

Humanizing Industry
A Training Ground for Advanced Manufacturing in Kent, WA

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Abstract

Humanizing Industry: A Training Ground for Advanced Manufacturing in Kent, WA

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Architecture

Where industry was once the backbone of community, it has since been relegated to sprawling industrial zones, on the edges of community, divorced from the people who benefit from its labors. However, a certain renaissance in “making” is evident in the Maker’s Revolution.

The typical manufacturing facilities used today are not the dark, soot covered factories of the past. Processes have changed and building technologies have become more efficient. Yet, the resulting environment for manufacturing has developed to be little more than large, sprawling boxes, disconnected from their human occupants.

Proposing a community education, co-working and manufacturing facility, this thesis is not intended to redefine the manufacturing process, but to address the physical environment in which it takes place, making it more fitting to the occupants therein. Scale, programmatic relationships and adaptability are used to explore various spatial experiences in which to interact, collaborate, and simply occupy.

Acknowledgements

to

my wife April

my son Paxton

my daughter Avery

and all those who have given me support and encouragement

...Thank You

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Introduction

As an industrialized society, the value of making, by hand and by machine, is expressed in our everyday interactions with our surroundings. The Industrial Revolution, a surge in making things by leveraging the capabilities of machines to produce work, was in response to the needs and desires of a society that demanded its existence. A similar cycle also occupied as industrial innovation gave way to technological innovation and the ubiquity of the personal computer in the Digital Revolution. A third cycle is currently underway as society is struggling to reconcile the 'physical making' of industry with the 'virtual making' of technology, resulting in what is referred to as the Maker's Revolution.

Where industry was once the backbone of new cities and the establishment of community, it has since been relegated to seemingly self contained areas, often on the edges of the larger community, divorced from the people who benefit from its labors. However, a certain renaissance in making is evident in the Maker's Revolution and an increasing proliferation of accessible fabrication facilities. Never in stasis, people's needs, interests and ways of doing things changes and morphs over time, often very rapidly, to best suit external influences forces. The physical context in which we live, however, does not always adapt so readily.



Figure 1 SparkTruck



Figure 2 Generic Manufacturing Facility Exterior



Figure 3 Generic Industrial Facility Interior



Figure 4 Tesla Factory Interior

The typical manufacturing facilities used today are not the dark, soot covered factories of the past. Processes have changed and building technologies have become more efficient. Yet, the resulting environment for manufacturing has developed to be little more than large, sprawling boxes, disconnected from their human occupants. Envisioned to maximize open space in which the needs of the machine are placed above those of the operator, little care is given to the human aspect of industrial space. Advanced technological capabilities have great potential; but the purpose for which they are intended, to enrich the human experience, must not be lost in the process.

As stated in the 2011 report by the United States Manufacturing Competitiveness Initiative (USMCI), “By marrying these technological capabilities with human insight, smart manufacturing promises to revolutionize the way production is organized and delivered.”¹

How then, might industry be adapted to cater to both man and machine? This thesis explores the humanization of the industrial environment, providing spaces crafted to give the user a sense of place and purpose within the larger whole. Expressed as a framework to facilitate the early commercialization stages of product development as well as educate the next generation of skilled workers, the Kent ManufactureLAB is positioned to be one node of a larger sub-network embedded within the manufacturing industry at large. This thesis is not intended to redefine the manufacturing process, but to address the physical environment in

¹ USMCI, “Make: An American Manufacturing Movement.” (U.S. Manufacturing Competitiveness Initiative, 2011) 42.

which these processes take place, making them more amenable to the occupants therein.

As an essential component of cities and community, industry deserves a place within its bounds, not segregated as a sprawling collection of the typical factories we know today. With advances in technology and a renewed awareness of making, the conditions are ripe to reintroduce industry as a cornerstone of community.

Prefabrication, in one form or another, has enamored architects and builders for more than a century but has produced only marginal success at the whole-building scale. Widespread adoption of prefabricated buildings still faces critical challenges. The concept of Open-Building addresses some of these challenges by focusing on the relative lifespan of various building components. Open-Building does not ascribe to any single method or system of construction, but is a rationale/theory of building that lends itself well to prefabrication and modularization. The Kent ManufactureLAB leverages this view as technology advances and intended uses change. The ability to efficiently adapt to new requirements is a core consideration affecting the useful lifespan of the building.

Exploring the reintegration of industry within the community, at a scale that addresses business, education and local residents, the Kent ManufactureLAB is intended to be a prototype of community-based manufacturing while also serving as an integral component to the community of Kent, Washington. Expanding its influence, the ManufactureLAB also incorporates a more public interface of open space, community outreach, retail, and a

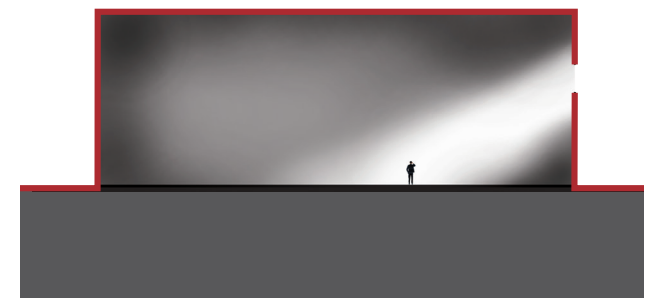


Figure 5 Human Scale Disconnect

café. Contrary to logic, the act of making something tangible results in the acquisition of something quite intangible. The notion that designers should reacquaint themselves with the act of building in order to become more effective designers suggests the acquisition of an unquantifiable quality attained from the act of physical making; the validity of which is brought into question by technological advances in the industry. The advancement of technology has primarily been used to automate or enhance what previously could only be accomplished by hand, resulting in a separation from the process. Recently, however, there seems to be the possibility of applying technological means to achieve a closer relationship between design and the process of making. Technology has opened many doors, once closed or unknown. It is the role of technology to leverage its capabilities to efficiently address the pragmatic and the utilitarian. It is the role of the architect to not only absorb the new technology, but to apply that technology in a way that is ultimately for the betterment of society, community, and the individual.

Scope & Survey of Field

The act and process of building had remained largely unchanged for centuries, until the modern era. How does the traditional model of the autonomous Master-Builder integrate with the rapid change and collaborative nature of the modern information age? The two ideals, one of the all-knowing individual and the other of the democratized knowledge and resource collective, seem to be at opposing ends of the spectrum. The reconciliation of the two extremes is currently underway in the fields of design and manufacturing. The Architect/Builder is poised to capitalize on the shifting trends and can even be instrumental in its implementation. Advances in the organizational structure of how projects are executed, as well as increased efficiency in information management and exchange, have been influential in beginning to bridge the divide between the process of design and the process of making. An examination of past attempts to broaden the scope of design to include also the execution thereof, serves to demonstrate that “the role of the architect should [not] be purely confined to designing. A new type of architect must therefore be called into being who would quite simply be an industrialist.”¹

¹ Benedikt Huber, and Jean-Claude Steinegger, *Jean Prouvé Prefabrication: Structures and Elements*, (New York: Praeger Publishers, Inc., 1971), 24.

Contemporary Architectural Practice

Collaboration is a key aspect in the successful navigation of increasingly complex building and design projects. Technological advances in building materials, as well as means and methods of construction, have dramatically increased the scale of which our built environment is taking form. So much so, that the autonomous Master-Builder is no longer an efficient model of practice. Buildings today require the expertise of many individuals, working in a collaborative network. Increasingly, alternative procurement and delivery methods are being implemented in the building industry. The traditional model of Design-Bid-Build (D-B-B) is giving way to ideas such as Design-Build (D/B), CM-at-Risk (GC/CM), and Integrated Project Delivery (IPD), where collaboration among the parties involved is emphasized. The need for such alternatives has arisen from a “liability gap” in the design and building process. Robynn Thaxton Parkinson, a local lawyer who deals primarily in the construction industry, describes it from a legal point of view in the following scenario:

The Architect is responsible to provide a design to the owner, who in turn commissions a builder to execute the design. The builder is responsible to execute the design as specified in the drawings provided by the Architect. With the division of responsibilities and assumed liability of each party, what happens when a problem does occur? The builder claims that they are not responsible because they built it according to what the Architect designed. The Architect claims that they are not responsible because they are not the ones who actually built it, citing that the design was executed according to a standard or reasonable care. The owner is ultimately the one to assume the consequences of the lack of collaboration during the design

and construction process.²

By limiting liability in an effort to protect one's own interests, the definition of assumed roles and responsibilities has been narrowed. Historically, the architect would be responsible for all aspects of the project. The Master-Builder of former times was "...a complete human being, an entrepreneur in the most complete sense. He was an architect, a thinker, an engineer and a man of accomplishment. He drew inspiration from his materials, secured respect for his ideas and shouldered all the responsibilities. He lived on the site."³ Does this definition still apply to the architect today, and should it? Increasingly, expertise and services once provided by the architect are being assumed by other parties. Client representatives attempt to interpret what the owner needs or wants, sometimes forming a prescriptive program to be followed by the architect. General contractors take the responsibility to determine the means and methods of construction. Ultimately, very little is left under the control of the architect. Circumstances surrounding design and construction have shifted radically in today's modern world. In response to increased complexity and liability concerns, among other factors, the architecture profession has taken deliberate steps away from the traditional Master-Builder role. A prominent local architect recalls hearing the situation described as architects doing little more than "decorat[ing] the cake." What the cake is, has already been decided and the architects task is to make it look presentable. When asked what the solution might be, he

² Robynn Parkinson. Lecture in CM560 Design-Build Project Management, University of Washington. May 6, 2013

³ Benedikt Huber, and Jean-Claude Steinegger, Jean Prouvé Prefabrication: Structures and Elements, (New York: Praeger Publishers, Inc., 1971), 23.

responds without hesitation, "...[architects need to] take on more responsibility and risk."⁴

Alternative procurement and delivery methods attempt to tackle the issue by encouraging collaboration and redistributing liability. In very condensed terms, Design-Build is where one entity or partnership is contracted to design and construct a building that adheres to predetermined performance criteria set by the owner. GC/CM allows a general contractor to come on-board with the design team early on in the process and act as a construction manager throughout. The design team benefits by gaining the expertise of the contractor in terms of constructibility, scheduling and pricing. IPD is a multi-party agreement where the owner, designer, and contractor share in the risk and reward of the project, greatly spurring effective collaboration.

