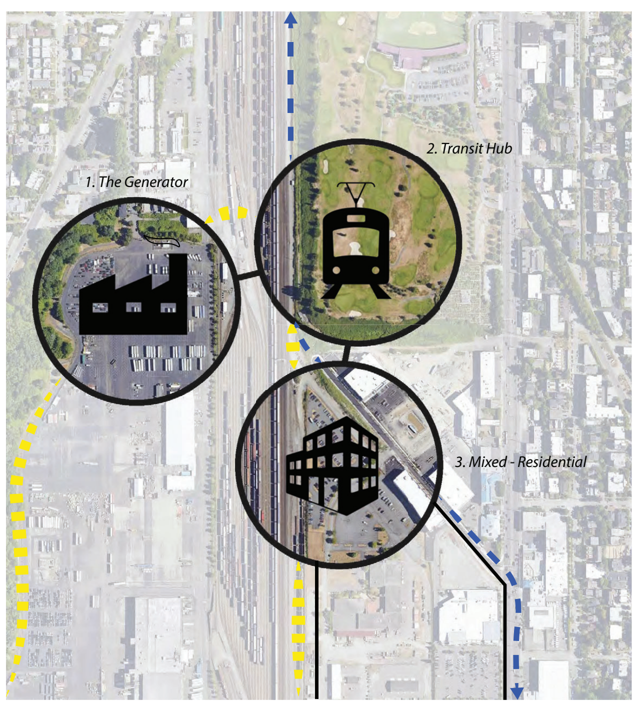


Figure 5.2: Conceptual Diagram Map

As mentioned previously, this immediate area is located at the intersection of several neighborhoods (in every direction), has proximity to downtown Seattle and will have the additional layer of connection from light rail transit. As community members move in to the new Interbay Project neighborhood, the advantages of locating a light-rail station in this spot seem clear. As Kimo Griggs (Associate Professor of Architecture, University of Washington) has said, "where there are riders, a stop makes sense." [1]

An additional design element of a pedestrian bridge is introduced to tie these elements together and re-connect the Interbay Project neighborhood with the Elliot Bay Bicycle Trail. The bridge facilitates engagement between the neighborhood and the factory buildings.

The factory buildings are, in the end, three separate structures. The main factory building is fronted by a community fabrication space, which is connected to an integrated design building. The east face of this building is oriented to face a community center across the tracks. This "facing" is an intentional move, designed to metaphorically collapse the distance between these two spaces and join them together.

The annotated site map and section-elevation on the following pages introduces these elements and illustrates the relationships between them.

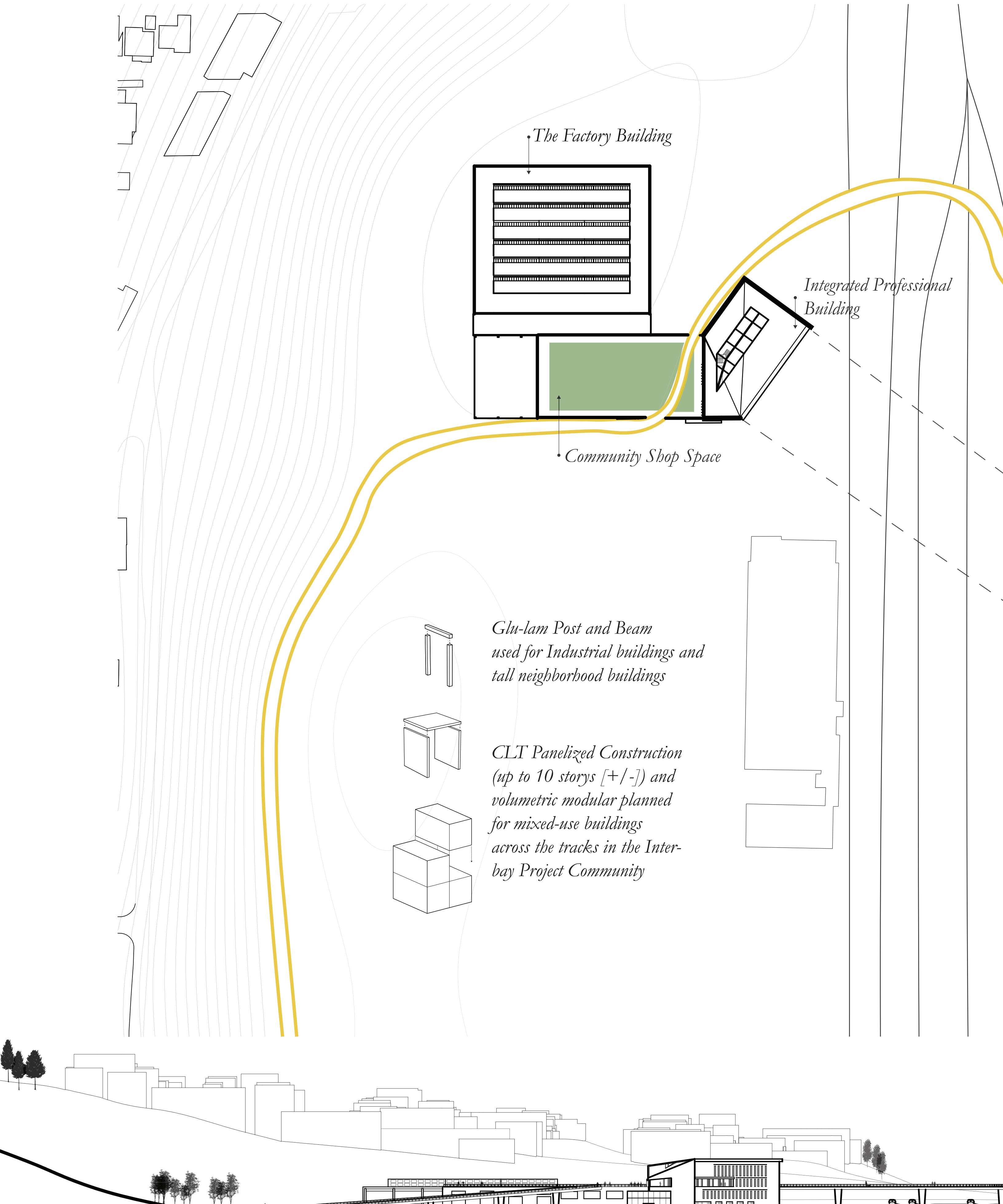
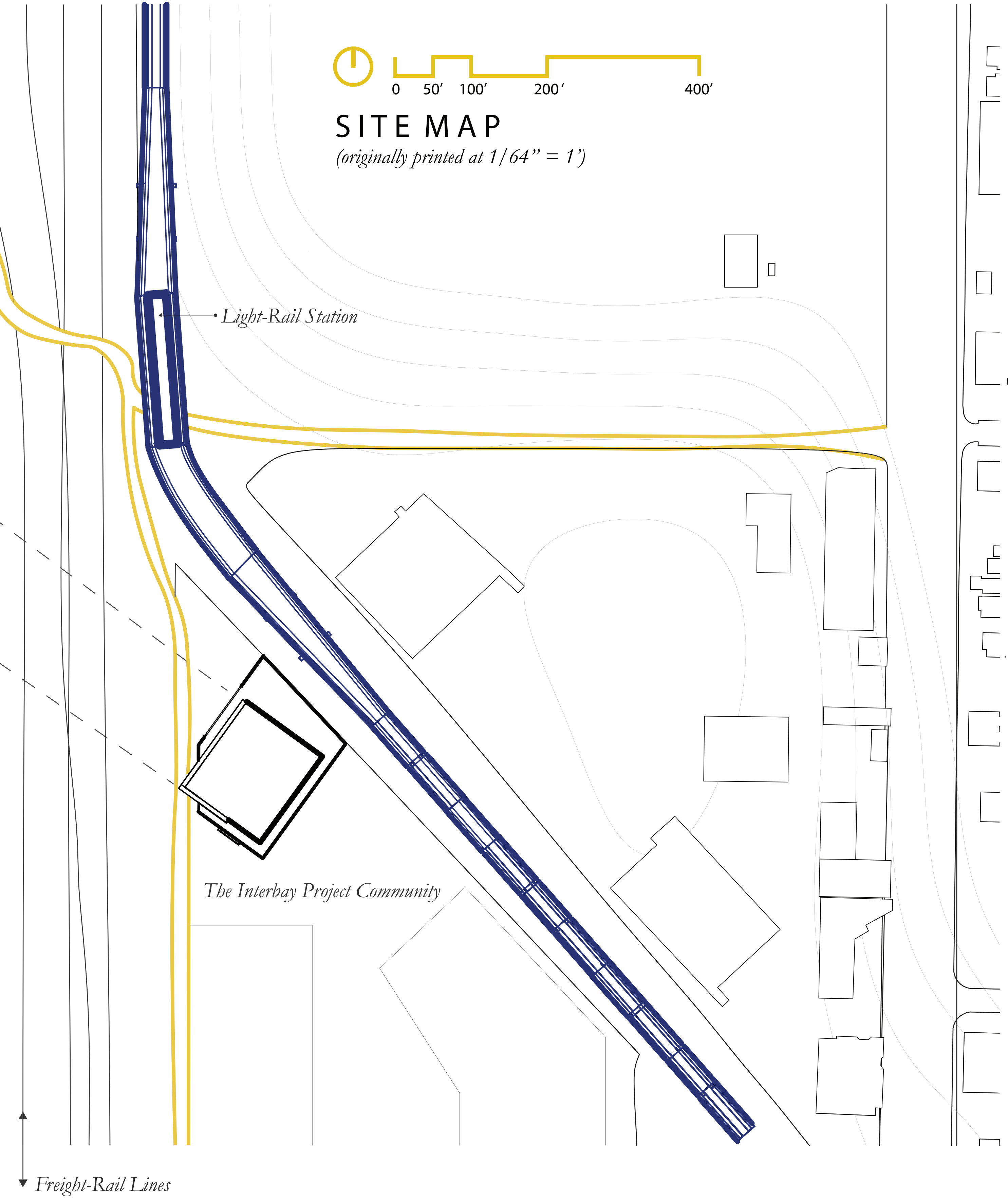
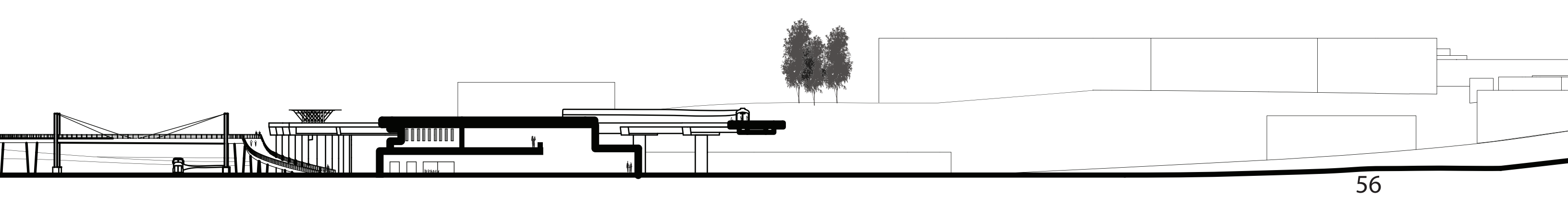


Figure 5.3: Site Map and Section-Elevation

SITE MAP

(originally printed at 1/64" = 1')





Rail Connection

The factory structures are sited on the Port 91 side of the site in order to maintain a heavier manufacturing presence here, while light industrial and residential are planned for the Interbay Project side. Also, the Port side has more immediate access to the rail line that runs through Interbay. The adjacency to this line is critically important, as it allows the transportation of wood products and connects this site to rural industries and community. I imagine a dynamic and reciprocal benefit to both the rural forest-product based communities and the urban factory.

The map (below) illustrates the network of rail lines in Washington State. Opportunities for the rejuvenation of the timber industry in the state will be facilitated by this network. The map shows a direct connection between Darrington, Washington and the Interbay site. The Washington State Department of Commerce recently awarded $483,000 total to several communities in Washington for "Wood Energy Projects," including forestry health projects that seek to maximize the benefits of carbon sequestration, the testing of woody biomass systems for generating heat and power, and a grant to interests in Darrington for the construction of a "Wood Innovation Center".[2] The facility will process forest products and produce CLT panels, glu-lam beams and other wood components. The Generator factory could receive these components and detail floor plates, wall assemblies, and full volumetric volumes for installation in the City and beyond.

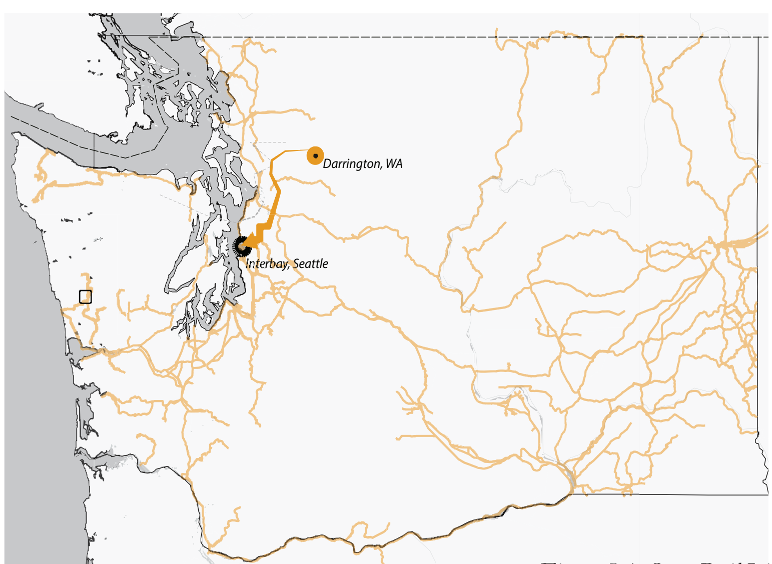


Figure 5.4: State Rail Lines, Darrington Connection

Community Resource

These connections to rural communities and the timber industry are fundamentally important to the concept of this project. The benefits of timber construction discussed earlier in this work will be made manifest in this community. The flow of materials and their management and use will be a part of the culture here.

Life on site will be enriched by the presence of these materials and the manufacturing capabilities the factory embodies. The factory buildings are a workplace, a center for research and innovation and a community resource. The Generator is designed to include access to community shop space, education and job training. This industrial foundation is the basis for a typology of urban development. The early conceptual diagram below expresses the basic ideas behind this strategy:

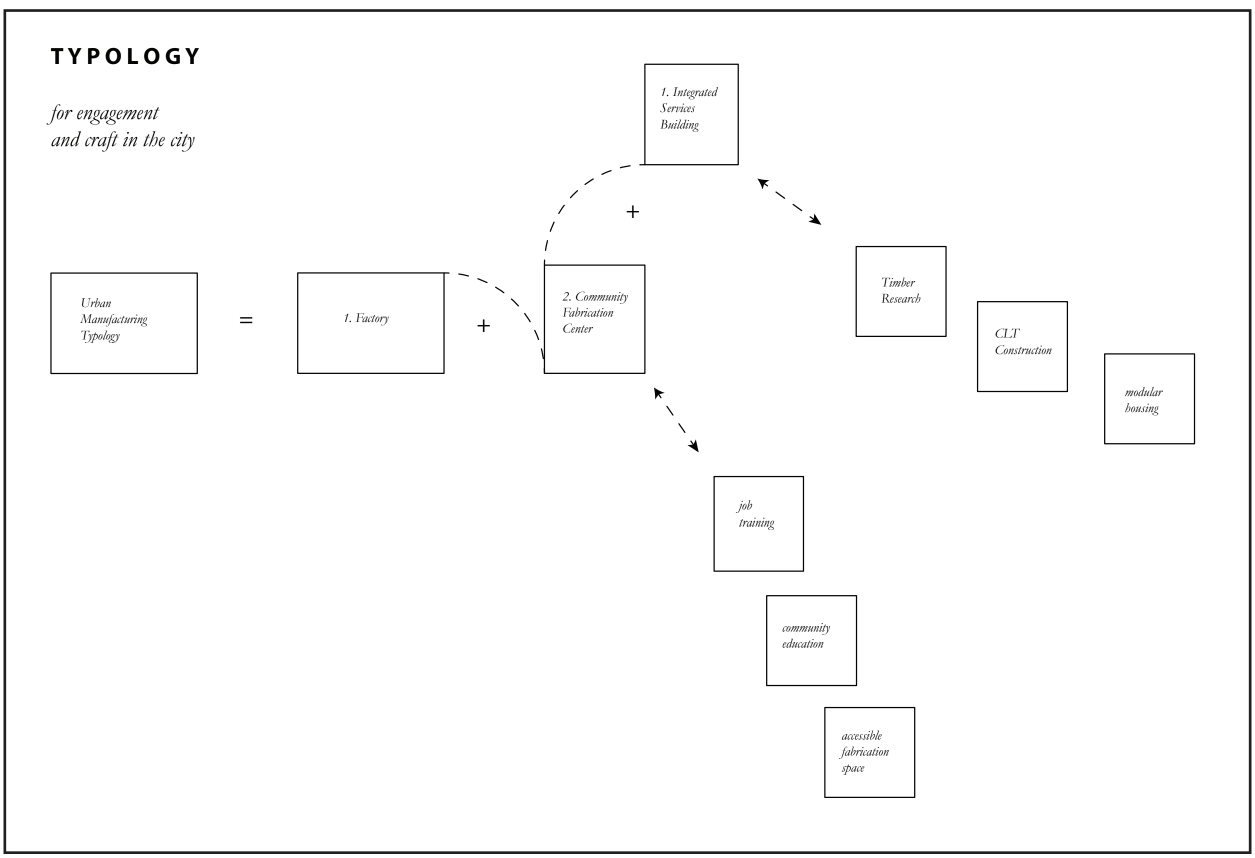


Figure 5.5: Urban Factory Typology Diagram

In keeping with the environmental concerns expressed earlier in this document, the Generator will be managed as a sustainable workplace. Industrial waste products will be use for the generation of energy (an important idea, that is certainly possible, though outside the scope of this project). The use of manufacturing scrap will also support the community's engagement with craft. The diagram below and on the following page describe this notion. The first image describes the concept, while the image opposite could be a community flyer welcoming residents to the shop.