As a byproduct of establishing architecture as a profession, the distinct separation of design and building was established. One essential trait of the Master-Builder was their immediate connection to the building process and their close involvement in craft. The above mentioned organizational strategies begin to put the architect in closer proximity to the building and construction process, attempting to alleviate, to some degree, the disconnect that has occurred over the course of time.

These facts suggest that effective means and opportunities to engage and collaborate with others, thereby drawing on their collective expertise while not deferring all responsibility,

4 Dennis Forsyth, Meeting at SRG Partnership, Inc. with Dennis Forsyth and Nathan Messmer. May 30, 2013

positively affects the end result or product being produced. The same could be said of most creative or complex working environments. A balance of individual investigation, supplemented with collaborative opportunities, can produce superior results.

A New/Old Direction

Architects have been dealing with these same issues for many years. Over four decades ago Jean Prouvé asks, “What has become of the architect entrepreneur?” He continues on to describe how the generally accepted position of the architect

...puts him at a distance from technical considerations and even further from the actual execution of the work. He has become an attorney, often a big business man, more of an administrator than an originator. Implementation goes through several stages: the client, the architect, the technical drafting office (engineers), the contractors (more engineers). Each of these operates separately and their interests too often only conflict. This leads to compromises and, as a result, to a deterioration in the work.⁵

More recently, considering the technical systems embedded in the more complex buildings of today, Kiel Moe and Ryan Smith discuss how

...[architects] often know relatively little about [technical systems]. A promising direction, however, is the architect’s resurgent interest and participation in all phases of technological development and sustenance, including predicting, forecasting, and projecting material, digital, and ecological technologies into the market sector. This

⁵ Benedikt Huber, and Jean-Claude Steinegger, Jean Prouvé Prefabrication: Structures and Elements, (New York: Praeger Publishers, Inc., 1971), 23.

redefines the architect as systems designer/builder.⁶

The wording of Moe and Smith emphasizes that this more direct involvement is indeed not a new concept to Architecture. Various architects of different era's have attempted to affect change at a large social scale by embracing the expanded role of "systems designer/builder." The architect's primary responsibility has always been to the client, but in a broader sense to society at large. The social aspect of architecture is as much, or more, important than the technical. The technical solutions derived of the architect's understanding of the broader "systems" at play, can also address underlying social conditions and needs.

Evolution/Revolution - The Maker Movement

William Massie, a principal at SHoP Architects, describes the trajectory of the modern process by defining three separate eras of evolution. The first, beginning with the Industrial Revolution, or the period of Making, characterized by "...the process of abstraction transmuted into object or space via mechanical means." With the advent of the machine, the laborious task of working repeatedly to refine and shape a particular material became automated. The second era, Information Transfer, can be considered the dot-com boom. Removing the physical object all-together, the focus became "...the transportation of abstraction to abstraction result[ing] in the communication of ideas to ideas without transcending ones and zeros." Inherent in this

⁶ Kiel Moe and Ryan E. Smith, "Introduction," *Building Systems: Design Technology and Society*, ed. Kiel Moe and Ryan E. Smith (New York: Routledge, 2012), 7.

process is the emphasis on the speed of information and the transmission thereof. Reliance on solely physical means of communication is enormously time consuming. What would traditionally take days or weeks to communicate, now happens almost instantaneously as digital information is encoded and transferred through the internet. Finally, the current era of Remaking, returns in part to past practices, albeit utilizing contemporary technologies and interpretation. Defined by Massie as "...the ability to move directly from information to work, marking for the first time Humanity's ability to use abstraction as more than simply a container or vessel of intent.", Remaking embodies the process of making, first digitally, to then re-make physically. The potential implications of this most recent era is summed up in Massie's view that, "When an author produces a drawing which becomes the information that drives the machine, it compresses the world of design and fabrication into a single process, [resulting in] a substantial increase in artistic autonomy."⁷ Removing any intermediary between the designer and the fabricated element, a shift back to the Master-Builder mentality is evident.

A parallel line of thought widely discussed is that known as "The Maker's Revolution." Although utilizing different nomenclature, the underlying concept remains the same, as described by Chris Anderson, the former editor for *Wired Magazine*. In Anderson's argument, the true power lies not in the technology itself, but in the democratization of that technology. For example, following the Industrial Revolution, the tremendous influence from the Digital Revolution came not from the advent of the computer, but from the eventual presence of

⁷ William Massie, "Remaking in a Postprocessed Culture," *Fabricating Architecture*. Ed Robert Corser (New York: Princeton Architectural Press. 2010). 100.

the personal computer in the homes of the masses. It was this collective nature that allowed people all over the world to begin to work together. It put tremendous, new capabilities within reach of the common lay-person. Commercial publishing, once reserved solely for large industries with access to costly printing presses, was transformed from an industrial act into a personal act with the desktop printer. Similarly, Anderson posits, we are only now beginning to scratch the surface of what is possible in the age of Digital Manufacturing. Harnessing the power to physically create digitally designed objects, on an individual basis, has enormously long reaching implications. With the potential to one day “reverse the arrow of globalization,” products could be manufactured where the ideas originate, allowing more rapid design iteration, make use of short and local supply chain management, while eliminating the search for cheaper and cheaper labor. In transitioning to the Digital Manufacturing revolution, Anderson states, “ The past decade was about finding new social and innovation models on the web. The next decade will be about applying them to the real world.” Putting things into perspective, the general consensus is that “atoms are the new bits.”⁸

The Digital Manufacturing revolution is beginning to be seen in the increasing proliferation of MakerLabs, Maker Spaces, or FABLabs around the world. Essentially a small scale workshop, these spaces aid in providing access to digital manufacturing tools such as laser-cutters, 3D printers, 3 axis CNC milling machines, and industrial sewing machines, among others. Accessible by the local community, MakerLabs are the beginning of the democratization of

⁸ Chris Anderson. “Wired Magazine.” In the Next Industrial Revolution, Atoms Are the New Bits. February 2010.

personal manufacturing.

What remains to be seen, however is a tie between large scale manufacturing and the small/medium scale entrepreneur. The MakerLab does not have the capacity to produce much more than the initial prototype for a novel product or idea. Physical scale, as well as production scale, is severely limited in its current condition. While traditional, full-scale, manufacturing would remove the limitation of physical scale and production scale, it is a field with a high cost of entry. Securing and fitting out a facility with traditional manufacturing equipment could easily surpass \$10 million in capitalization costs, something far out of reach for a typical entrepreneur looking to bring a product to market. Furthermore, the product in question may not even be suitable for mass manufacturing and global distribution. Certain niche products may do very well in the range of 5-10 thousand units, but not elicit the demand for mass marketability.

Enabling Technologies

Availability and access to technology by the larger community is a precursor to innovation in the field. Three enabling technologies in the field of architecture and construction, once out of reach for most, are now trending toward becoming common practice: Building Information Modeling (BIM), Parametric Design, and Mass Customization. These technologies are enabling innovation in the AEC industry affecting every aspect of the process, from design

and collaboration to production.

BIM, which is an information database that is tied to geometry, can be seen as a powerful “information management tool”, referring to Kieran and Timberlake’s view.⁹ The more efficient management of pertinent information about a building enables an increase in productivity and speed of design, leading to greater profit margins and financial stability for the industry. The current implementation of BIM in the industry is not completely in-line with the ideal vision in most cases, but is rapidly being adopted by design and construction professionals. Ideally, to foster the greatest amount of collaboration and accuracy, all parties involved in the creation of a fully detailed BIM model (Architect, Contractor, MEP Engineers, Structural Engineer, etc...) would be working on and contributing to one central model. In practice, however, this is not typically the case. The specificity of each trade has led to a more federated approach where multiple BIM models, often developed on differing software platforms, are being brought together at various intervals throughout the process to check for interferences, otherwise known as clash detection. Further complicating the matter is that each model may be developed to a differing Level of Detail (LOD). Each LOD refers to the degree of specificity included in the model. A general outline is as follows: LOD 100 - General Massing, LOD 200 - Basic Geometry, LOD 300 - Precise Geometry, LOD 400 - Fabrication Ready, and LOD 500 - As Built Condition. Currently, most useful BIM models are developed to an LOD of 300, enabling a review of constructibility and can be used in model-based takeoffs for estimating

⁹ Stephen Kieran and James Timberlake, “Refabricating Architecture,” *Fabricating Architecture*. Ed Robert Corser (New York: Princeton Architectural Press. 2010). 15.

purposes.

Associative design and parametric relationships have aided in the exploration of new forms and processes of design. Associations and manipulations that are based on complex mathematical formulas, enabled by the advancement in computing technology, are allowing designers to explore options that would be otherwise cost and time prohibitive to pursue.

User involvement in the manufacturing process has always been elusive due to the prohibitive costs associated with making even minute changes. Manufacturing benefits from, and relies upon, economies of scale in order to make mass production feasible. Mass Customization, however, implies that custom specifications can be incorporated into the mass production process and still benefit from the associated efficiencies. With new technology in production automation, a change in a product can be as simple as a new data set entry.

Society and Technology

Tools always presuppose a machine, and the machine is always social before it is technical. There is always a social machine which selects or assigns the technical elements used.¹⁰

Inextricably related, technology is developed to address a social need or desire. In turn, the technology then informs the socio-cultural context in which it resides, leading to the next set

¹⁰ Kiel Moe and Ryan E. Smith, "Introduction," *Building Systems: Design Technology and Society*, ed. Kiel Moe and Ryan E. Smith (New York: Routledge, 2012), 2.

of social needs. This feedback loop is one that reoccurs throughout history and applies to all fields of inquiry. One example is the development of the Ford automobile assembly line. In 1907, addressing society's need for faster, cheaper and better quality production of personal transportation, Henry Ford announced his goal for the Ford Motor Company: to create "a motor car for the great multitude." Over the course of the next twenty years 15 million Ford Model T's were produced. "Henry Ford went beyond his 1907 goal of making cars affordable for all; he changed the habits of a nation, and shaped its very character."¹¹

Manufacturing was at a high throughout the world. The building industry and its designers attempted to apply a similar logic to the production of housing to meet the mounting need of those returning home after WWI and WWII. Although their efforts almost universally failed to gain traction with the masses, the creative use of resources employed during this time period is an example of how the profession of architecture can address broader social needs through the thoughtful application of technology and process.

Industry and Pragmatism

Industry has played a pivotal role in the development of our cities and communities. As society and its needs expanded in the 19th and 20th Centuries, industry acted as a central hub in the establishment of new cities by drawing more and more workers to fill its needs.

¹¹ PBS, "Ford installs first moving assembly line." Last modified 1998. Accessed June 2, 2013. <http://www.pbs.org/wgbh/aso/databank/entries/dt13as.html>.

The draw of employment spurred the need for residential development to house the workers and their families. As success and profitability increased, so did the town until it became a lively city, all built on the back of industry. However, industry was never given proper accolade and was relegated to a lesser status both socially and aesthetically.

The utilitarian nature of the factory led to its austerity, being devoid of ornamentation and rather focused on functionality and flexibility to accommodate a variety of manufacturing processes.¹² Albert Kahn was an architect, among others such as Behrens, Gropius and Meyers, who had an influential effect on industrial architecture and spurred its progression. Kahn, noted for his design of the Packard Building in 1903, used reinforced concrete, daylight and long span structure to change the nature of the traditional factory. The designing of factories was not tied to any particular style or preconception, and therefore allowed Kahn to experiment, in a pragmatic sense, to solve unique challenges. As the need for greater interior flexibility increased, iron and eventually steel were used to shape large open space, now characteristic of the industrial typology. The greater flexibility also required more land to accommodate it, which led to the acquisition of cheaper, more open land on the outskirts of the cities. Industry, housed in the now ubiquitous one-story sprawling factory, was taken out of the city it helped create.

The utilitarian factory, meeting its functional need by efficiency and simplicity of form, had a

¹² Ljiljana Jevremovic. "Aesthetics of Industrial Architecture in the Context of Industrial Building Conversion." (PhIDAC 2012). 81.



Figure 6 Packard Building - Kahn



Figure 7 Fagus Shoe Last Factory - Gropius



Figure 8 AEG Turbine Factory - Behrens

far reaching effect on the profession of architecture and the Modern Movement. Speaking of the aesthetics of industrial architecture, Jevermovic states,

Industry and its processes inspired and continue to engage the imagination of the artists and architects: from the voice against ornament by Adolf Loos to the design explorations of the Bauhaus and the sleek lines of the International Style to the explicit expression of construction elements in the work of Richard Rogers and his partners. Industrial architecture showed a simplicity that was expressed on the exterior by undecorated flat surfaces, whether in brick, stone or wood. While these buildings were obviously required for the rise of industry, their designers were often anonymous and these structures remained outside the scope of traditional architectural practices.¹³

The adage 'Form Follows Function' is an embodiment of utilitarian architecture in that the ultimate form and character of the product is a direct result of its pragmatic requirements. However, as seen in many examples throughout history, utilitarian architecture can also be a celebration of innovation and an iconic component of the city. The aqueducts of Rome are just one example of this celebration of function. By merely fulfilling a functional requirement of bringing water to the city, the aqueducts of Rome have become a symbol of advanced society and innovation held in high esteem. When utility takes on something more than mere functionality, it can affect how it is perceived and used.

Architecture goes beyond utilitarian needs. You employ stone, wood, and concrete and, with these materials, you build houses and palaces. That is construction. Ingenuity is at work. But suddenly you touch my heart. You do me good and I am



Figure 9 Roman Aqueducts

¹³ Ljiljana Jevremovic. "Aesthetics of Industrial Architecture in the Context of Industrial Building Conversion." (PhIDAC 2012).

happy and I say, This is beautiful. That is Architecture. Art enters in.¹⁴

The artistic component of architecture is essential, but should be grounded in some ways by pragmatics and how a building functions, programmatically, socially, technically, etc... A complete “architectural” experience is achieved if all the components come together in a holistic manner. Speaking of design education Mathew Ziff describes the merits of pragmatics and aesthetics thus:

Clearly, function is more than a mere factor to be accommodated in a work of architecture. The functional requirements of a work can and should influence the overall character of a work in terms of form, materials, and even colors. Addressing functional requirements in a work of architecture is not merely a matter of providing a response, in the form of an object, a space, or an organization. Addressing functional requirements involves making design decisions that present a synthesis of form, color, material, size, scale, texture, and location.

Aesthetic character in a work of architecture has to be consciously sought out. Texture or pattern, varied qualities of light, and colors of materials and finishes each offer opportunities to have an aesthetic experience and to appreciate those characteristics of the work.¹⁵

Functional requirements, if addressed through aesthetics and spatial experience, can be instrumental in forming a connection between the a space and those inhabiting it. Crafting space in these terms can create a dramatically different result than if one were to simply

14 Le Corbusier. *Toward a New Architecture*.

15 Matthew Ziff. *Exploring Pragmatics and Aesthetics in Design Education*. *Journal of Aesthetic Education* , Vol. 34, No. 2 (University of Illinois Press, 2000), 31-32.

optimize the use of space to accommodate the utilitarian needs.

Industrial Process and the Built Environment

One of America's first attempts to integrate industrial production with architecture and design is readily seen in the prefabricated housing of the early to mid 20th Century. In the most general sense, prefabrication simply means the prior manufacturing of components to enable quick or easy assembly on-site. The field of architecture and construction has had multiple attempts and explorations in incorporating prefabrication to enhance efficiency in the building process. Soon after the success of the first Model T's, a number of companies were established to capitalize on the "factory kit house" market. Aladdin Ready-Cut Houses is recognized as the first to produce a true "kit" house using all factory cut lumber and numbered pieces for erection. Houses began to be marketed in catalogs and could be ordered by mail. Sears Roebuck and Co. enjoyed great commercial success by doing so. Priced from \$650 to \$2,500 and mailed directly to the customer complete with instructions, Sears Roebuck & Co. envisioned practical home ownership for the masses.

Similar ideas were being explored in other parts of the world as well. Following World War I, Europe and Scandinavia were seeking solutions to their own housing shortage, being drawn to prefabrication for its speed of construction and cost-effectiveness. Britain, France and Germany were developing systems based in steel and concrete while Sweden was centered

in wood construction. LeCorbusier was a fervent advocate of the movement, himself contributing the Maison Domino (Domino House) in 1914, exhibiting a skeletal framework structure of reinforced concrete, thus eliminating the need for load bearing walls and introducing the “free plan.” His ideas were articulated in his 1919 essay, “Mass Production Houses” in which he boldly asserts that architecture must incorporate the lessons of mass production or perish. LeCorbusier continues, “The only solution... is the abandonment of hand-crafted production and the widespread adoption of modern industrial techniques - technical specialists, workshops, standardization, mass production; the innovations of war manufacturing must be applied to housing.”¹⁶

A similar sentiment was held by Walter Gropius and was a leading tenet of the Bauhaus movement and its effort to create “a new architecture for a new age.”¹⁷ Other contemporaries, such as Mies van der Rohe, Alvar Aalto, and JJP Oud took on early experiments, but the work occurring in Europe was not known to most Americans. This changed in 1932 with the MOMA exhibition in New York, *The International Style: Architecture Since 1922*. Although a bold new aesthetic was introduced, the kit builders, Sears and Aladdin among others, did not see any reason to adopt it, as they were seeing relatively good success with their current model of business. Although some very innovative examples came about, such as the House of Tomorrow by George Keck and the Wichita House by Buckminster Fuller,

16 Mary McLoud, “‘Architecture or Revolution’: Taylorism, technocracy, and society,” *Building Systems: Design Technology and Society*, ed. Kiel Moe and Ryan E. Smith (New York: Routledge, 2012), 118.

17 Allison Arieff, *Prefab*, (Salt Lake City: Gibbs Smith, 2002), 15.



Figure 10 Case Study House #2

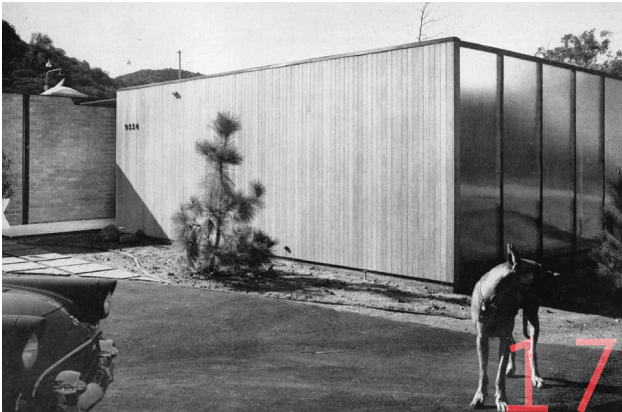


Figure 11 Case Study House #17



Figure 12 Case Study House #22

the aesthetic was a bit too radical for the average home buyer. Further complicating the issue was the difficulty in acquiring financing for such structures which consequently inhibited production. The goal of the more conventional industry, headed by Sears and Aladdin, was “to simply make residential design and construction more practical and, by extension, more inexpensive. And the home buyers didn’t seem too troubled by that business decision.”¹⁸

The resulting housing crisis from the war spurred the building of roughly 1.6 million units, of which over 12% were prefabricated, and the demand was rising. Under the direction of President Truman, the prefabrication industry gained federal support and began to grow tremendously. To make up for a reduction in aircraft manufacturing, many factories were repurposed to be used in the manufactured housing sector. Vultrex, Lustron, and Spartan are a few examples of such cases. The focus was placed on economy, speed, and eventually mobility in the development of the mobile home. Large housing developments became common modes of efficiency by developers like William Levitt and Joseph Eichler. Efficient business models, yes, but at a price resulting in monotony and little individuality. Filling the immediate housing need was the prime goal. What were the long term effects of such practices, however?