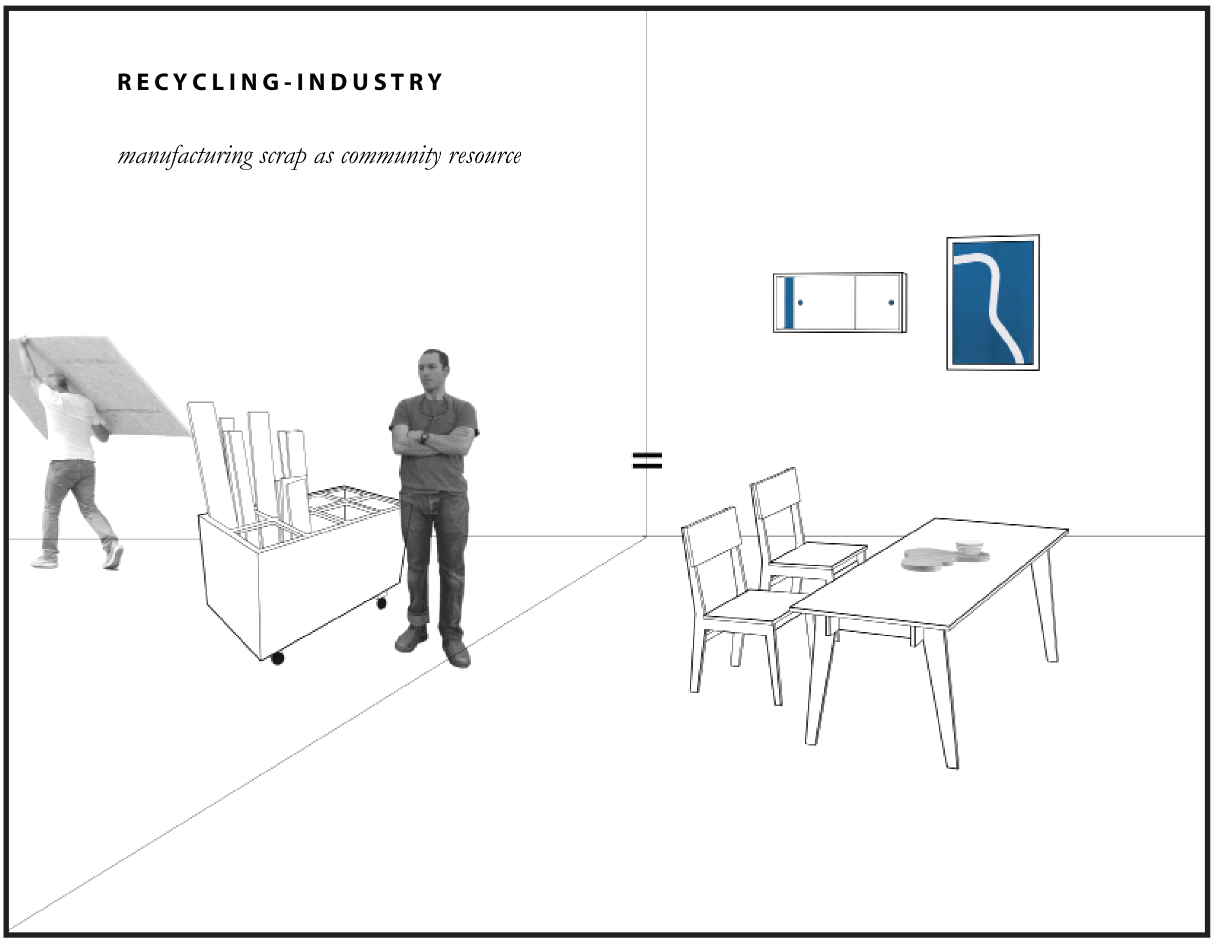


Figure 5.6: Recycling Industry

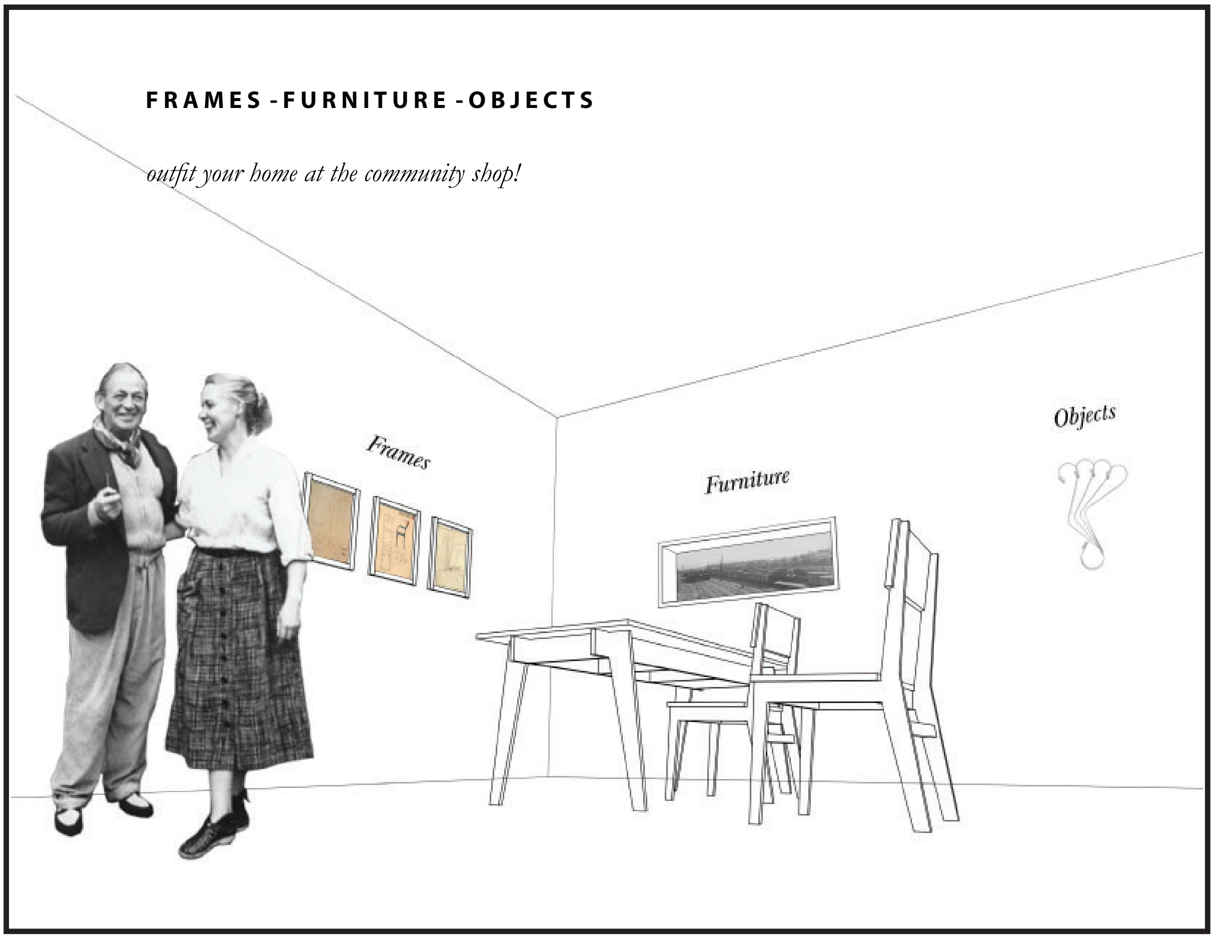


Figure 5.7: Frames - Furniture - Objects

The final set of images are an imagining of a furniture line and a simple "how-to" document that would be made available in the community shop space. Opportunities for making established designs and working with digital tools to take advantage of customization of standards exist in these spaces.

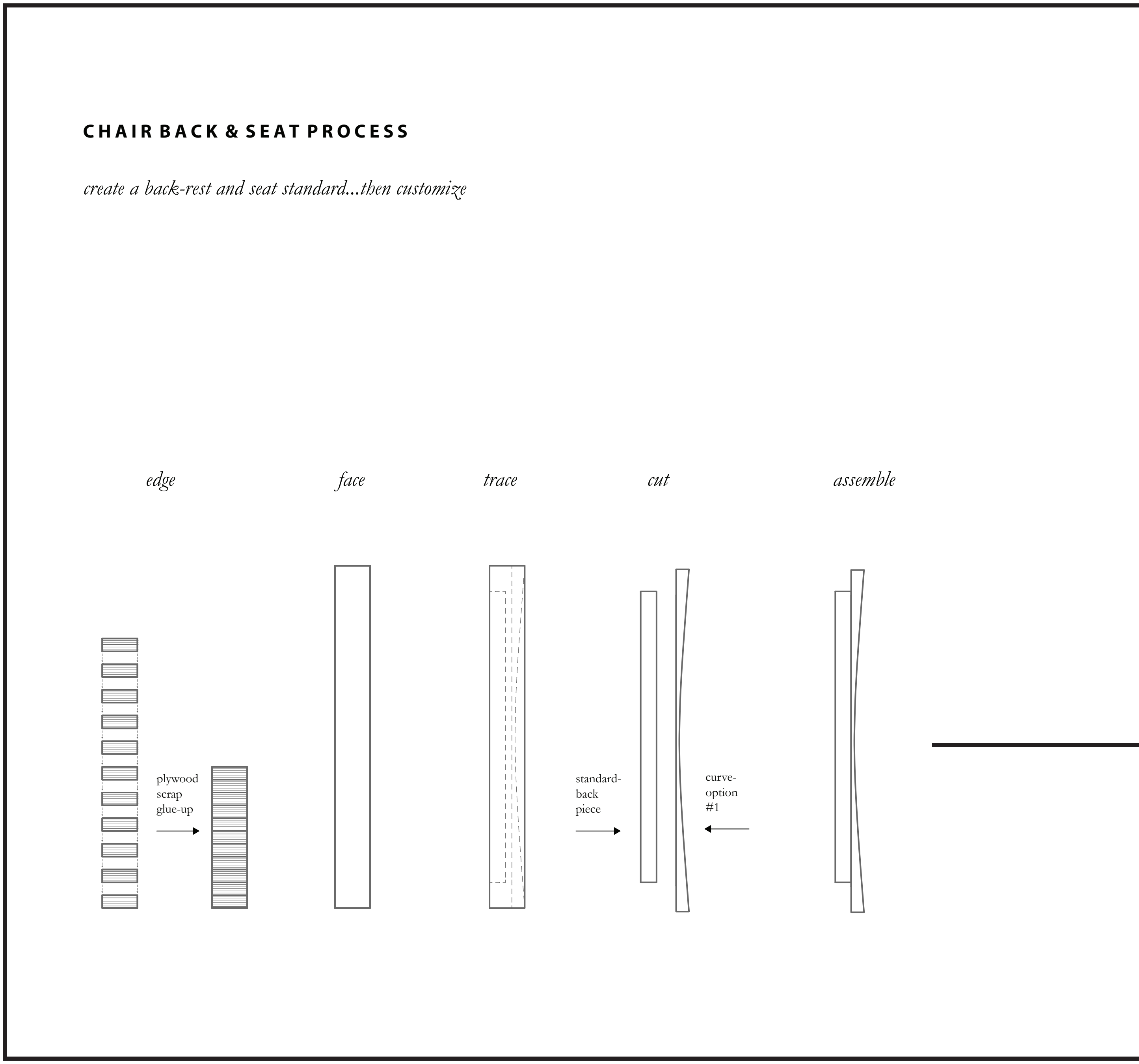
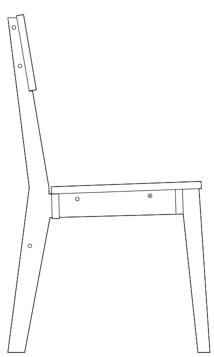


Figure 5.8: Chair Back & Seat Process / Chair Template # 1

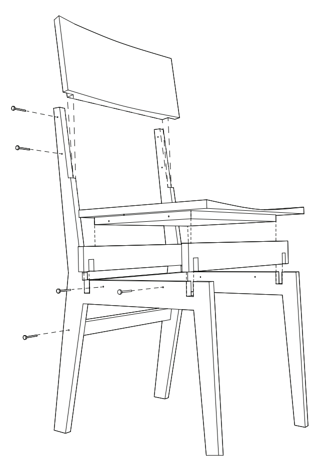
CHAIR TEMPLATE #1

back rest and seat profile cut on band saw...connector bolt connections

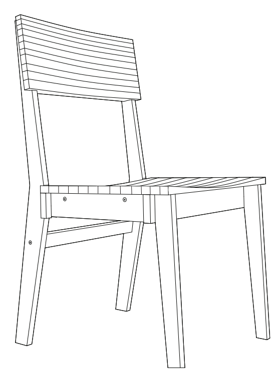
chair profile



exploded parts diagram



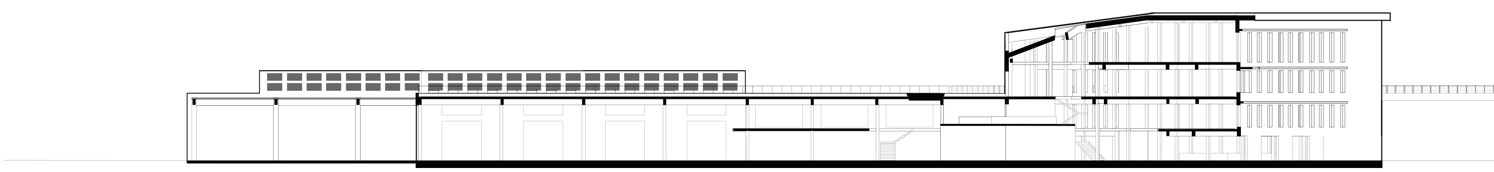
chair perspective



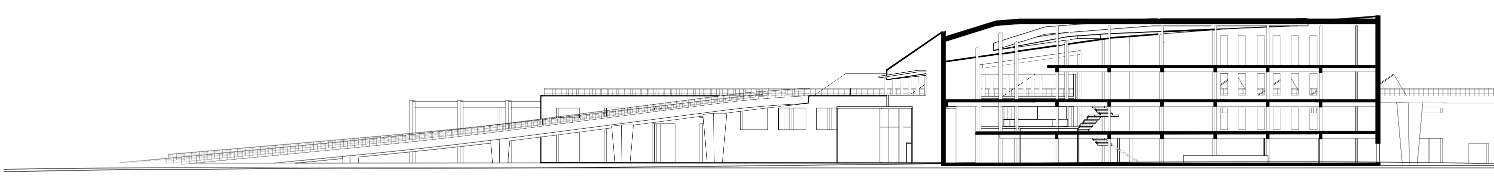
The Buildings

The factory, community shop space and the integrated professional building are the focus of the building design phase of the project. The buildings are intended to work together as described in the Urban Typology Diagram; factory as generator that supports the other buildings and helps build the community across the rail tracks. The sections below offer a look at some of these relationships. The volumes are kept open and flexible…with timber frame and panel construction. The pedestrian bridge is visible as a connector between the Pier 91 side and the Interbay Project side, and the light rail station is pictured in the Longitudinal 2 – North section.