Although some commercial success was being had by developers, the search for well-designed, affordable single-family homes was still underway. The Case Study Program, initiated in 1945 by John Etenza, the editor of Arts and Architecture Magazine, began an exhilarating

¹⁸ Allison Arieff, *Prefab*, (Salt Lake City: Gibbs Smith, 2002), 19.

investigation of designing a cost-effective home without compromising modernism's utopian principles. There were a total of 36 homes designed over the subsequent 20 years. Looking back at the collective results of the study, writer Luc Sante states,

They were the offspring of the marriage of European theory with the free-spending and limitless southern California landscape. They had aristocratic veins and factory workers' hand, tons of cool mathematical rigor and no fancy stuff. They know their kind would soon be everywhere, the way big cars and scotch highballs were everywhere. Then the earth revolved a few times. Economic cycles passed, and so did their moment.¹⁹

The generic planned community model, developed by Levitt and Eichler eventually took root, where the Case Study homes did not. Over the course of time, with a lack of emphasis on design, the proliferation of cheaper, lower quality homes as well as the mobile-home park, led to a certain stigma associated with the prefabricated dwelling. As the housing market stabilized, builders and home-buyers alike tried to distance themselves from prefabrication altogether. It wasn't until the latter part of the twentieth century that a sort of resurgence in mainstream prefabrication was, and continues to be, tested.

Technological advancements in manufacturing, including certain forms of automation, have begun to make prefabrication an attractive alternative to site-built construction for certain parts, or even the entirety, of new buildings. With the precision of CNC fabrication and new manufacturing materials, the quality of prefabricated building components has risen to

¹⁹ Allison Arieff, Prefab, (Salt Lake City: Gibbs Smith, 2002), 28.



Figure 13 Case Study House #8



Figure 14 Case Study House #20



Figure 15 Case Study House #25

dramatically higher standards than early attempts of the previous century.

However, prefabrication for the building industry is not without its challenges. In spite of the potential benefits of time savings, quality, and cost reduction, widespread adoption of prefabrication methods has not been embraced by the industry. Critical obstacles still remain, including the proximity of regional manufacturers, transportation from factory to site, and inherent design constraints.²⁰ Furthermore, the cost savings are typically difficult to attain with smaller projects, lacking economies of scale and repetition.

Prefabricated buildings generally fall into two categories, modular and panelized. In a modular building, volumes of finished space are prepared in the factory, constrained to the maximum size able to be transported by truck. Made up of mostly empty space inside, typical module sizes are 11 feet high, 12 to 16 feet wide, and 55 to 65 feet long. Trading shipping efficiency for ease of installation, the modules are usually finished to a high level of completion to minimize on-site assembly time and effort.

Panelized construction enables a much more efficient use of space while in transport. Separating the building components into wall, roof and floor panels can greatly reduce wasted shipping volume, but requires a greater number of connections to be managed during the assembly process once on-site. Although, in panelized construction, the interior volumes once assembled are not limited by shipping dimensions, as is the case with modular

²⁰ Rahman Azari, "Modular Prefabricated Residential Construction Constraints and Opportunities" (PNCCRE Technical Report #TR002: University of Washington, 2013)

construction. Choosing one method over the other has a great deal to do with the spatial requirements of the program and desired architectural strategy. A hybrid of multiple methods is also possible.

Shipping distance is one of the main obstacles when balancing the costs to benefits in prefabricated construction. A radius of 200 miles from the manufacturing facility is typically considered to be the maximum distance. Beyond that distance, the associated costs are the limiting factor. Among the top three reasons in common with architects, contractors and engineers for not using prefabrication is the availability of local prefabrication shops. Other top reasons for the lack of prefabrication include that the architect did not design it into the project and that the owner did not request it.²¹ A better understanding on the part of owners, architects and builders about the capabilities and limitations of prefabrication in the building industry could have a large effect on its adoption and continued innovation. As a subset of the manufacturing industry at large, increased use of prefabrication for buildings relies heavily on the already established network of manufacturers and the future direction of manufacturing in the United States.

A differing approach to prefabrication can be seen in Open-Building. The concept of Open-Building addresses some of the traditional challenges to whole-building prefabrication by breaking the design of the building down to its various components and focusing on the

²¹ McGraw-Hill Construction, "Prefabrication and Modularization: Increasing Productivity in the Construction Industry" (Smart Market Report, 2011). 32.



Figure 16 Prefabricated Steel I-Beams

Components

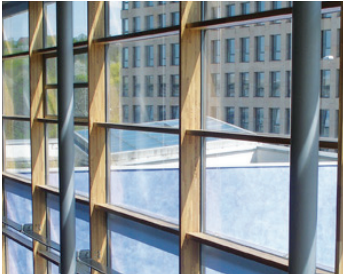


Figure 17 Prefabricated Window Wall

Assemblies



Figure 18 Prefabricated SIPS Panel

Panels



Figure 19 Prefabricated Module

Modules

relative lifespan of discrete systems. The frequently recurring cycle of growth, demolition, and rebuilding as communities expand and require change over time exhibits an unsustainable approach to current building practices. Implementing Open-Building principles in new and re-development can dramatically increase the useful lifespan of buildings and mitigate multiple factors stifling change, innovation and integration in the building industry. Open-Building does not ascribe to any single method or system of construction, but is a rationale/theory of building that lends itself well to prefabrication and modularization. All building elements are prefabricated in a sense. It is only the degree of prefabrication that varies between them. Technology improves and intended uses change. The ability to efficiently adapt to new requirements must be a core consideration in the built environment.

Open-Building views a structure as a combination of elements and layers, each discrete performing respective roles and having an expected lifespan. The general principles, developed by John Habraken in the 1960's, proposed an alternative structure to mass housing. This approach included the separation of "support" and "infill." The support, or base building would be less user specific, more durable and permanent, having an expected lifecycle of 100+ Years. The infill would be intended as an interior fit-out that could be easily replaced or modified, based on a much shorter expected lifecycle, as the needs and intended uses required. The same thinking is applied to the larger context of the built environment as a whole. Certain elements, such as the city layout and street grid, are more permanent and resistant to change. Others, such as the support structures and its interior divisions and infill

are much more accommodating to change and renewal. The various categories are identified as levels within the system. Multiple levels can exist within one structure, intending to allow for adaptation and change based on normal cycles of advancement and renewal.

Planned accordingly, modifications or replacement of the various levels would be less disruptive and incur less cost over a building's lifecycle than compared to the traditional model of periodic renovation. Such secondary infill layers could be developed as prefabricated assemblies or units.

Kent Larson, director of the Open Source Building Alliance at the MIT Media Lab, points out that the manufacturers of building products are looking to “migrate from low-margin commodities (such as pipe, wire, and drywall) to high-value integrated assemblies at the same time that 80 percent of contractors site a shortage of skilled labor as their biggest challenge.”²²

A closer alignment to the manufacturing industry and new production technologies, along with the establishment of non-proprietary standards, such as Open-Building, can enable the construction industry to overcome the current inefficiencies of common building practice. The relationship could prove mutually beneficial for both construction and manufacturing, as suggested by a recent report evaluating the competitiveness of U.S. Manufacturing.

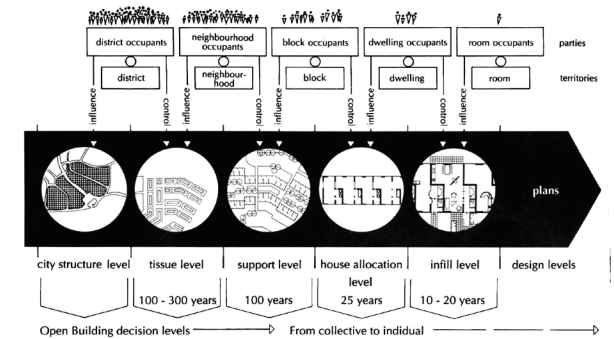


Figure 20 Open-Building Levels

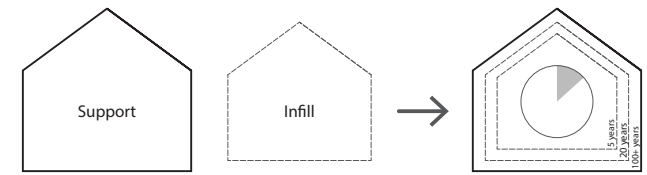


Figure 21 Open-Building Lifecycles

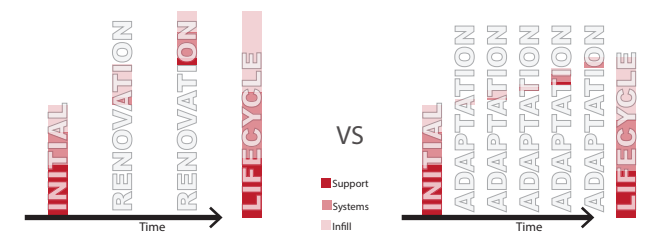


Figure 22 Renovation vs. Adaptation

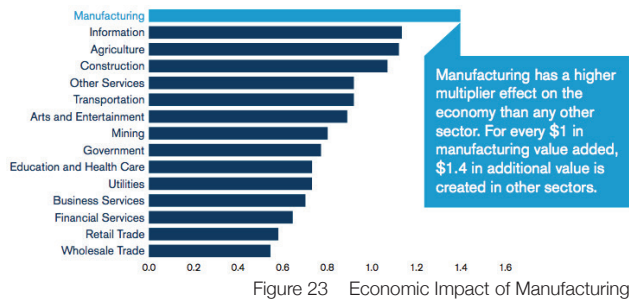
²² Kent Larson, “Open Source Living”

The State of Manufacturing in the U.S.