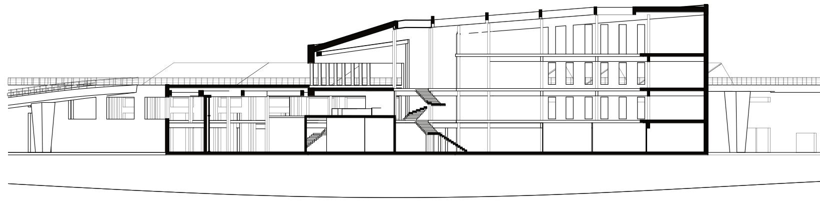
LONGITUDINAL 1 - EAST



LONGITUDINAL 2 - NORTH

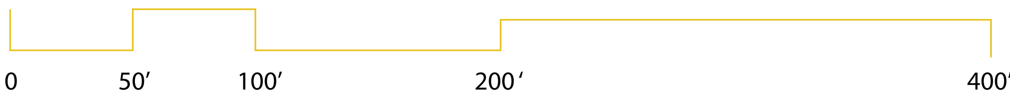


TRANSVERSE 1 - NORTHEAST



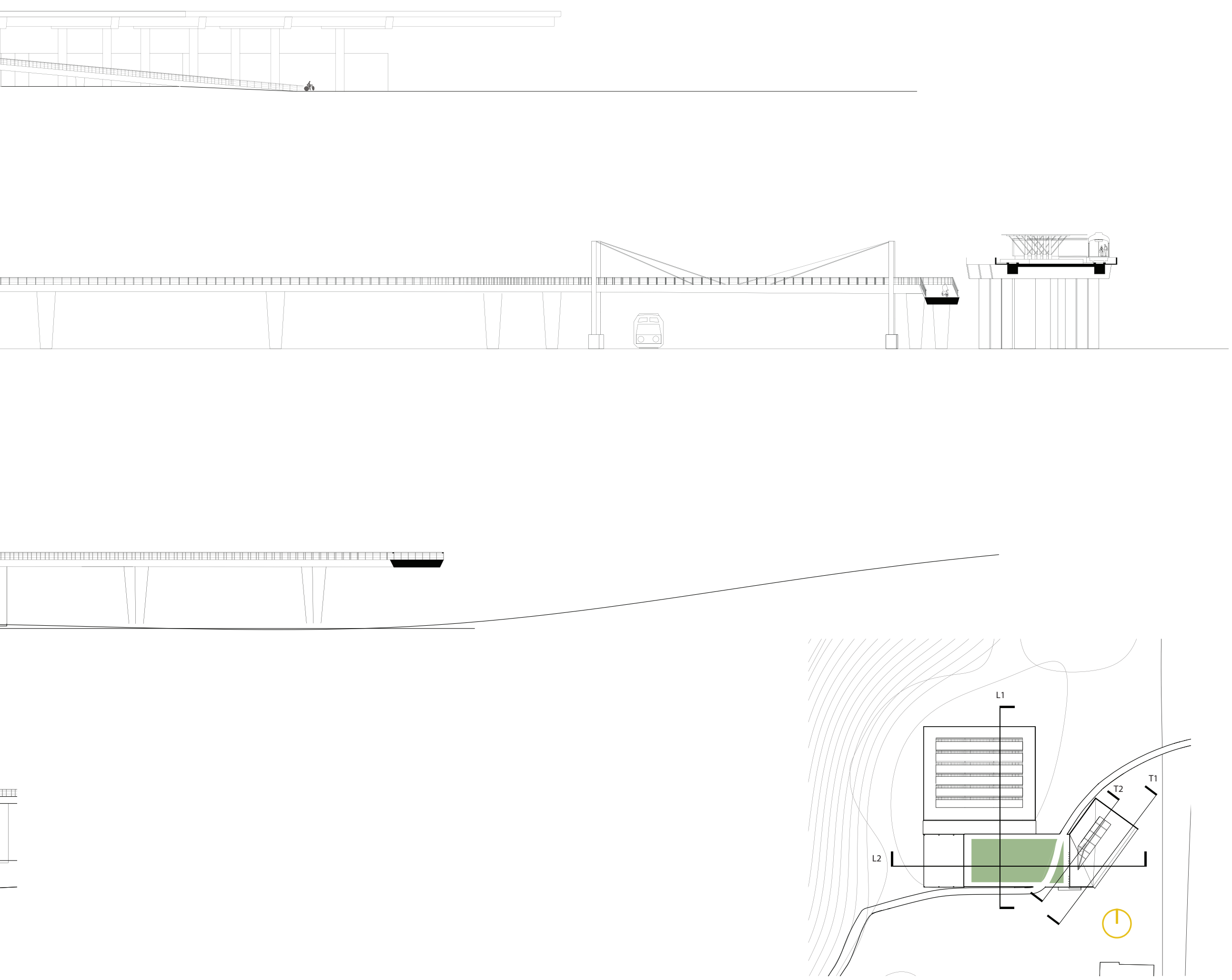
TRANSVERSE 2 - NORTHEAST MID-BUILDING

Figure 5.9: Building Sections

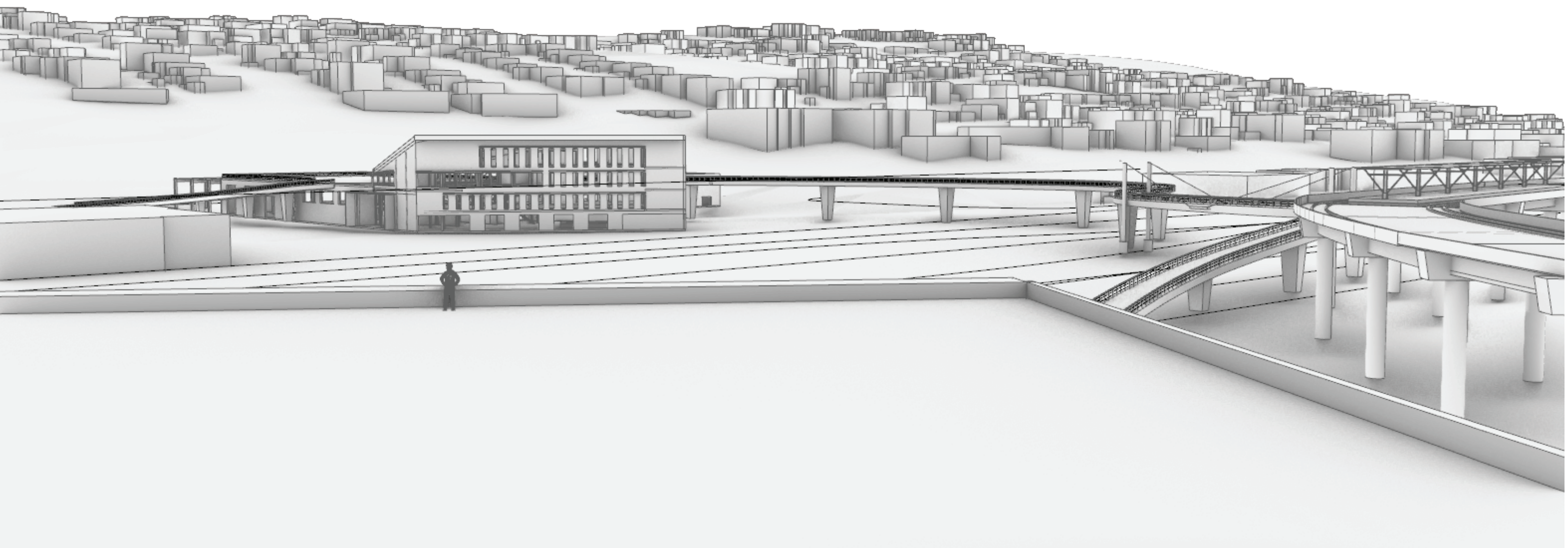


BUILDING SECTIONS

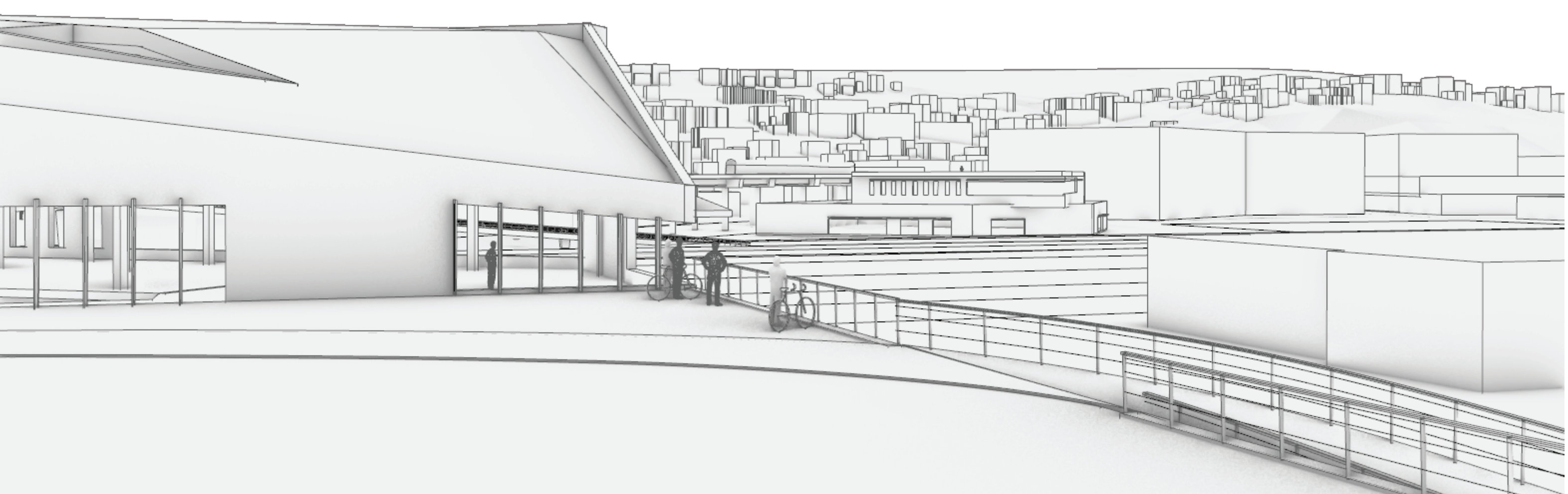
(originally printed at 1/16” = 1’)



The Industrial buildings on the Port 91 side are linked to the proposed Interbay Project development. The images below show this relationship and give a sense of the work the pedestrian bridge does to facilitate the connection.