Drawing from the recent United States Manufacturing Competitiveness Initiative (USMCI) report, *Make: An American Manufacturing Movement*, from December 2011

The U.S. MANUFACTURING COMPETITIVENESS INITIATIVE (USMCI) is led by a CEO-level leadership council and steering committee, comprised of chief executives from industry, academia, organized labor and national laboratories...

...Together, these individuals will frame the critical questions, provide the strategic direction, and develop a comprehensive set of actions to ensure a vibrant manufacturing base for America's future.²³



The importance of the manufacturing industry to our society and economy is undeniable. Speaking of the preconceived notions surrounding industry, The USMCI report points out that “The image of manufacturing as dumb, dirty, dangerous and disappearing is far from accurate. Today, manufacturing is smart, safe, sustainable and surging.” The advanced manufacturing facilities of today employ cutting edge technology and equipment to be able to make things of incredible design and quality. Further stated in the report, “By marrying these technological capabilities with human insight, smart manufacturing promises to revolutionize the way production is organized and delivered.”²⁴ However, the implementation of smart manufacturing presents challenges and opportunities deserving of consideration.

²³ USMCI, “*Make: An American Manufacturing Movement*.” (U.S. Manufacturing Competitiveness Initiative, 2011) 2.

²⁴ USMCI, “*Make: An American Manufacturing Movement*.” (U.S. Manufacturing Competitiveness Initiative, 2011) 42.

Though industry is adopting components of smart manufacturing, the infrastructure, capabilities and investments needed to deliver the full potential of this knowledge-based environment have yet to be developed... Building and linking emerging advanced manufacturing clusters and centers of excellence across the country is a needed step to cultivate the advantages offered by smart manufacturing.²⁵

America must do more to enable entrepreneurs to take risks and to translate ideas into innovation. America is still leaving ideas on the table. On average, only one in ten U.S. patents is ever commercialized. Thousands of inventions lie dormant in the hands of universities, research centers and private companies. For those ideas that are pursued commercially, only seven out of every 1,000 business plans receive funding. And even fewer are scaled to full production in the United States.²⁶

Advanced manufacturing facilities that break away from the status quo need to be realized. Multiple factors and considerations come into play when bringing a product, of any scale, to market. More can be done to facilitate the process of commercialization and to educate the next generation who will continue to push the boundaries of what is possible.



Figure 24 Tesla Factory Automated Assembly



Figure 25 Aerospace Advanced Manufacturing Facility

25 USMCI, “Make: An American Manufacturing Movement.” (U.S. Manufacturing Competitiveness Initiative, 2011) 45.

26 USMCI, “Make: An American Manufacturing Movement.” (U.S. Manufacturing Competitiveness Initiative, 2011) 47.



Figure 26 CCAM Exterior View

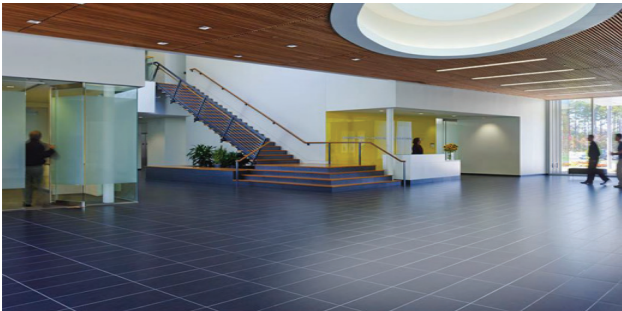


Figure 27 CCAM Lobby Interior



Figure 28 CCAM High Bay Manufacturing Space

Precedent Analysis

Commonwealth Center for Advanced Manufacturing (CCAM) - Perkins+Will

Located in Prince George County, Virginia and completed in late 2012, the CCAM represents a new model for public-private partnership focusing on research and development in the manufacturing industry. Paul Harney, Associate Principal at Perkins+Will states that, “The CCAM project presented an opportunity to develop a unique architectural and planning solution at the intersection of laboratory and factory, and to make a contribution to the renaissance of high-technology manufacturing in the United States.”²⁷ CCAM was envisioned to enable better collaboration and cooperation between manufacturers and top research and teaching universities. The facility operates as a non-profit organization, allowing its members to access intellectual property rights and conduct a variety of research projects related primarily to surface engineering and manufacturing systems. Addressing the programmatic needs of the diverse users and activities, “CCAM houses engineering and computational labs, as well as a large high-bay space for prototypical manufacturing processes, including thermal spraying, directed vapor disposition, and multi-axis milling. The facilities also include core laboratories for materials preparation, surface characterization, and computer visualization, as well as conferencing and amenity spaces for CCAM employees and visitors.”²⁸

27 Perkins+Will, “Perkins+Will Designs New Research and Product Development Facility for the Commonwealth Center for Advanced Manufacturing.” Last Modified 2013. Accessed Dec 11, 2013. <http://www.perkinswill.com/news/perkins-will-designs-new-research-and-product-development-facility-for-the-commonwealth-center->

28 Perkins+Will, “Commonwealth Center for Advanced Manufacturing.” Last Modified 2013. Accessed Dec 11, 2013. <http://www.perkinswill.com/work/commonwealth-center-for-advanced-manufacturing-ccam.html>.

Notably, the facility was cited in a speech given by President Obama in March of 2012. In his speech at the Rolls-Royce Crosspointe facility, which produces engine components for the aerospace industry, President Obama outlined the National Network for Manufacturing Initiative (NNMI) “that would bring together private industry, universities, community colleges and government to spur innovation. Obama noted that the CCAM project...[is] a model of the kind of education-manufacturing partnerships that [are] a key part of the National Network for Manufacturing Innovation.”²⁹

Programatically, the building is organized with the laboratories and offices adjacent to a high-bay industrial manufacturing space. Daylight and “thru-views” emphasize a connection with the surrounding wetlands and woods by allowing occupants to view from the manufacturing bay through the labs and offices and out into the landscape. Openness, transparency and clear circulation supports collaboration and accommodates the large number of expected visitors.

Furthermore, the design supports Open-Building principles as evidenced by the statement included in the AIA Design Award brief stating, “The internal planning and utility distribution provides flexibility for ever-changing research projects and associated industrial equipment.”³⁰

29 Perkins+Will. “Obama Cites Perkins+Will Project CCAM.” Last Modified 2013. Accessed Dec 11, 2013. <http://www.perkinswill.com/news/obama-cites-perkins%20will-project-ccam.html>.

30 AIA Patomac Valley, “2013 AIA Potomac Valley Design Awards Winner.” Last Modified 2013. Accessed Dec 11, 2013. <http://www.aiapv.org/2013designawards/2013/10/14/perkins-will-commonwealth-center-for-advanced-manufacturing/>.

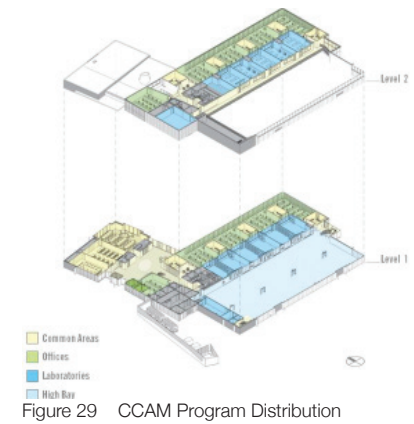


Figure 29 CCAM Program Distribution

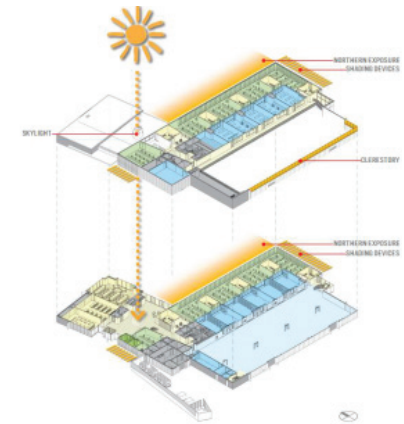


Figure 30 CCAM Daylighting Strategy

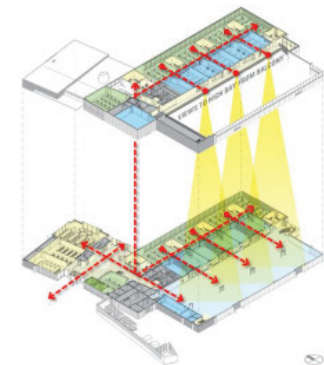


Figure 31 CCAM Connectivity

Looking Ahead

Implications of forthcoming technologies and accessibility to manufacturing for the architect are vast and far-reaching. The words of Oliver Cox, given as part of the 1967 conference in London: *Industrialized Housing and the Architect*, are still remarkably poignant to this day. Some of his remarks were,

Many architects seem to think that the most important implication of industrialization for them as professionals lies exclusively in the direction of absorbing the new technology. This I think is a dangerous fallacy. It is my contention that the architect is one of the very few professionals in a position to ensure that a massive technological change can be shepherded along in a direction that is in the best and widest interests of society. And this is best done, I submit, not so much by concentrating on technique as by the very reverse - by concentrating on people and their needs, and ensuring that, however the means of production may change, our social objectives remain constantly in view, and constantly under review.

If I am right in my conception of industrialization, there will soon be no such thing as “industrialized housing.” Soon all housing will be “industrialized”; it will be merely a matter of more or less so. All architects will have to come to terms with this inevitable process and they have a deep and vital role to perform; to ensure that the sort of industrialization we have is one which enables us to answer functional problems and provide surroundings that can be in every way better than is our present practice. The profession must rise to this challenge; its own future as well as that of industrialization in this country may well depend on it.³¹

³¹ Oliver Cox, “Implications for the Architect,” *Industrialized Housing and the Architect*, (London: RIBA, 1967), 175, 183.