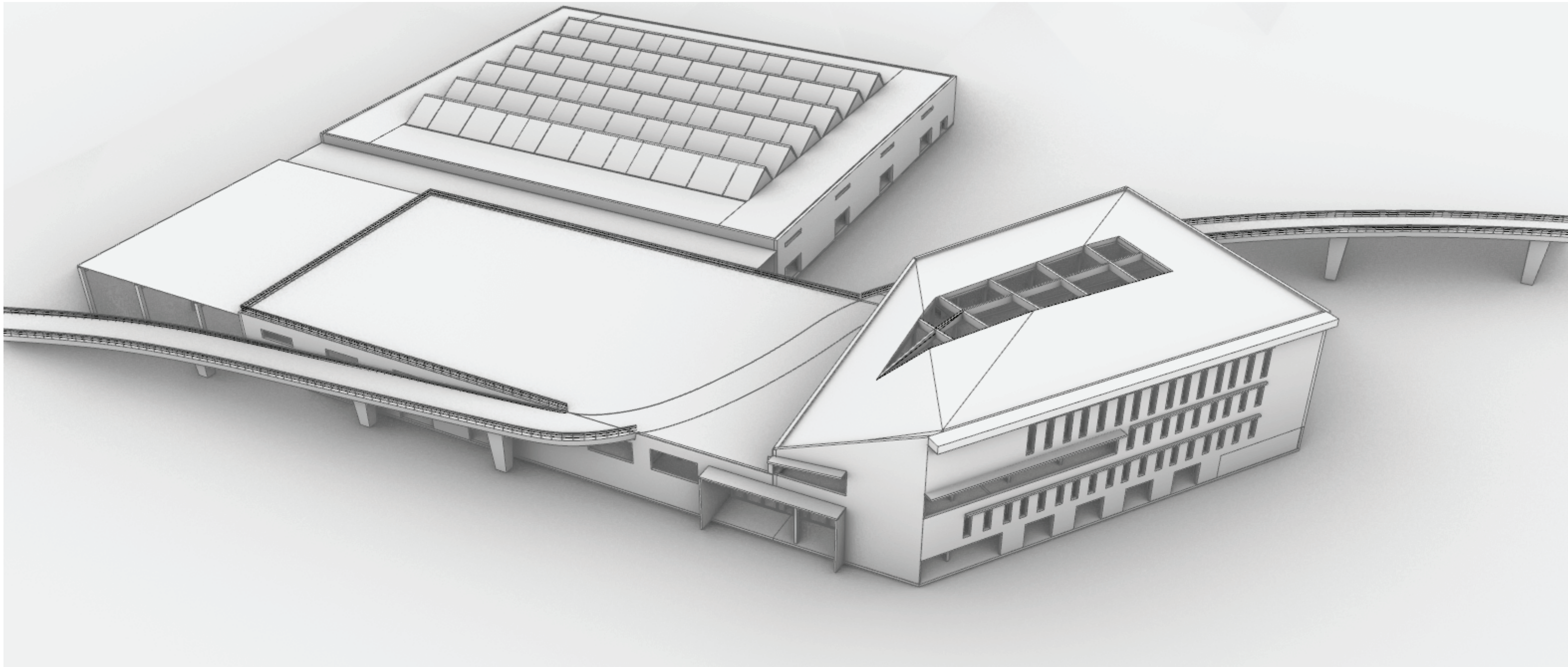
neighborhood looking across the tracks to the shop side



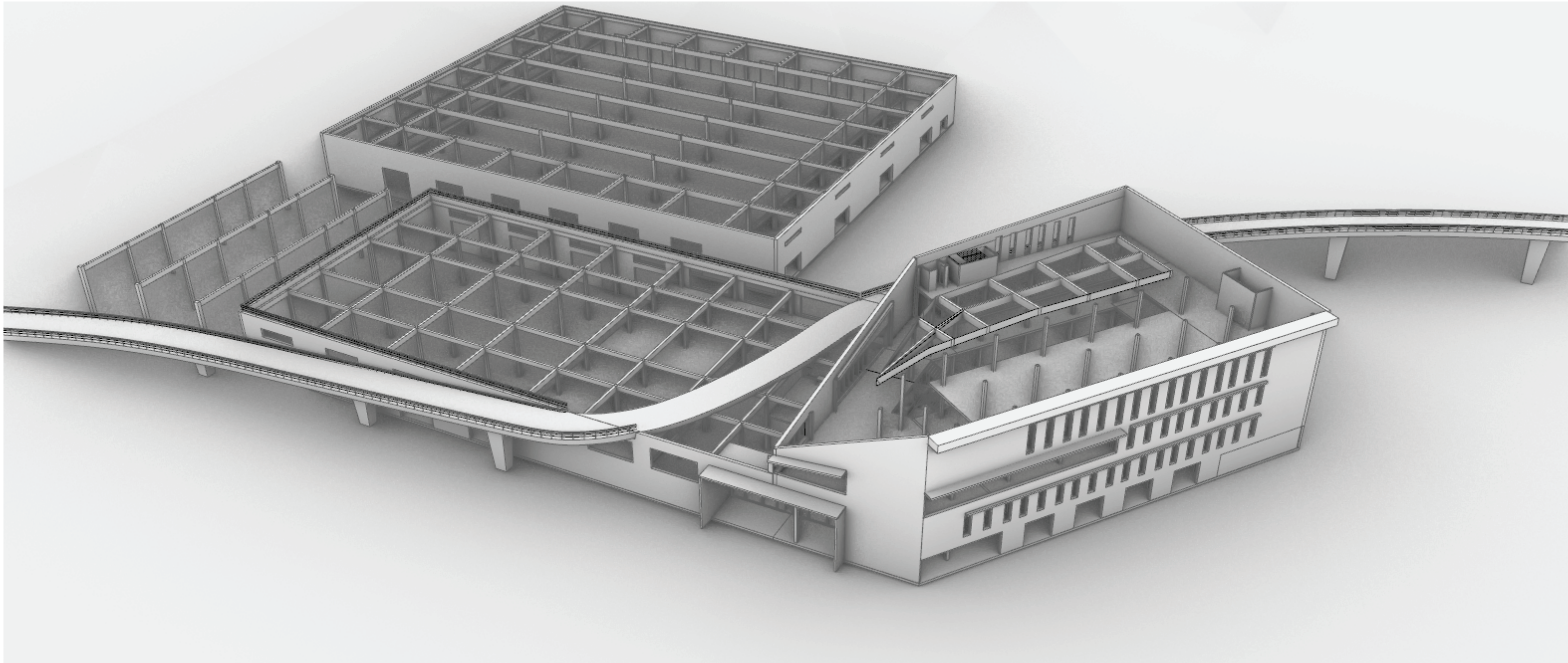
shop side looking back to the neighborhood

Figure 5.10: Model views

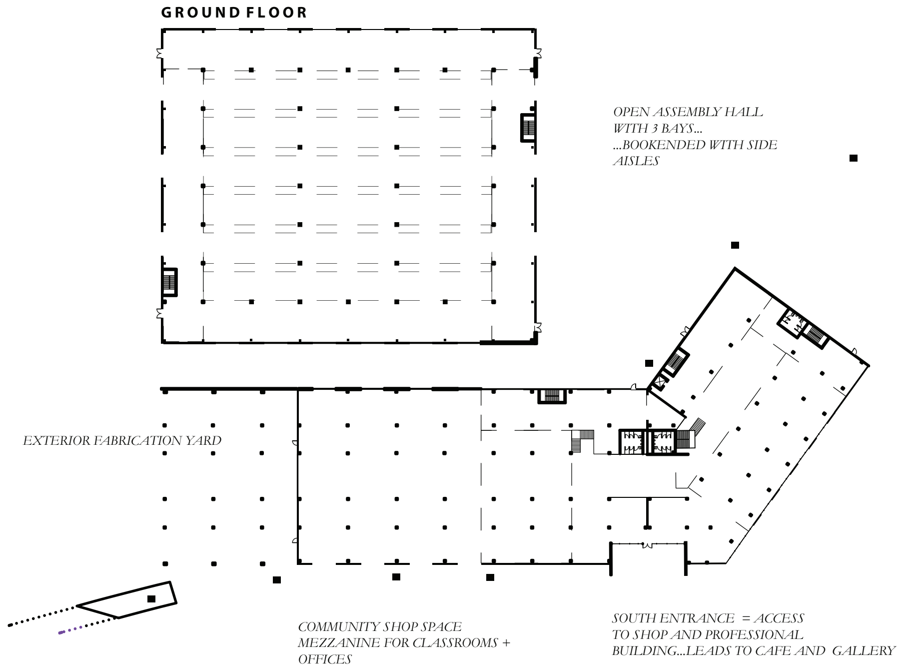
The buildings are designed with heavy-timber construction. The industrial and professional buildings are primarily timber frame and panel. The buildings are designed to be open and adaptable, which is facilitated through the use of this material.