We are, in-fact, past the industrial revolution and in the midst of a digital manufacturing revolution. Work, once replicated by the machine, is increasingly being directed and controlled digitally. The current socio-economic climate has opened new possibilities. In his article, “How the New Economy is Changing Theory and Practice” Michael Speaks discusses the emergence of the “post avant-garde” entrepreneurial architect [and a] practice defined by “conceptual athleticism,” opportunism and risk-taking.³² The profession must steward the opportunities and technological advances presented to affect real change and address the broader system of design, technology, and society. Speaking to a call for integration of social and technical factors, Moe and Smith point out something hidden in plain sight: “architects [are to] finally realize that the term “building systems” is best grasped as a verb, not a set of nouns.”

The potential effects of personal manufacturing for the general population are equally astounding. The USMCI report on U.S. Manufacturing outlines how previous barriers to the industry are beginning to subside, opening new doors to innovation for all.

Although supply networks will continue to draw together large and small firms, widespread access to technology, knowledge and markets is reducing barriers to entry and enabling some small or even individual producers to thrive. Personal manufacturing and user-based innovation could be poised to be the next megatrend.

In the industrial age, the world was divided into producers and consumers, with the

³² Ellen Dineen Grimes, “Risky Business, Fishy Forms,” *Building Systems: Design Technology and Society*, ed. Kiel Moe and Ryan E. Smith (New York: Routledge, 2012), 175.

former in control. But the center of gravity is shifting as innovation and manufacturing become more decentralized and customization the norm. Access to data and computing through the cloud, along with new tools and technologies like rapid additive printing are reviving a “maker” culture in America.

The next phase of this micro-manufacturing megatrend will be to put the tools of production into the hands of consumers. Imagine the possibilities for rapid innovation and value creation with a “micro-factory” in every home.³³

The relentless advancement of technology and ever increasing access to that technology is bound to have an impact on the way we work, collaborate and produce. As Oliver Cox emphasized, it remains to be seen if we simply absorb the technology allowing it to dictate our interactions, or if we take it upon ourselves to shepherd the use of such advancements for the betterment of ourselves and society.

³³ USMCI, “Make: An American Manufacturing Movement.” (U.S. Manufacturing Competitiveness Initiative, 2011) 36, 37.

Design Approach

The Maker Movement has become more than just providing access to fabrication means, it has also become a tight-knit community of individuals with widely differing backgrounds. The desire to create and personalize is common to all. Small scale collaboration and manufacturing can have a beneficial effect, both for the individual and for the local community. This thesis attempts to address the middle-ground between small-scale personal manufacturing and full-scale industry. The aspiring entrepreneur or community member looking to produce anything larger than object roughly a cubic foot in size will find it difficult to access appropriate fabrication equipment. Furthermore, the skilled labor in the manufacturing industry is in short supply. As the technology and manufacturing methods have grown and advanced, the supply of knowledgeable and trained individuals to operate them has not kept pace.

A Tight-Knit Network

In the realm of manufacturing, business relationships and economies of scale are key contributors to a company's success, or lack thereof. As a response to frustrations expressed

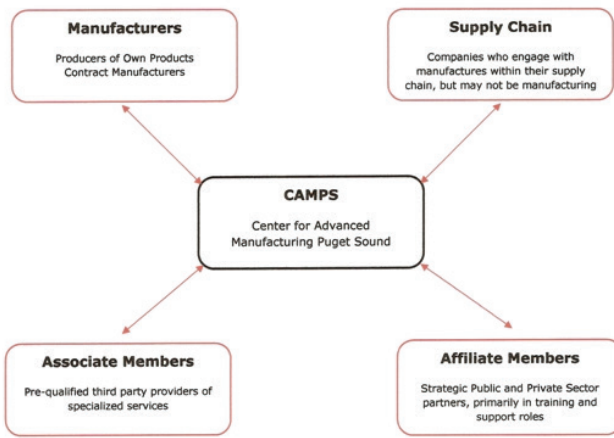


Figure 32 C.A.M.P.S. Relationship Network

by the local manufacturing industry, the Kent Chamber of Commerce sought to help even the playing field. The Center for Advanced Manufacturing in the Puget Sound (CAMPS) was established in 2008, acting as a resource center, “bringing together manufacturers, supply chain partners, pre-qualified business development specialists, and strategic partners.” The organization did not spring up over night, however. It was a result of a lot of hard work and patience. Beginning in 2003, city officials met to discuss the importance of the manufacturing sector to the region and how it might be supported. Over the course of the next five years, the formation of public/private partnerships, a new advisory council, and the execution of a feasibility study brought much needed attention to the issues at hand. The newly established center helped facilitate supply chain management for local manufacturers and took a critical look at future opportunities. In April 2008, the CAMPS members identified the Alternative Energy market, including solar, wind, and smart grid infrastructure, as an emerging industry worth pursuing. Subsequent steps were taken to capitalize on such opportunities.

A major challenge facing the industry is the shortage of candidates for high skill leveled jobs as well as applicants to train those who may be interested. CAMPS states, “Many of the existing training programs are not compatible to the skill requirement in the companies – in essence, in many cases the skill training in the classroom is not in sync with those needed on the production floor.” Adding to the issue at hand, it is expected to see a high number of retirements over the next five to ten years, with an insufficient replacement pool.¹

¹ CAMPS, “Evolution of CAMPS.” Last modified 2011. Accessed May 30, 2013. <http://www.camps-us.com/about-camps/evolution>.

Various staffing agencies exist and attempt to fulfill the needs of the local industries. Northwest Industrial Staffing (NWIS) is one such agency located in Kent. They pride themselves on offering a more person level of involvement with the industry and those seeking employment. Cultivating strong relationships is one way in which they attempt to align individuals with appropriate positions on a long-term basis. Also recognizing the need for specific skill sets, they have attempted to establish training programs. They, however, found difficulty in finding an appropriate facilities for such training and education. The Kent ManufactureLAB directly addresses such issues by combining the fabrication facility with dedicated spaces for training, collaboration, and community outreach.

Site Selection

At the macro-scale, the Pacific Northwest is a logical environment for a space that is focused on manufacturing, fabrication and innovation. The city of Seattle and its outlying area is an ideal candidate considering the already established corporations that are viewed as leaders in their respective industries. Boeing, one of the biggest names in aerospace manufacturing, operates its main assembly facility based in Everett, north of Seattle. Also, Microsoft is based out of Redmond to the East. Representing a tech-industry powerhouse, Microsoft is an unmistakable icon in the proliferation of personal computing. Looking at the region as a whole, the Puget Sound is a magnet for technology, manufacturing and industry.

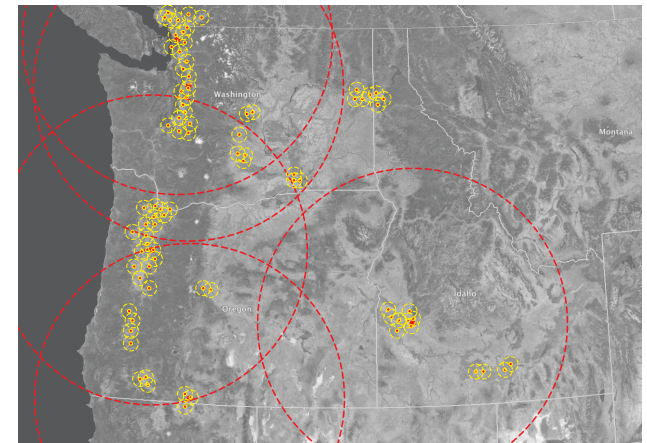


Figure 33 Regional mLAB Network

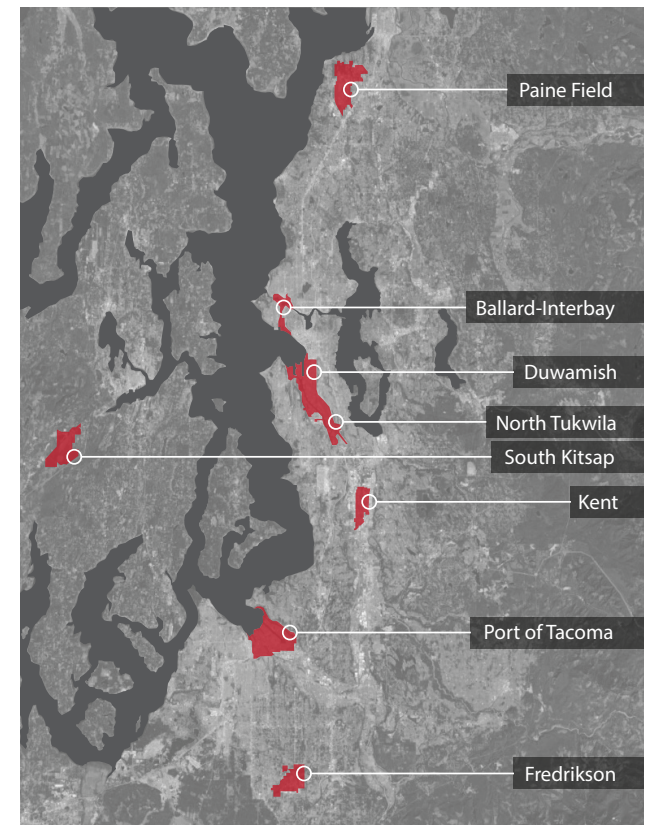


Figure 34 Puget Sound Manufacturing Industrial Centers

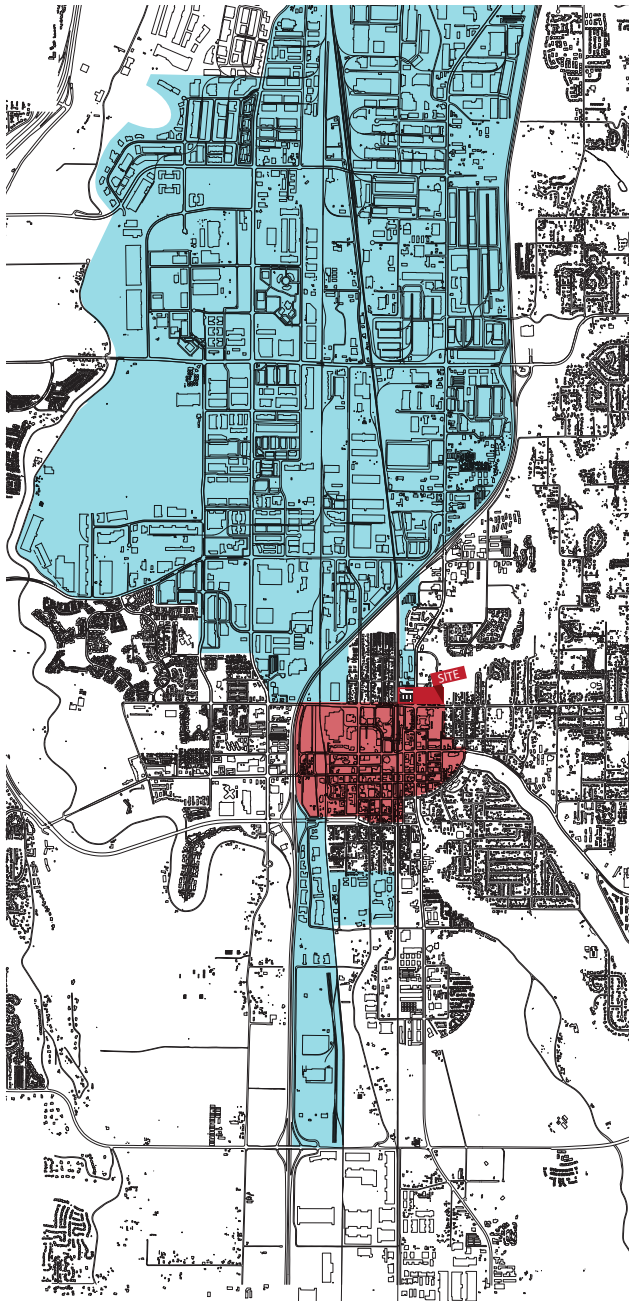


Figure 35 Vicinity Plan

Further investigation of the manufacturing industry in the Puget Sound region reveals various epicenters of activity, commonly referred to as Manufacturing Industrial Centers (MIC). It was important to investigate these areas to see where progressive manufacturing, technology and education overlap. Empirical data, related to jobs and growth provides additional insight to the nature of each. As a result of these investigations, the Kent Manufacturing Industrial Center has been identified as being an ideal candidate for examination.

In the case of Kent, the MIC abuts the Urban Center at a narrow point as a small sliver of industrial use following the rail line that services the MIC. The rail line runs the length of the MIC, providing additional spurs to the local manufacturers and warehouses. The line connects Kent to the larger manufacturing network, including the Port of Tacoma which provides extended access to the waterway network throughout the Puget Sound and beyond.

The ManufactureLAB would be seen as an intermediary between the Manufacturing Industrial Center and the local community in which it resides, which has been identified as a regional growth center by the Puget Sound Regional Council.² Located at the center of a mix of uses contributing to the identity of the city, the site embodies the purpose of the ManufactureLAB, to bridge industry and community in a way that is beneficial and accessible to the diverse range of users.

² Puget Sound Regional Council. "The Development Toolkit." (PSRC.org, 2003) 16.

Program

Progressive ideas are often born through untraditional means. Offering more flexibility than traditional business incubators, co-working spaces provide entrepreneurs and start-up companies with a place to collaborate with peers, who are often working in a completely unassociated field, on a schedule and on terms that work best for them. Inescapably, a generous cross-pollination of ideas takes place under such conditions. With an emphasis on community and supportive networks, co-working has quickly become a highly successful model. Some co-working spaces, such as Techshop, offer additional amenities that aid in design and manufacturing. With fabrication tools, in addition to a collaborative working environment, individuals or small business start-ups can go very quickly from idea to prototype. Taking the idea to a larger scale, however, proves to be more challenging.

The proposed program is one that draws upon the resources in close proximity to the site. Inserting itself within the community as an academic building, with close ties to the local education community and local staffing agencies, the proposed facility incorporates amenities for education and training as well as community access and use, expanding the capabilities from MakerLab to “ManufactureLAB.”

Following a membership model similar to that of a co-working space, the local community are able to have access to a workspace as well as the fabrication facility in the ManufactureLAB. Where needed, organizations such as CAMPS and NWIS are able to provide additional



Figure 36 Techshop

business development and expansion assistance. Deep pockets and specialized business connections are no longer necessary to bring a product to market, liberating novel ideas to become reality.

The focus is rooted in the user and their ability to effectively collaborate with others and interface with the industrial process. Providing spaces dedicated to the production of relationships, ideas, and sense of place rather than limiting activity to strictly the production of things, the facility as a whole becomes more accessible to people; a more humanized industry.

Construction Methodology

The application of prefabrication and Open-Building strategies serves multiple purposes. In a practical application, it provides the framework to allow for future expansion and adaptability of programmatic and equipment needs. As Kent evolves to incorporate more and more advanced manufacturing endeavors, the ManufactureLAB can expand to accommodate the increased demand for training as well as further establish its prominence in the community. The support, or base building, is designed to be completed in phases. This approach reduces the initial capital requirements while also allowing the facility to adapt in scope should market conditions change. The infill layers take into account the highly dynamic nature of technology advancement and collaborative environments. Similarly, the mechanical

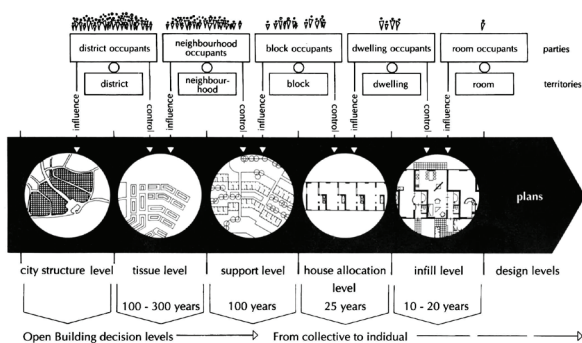


Figure 37 Open-Building Levels

systems needed to support the various spaces are intended to be a self contained unit that can be easily swapped out or upgraded as required. Envisioned as discrete layers, each with varying degrees of permanence and expected lifespan, the building is better able to accommodate change in user and programmatic needs. Leveraging the idea of permanence and temporality, a hierarchy of spatial experience is developed. Allowing a seemingly uniform framework to be broken down in scale and purpose creates a layering of spaces, personal yet interconnected with the whole. The adaptable nature of the infill layers extends to increase the functionality of the building. Providing a means by which equipment and use of space may be easily reconfigured, Open-Building increases the specificity of possibilities, allowing a human connection, without reducing future flexibility.

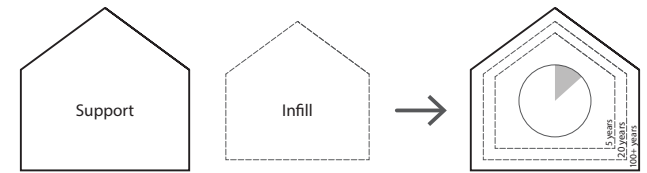


Figure 38 Open-Building Lifecycles

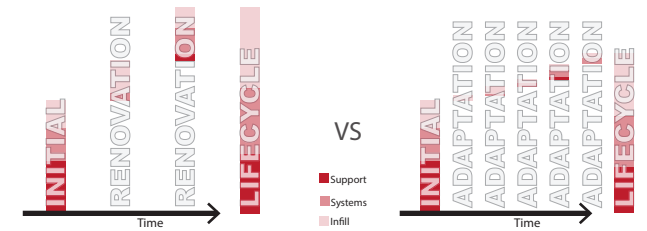


Figure 39 Renovation vs. Adaptation

Preliminary Findings

Analysis of the Site

The chosen site is in close proximity to various points-of-interest near the urban core of Kent. Notably, the site is easily within walking distance of two academic institutions, Green River Community College and Mill Creek Middle School. Also, the highly trafficked area of Kent Station, serving as a pedestrian oriented shopping center and stop for the Sounder Rail Line, is easily accessible. Other areas that draw significant foot traffic include the Showare Center, the Kent Recreation Center, the Kent Library, and Town Square Plaza. Directly north of the Urban Center lies the Manufacturing Industrial Center. Future development plans call for increased density in adjacent residential areas as well as the continued development in the Urban Core.