factory, shop, and professional building from above



factory, shop, and professional building timber elements



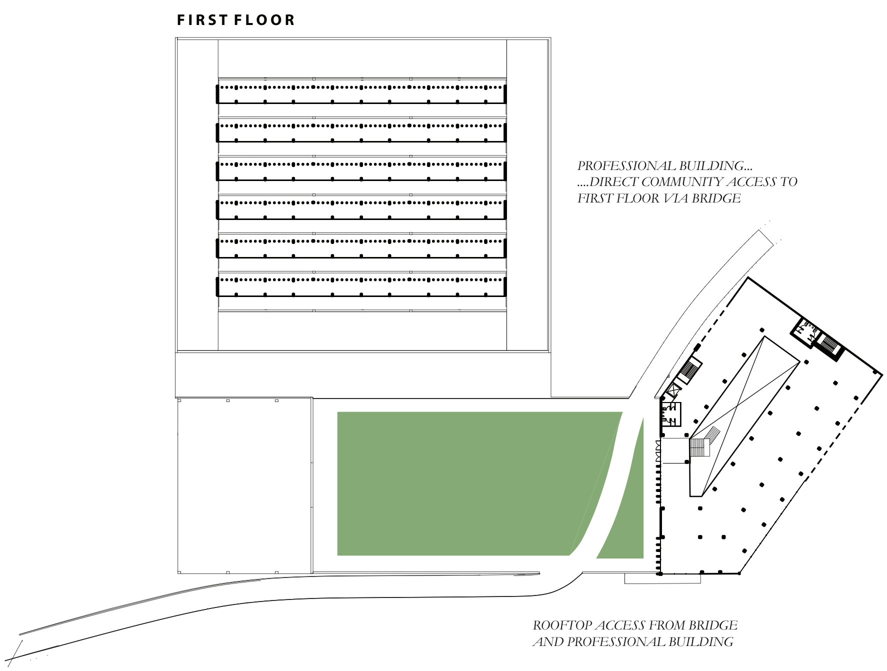
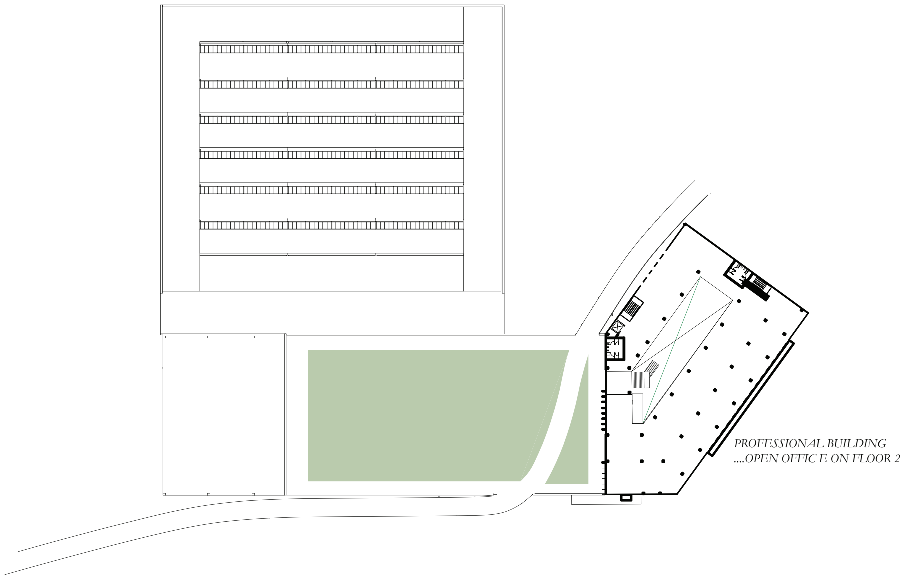


Figure 5.11: Building Plans

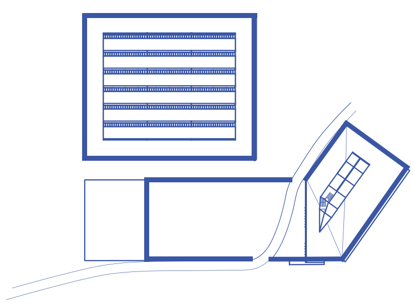
SECOND FLOOR



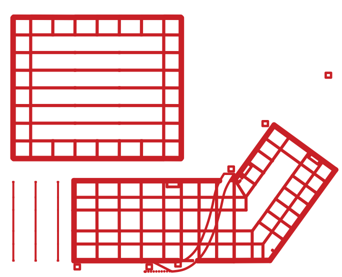
PLAN DRAWINGS

(originally printed at 1/32" = 1')

ROOF DETAIL



STRUCTURE BASICS



The View

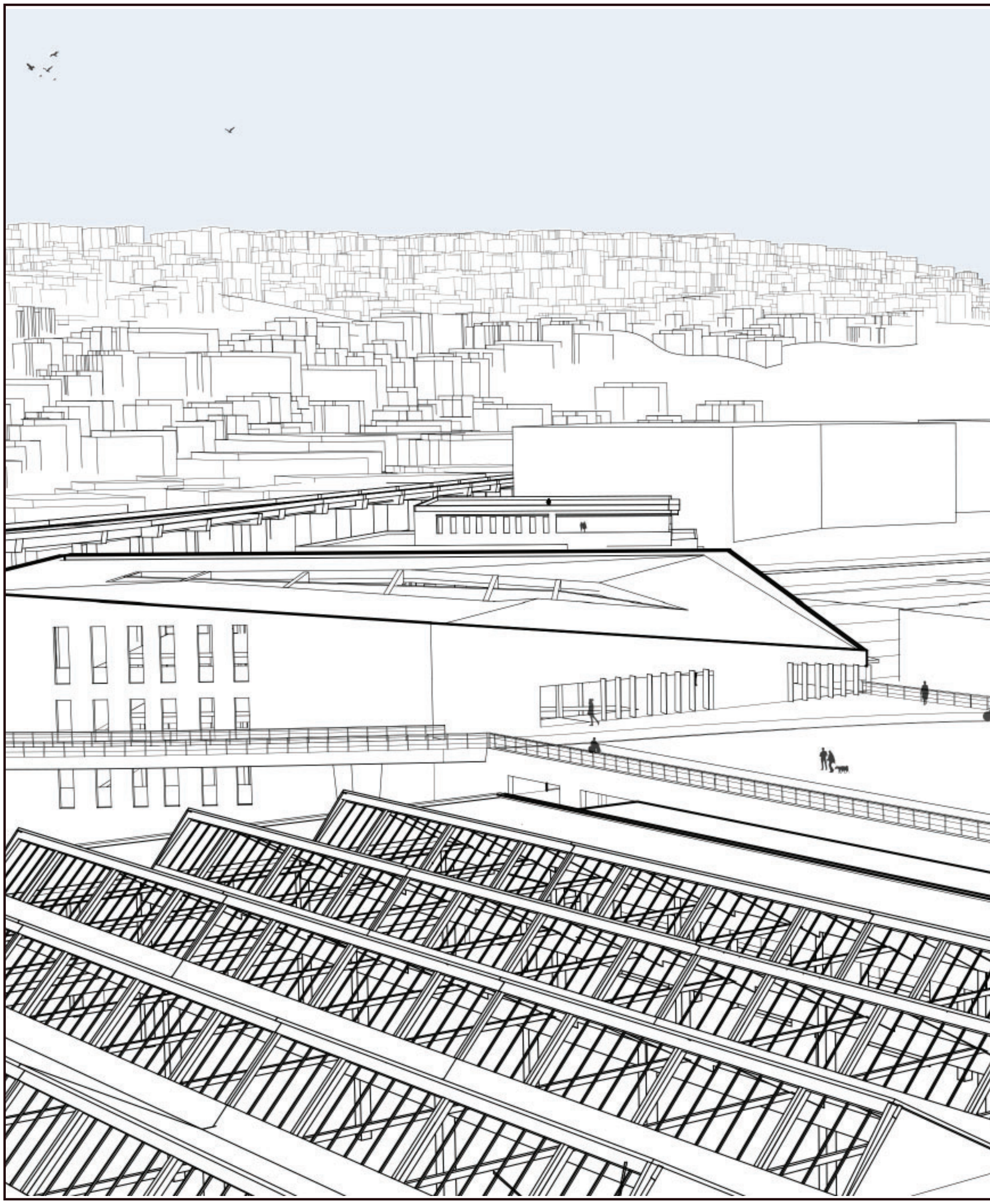
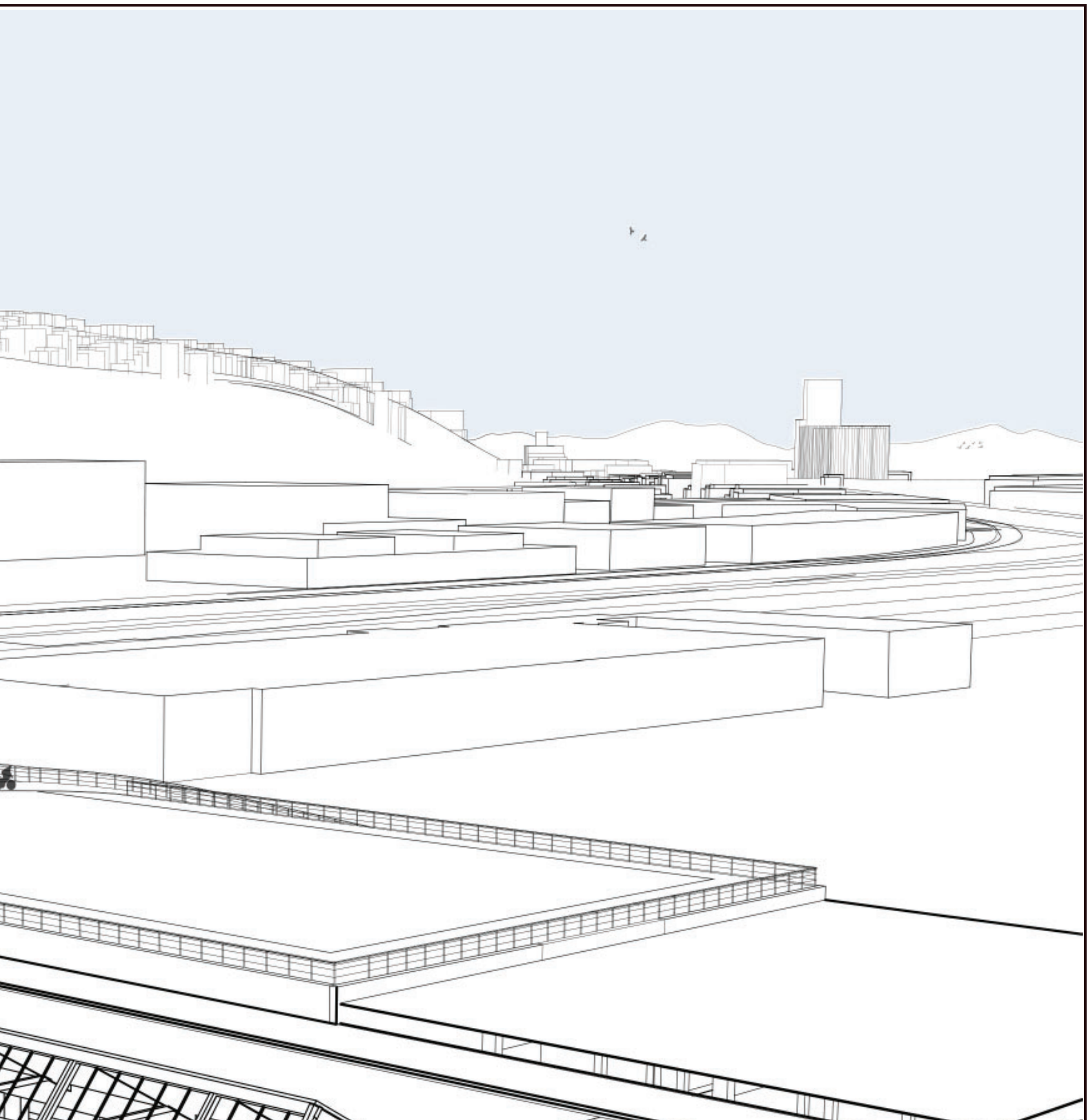


Figure 5.12: Site Drawing



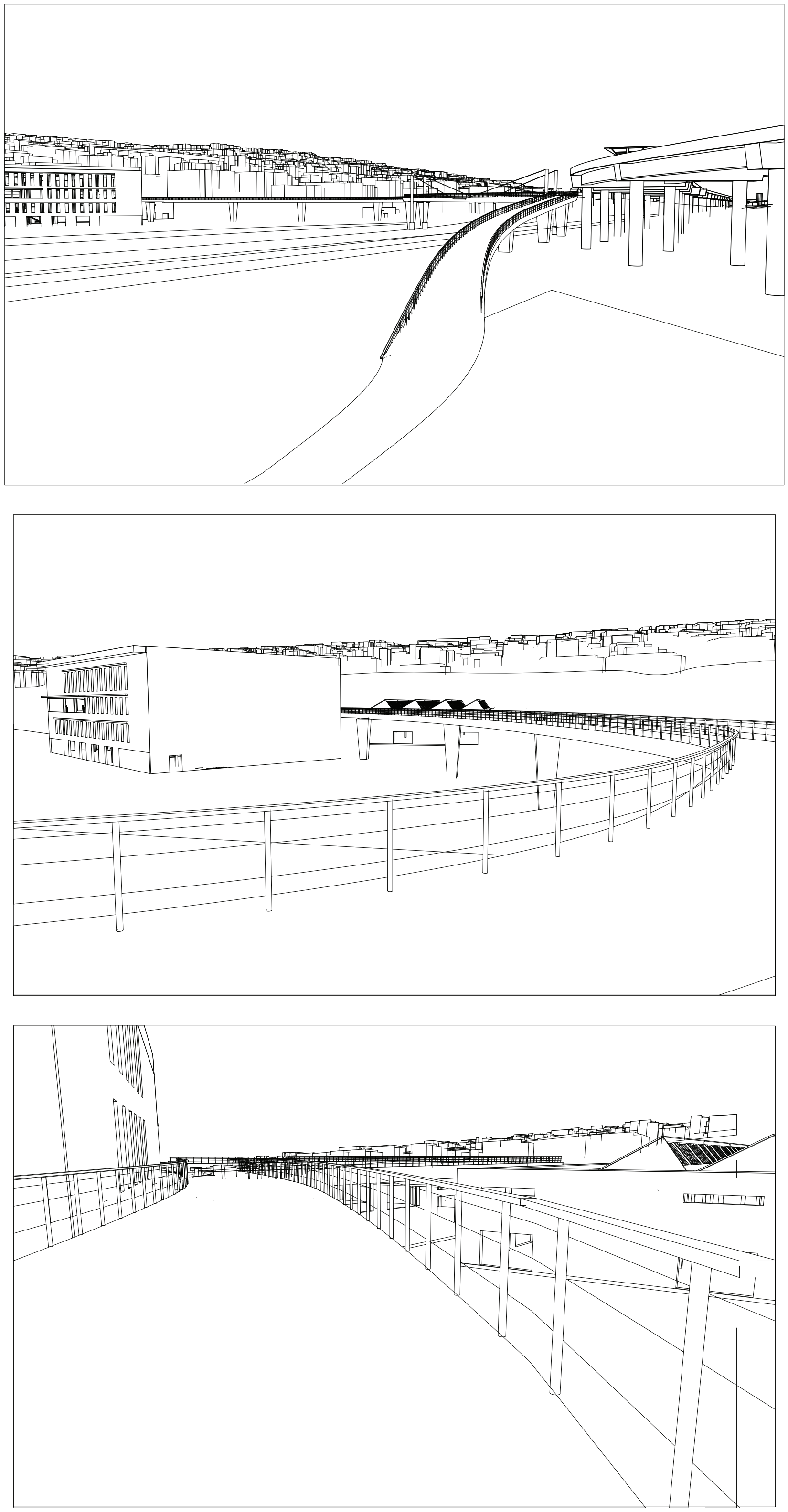


Figure 5.13: Bridge Sequence Drawings

Figure 5.14: Interior Drawings

Figure 5.15: The Interbay Project

6. Conclusion

The community described in the previous section is the location where the research and interests articulated throughout this project come together. This thesis makes the proposal that the Interbay Project will benefit from the introduction of an urban-manufacturing typology that includes a production facility as the foundation of community development. This is the primary idea…which offers part of one possible solution to how this site could be developed.

Heavy Timber construction and manufacturing processes have been emphasized; the future of our city belongs at least partly to buildings constructed primarily with wood. The environmental benefits of this path are clear. The realization of these benefits requires coordination between urban and rural communities in the shared goals of responsibly using a local resource and protecting the environment.

The relationship between the industry and the community helps make materials and processes visible. The culture of wood is celebrated in this relationship and positions the area to contribute to the movement to build more buildings with heavy timber in the city. Prefabricated and modular concepts are an important aspect of the factory's output and the composition of the community buildings. Community spaces are linked to the factory; a connection that brings industry and community together as foundational aspects of place.

7. References

Figures

Figures are by author, unless otherwise noted.

Sources noted here. Full citation included if not available in Bibliography.

1. Introduction

2. Industrial Building

3. Timber!

4. Interbay

Base maps of the Interbay neighborhood used in this thesis were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © Esri. All rights reserved. For more information about Esri® software, please visit www.esri.com."

The ArcGIS Pro Base Map "Light Gray Canvas" was used for all maps. MapEsri, Scale Varies.https://cdn.arcgis.com/sharing/rest/content/items/291da5eab3a0412593b66d384379f89f/resources/styles/root.json. (09.28.2019)

(1. Google Earth Pro 7.3.2, Interbay, Seattle 06.21.2000. Map Data, U.S. Geological Survey, 47^{0}38’15.17” N 122^{0}22’55.91” W elevation. 5450 ft. Map. Viewed 09.27.2019

2. Google Earth Pro 7.3.2, Interbay, Seattle 06.21.2005. Map Data, Maxar Technologies, 47^{0}38’15.17” N 122^{0}22’55.91” W elevation. 5450 ft. Map. Viewed 09.27.2019

3. Google Earth Pro 7.3.2, Interbay, Seattle 06.21.2010. Map Data, U.S. Geological Survey, 47^{0}38’15.17” N 122^{0}22’55.91” W elevation. 5450 ft. Map. Viewed 09.27.2019

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5. The Generator

Notes

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Appendix

The following works were generally instructive during this project and are recommended for the reader interested in these topics:

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