The proximity of the MIC to the town center, in conjunction with zoning and land use plans help identify one particular site that is ideal for an interface between the community and the larger industrial activity. The small sliver of industrial use is flanked by residential on one side and mixed-use on the other. The land use indicates the presence of a mixed-use commercial

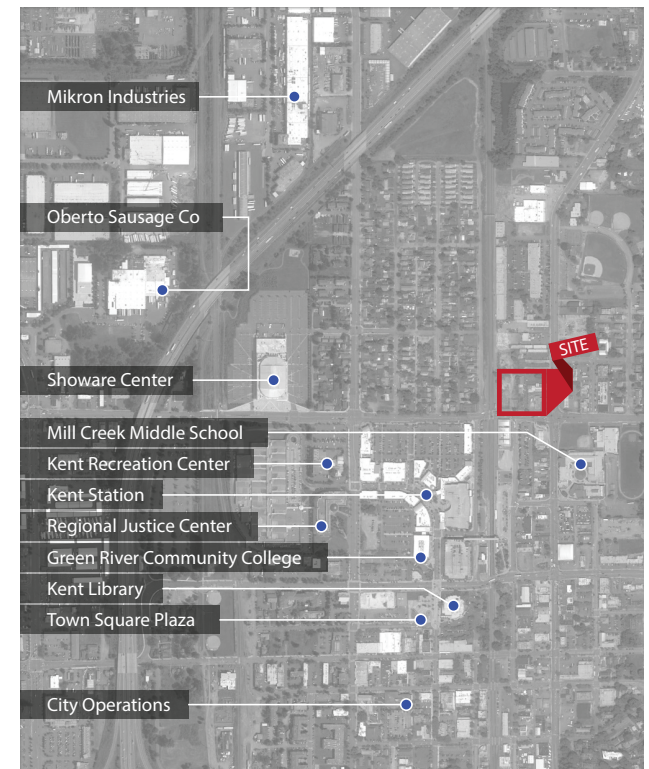


Figure 40 Points-of-Interest

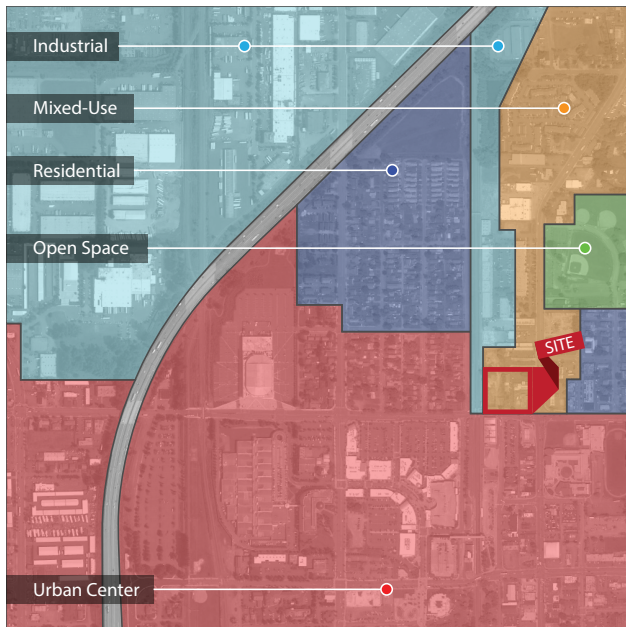


Figure 41 Land-Use Map

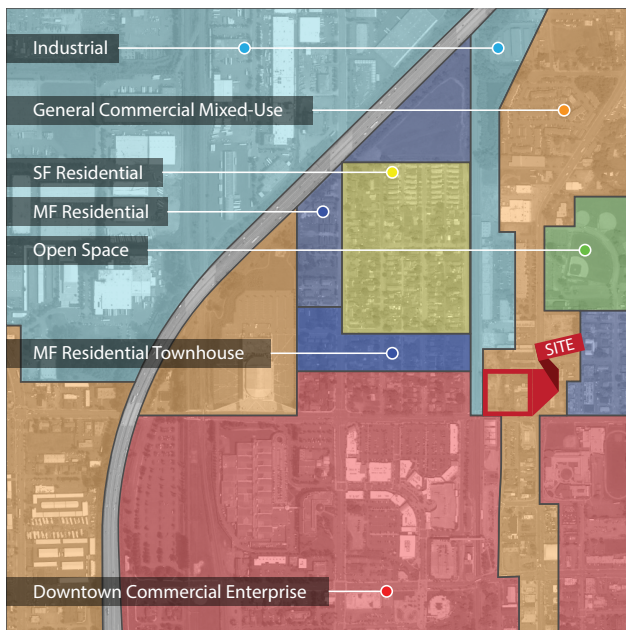


Figure 42 Zoning Map

corridor running north to south adjacent to the proposed site. The area dedicated to the first phase of development is currently an empty lot, directly adjacent to the railroad tracks. The other buildings that would be replaced in future phases include a funeral home and a gas station. Positioning the ManufactureLAB on this particular site enables it to play a direct role in the development of multiple aspects of future city growth. Located at the juncture between industry and the urban core, it acts as a link or mediator between the two. Also part of the developing mixed-use corridor, community involvement and ease of access are increased. Furthermore, the connection to adjacent residential areas, both multi-family and single-family, provides additional amenities that directly service the local residents.

Access to the site is facilitated by multiple means. Well connected via mass-transit, the Sounder Rail Line connects to Tukwilla, Downtown Seattle, and continues north through Everett. Also, the network of bus routes provides easy access by way of Seattle or Redmond. The major roads surrounding the site give easy access to the major freeways in the area. The only mode of access lacking in some way is that of the trail system. Throughout Kent it is sporadic and incomplete, something that will hopefully be resolved as the area continues to develop.

Of particular benefit is the connection to the Sounder Rail Line. The line runs directly adjacent to the site and is part of the primary network servicing the MIC and beyond. The two lines shown on the map converge north of the MIC as it enters the Port of Tacoma.



Figure 43 Access Map - Roads

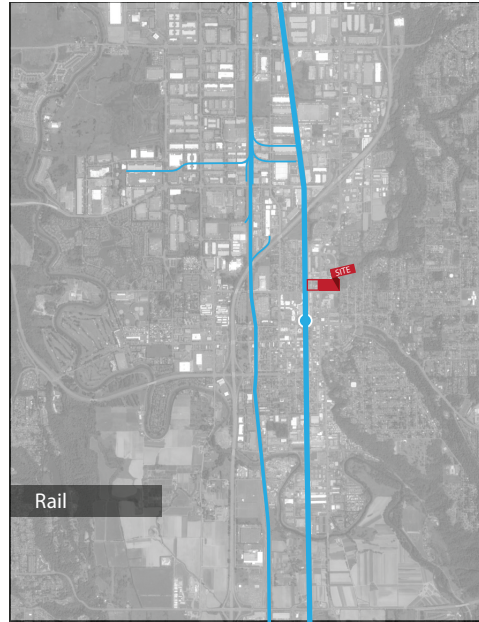


Figure 44 Access Map - Rail

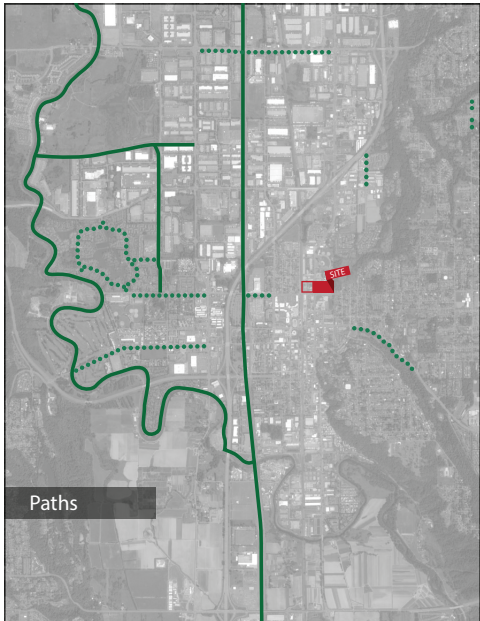


Figure 45 Access Map - Trails

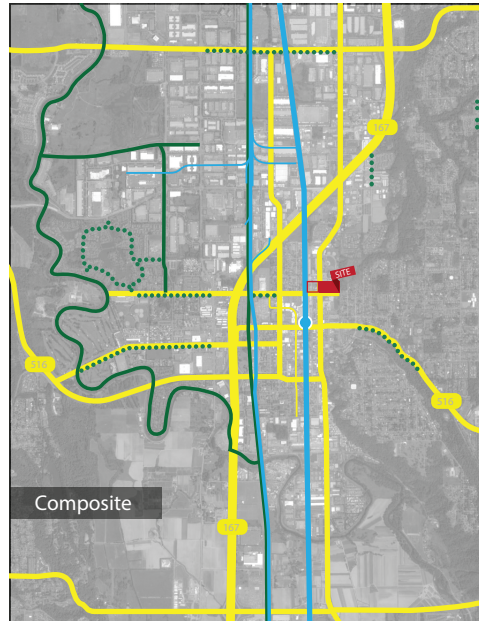


Figure 46 Access Map - Composite

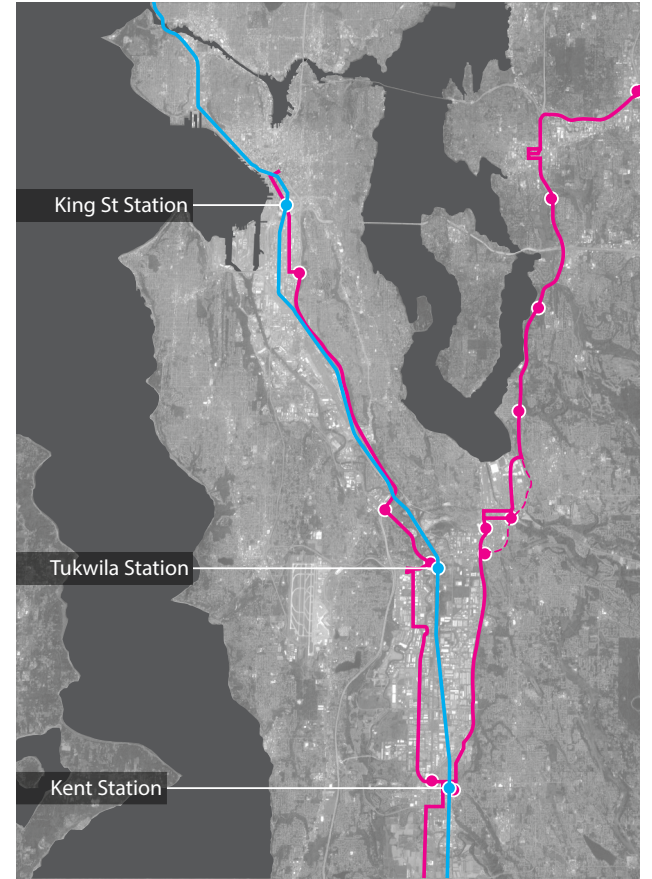


Figure 47 Access Map - Mass Transit

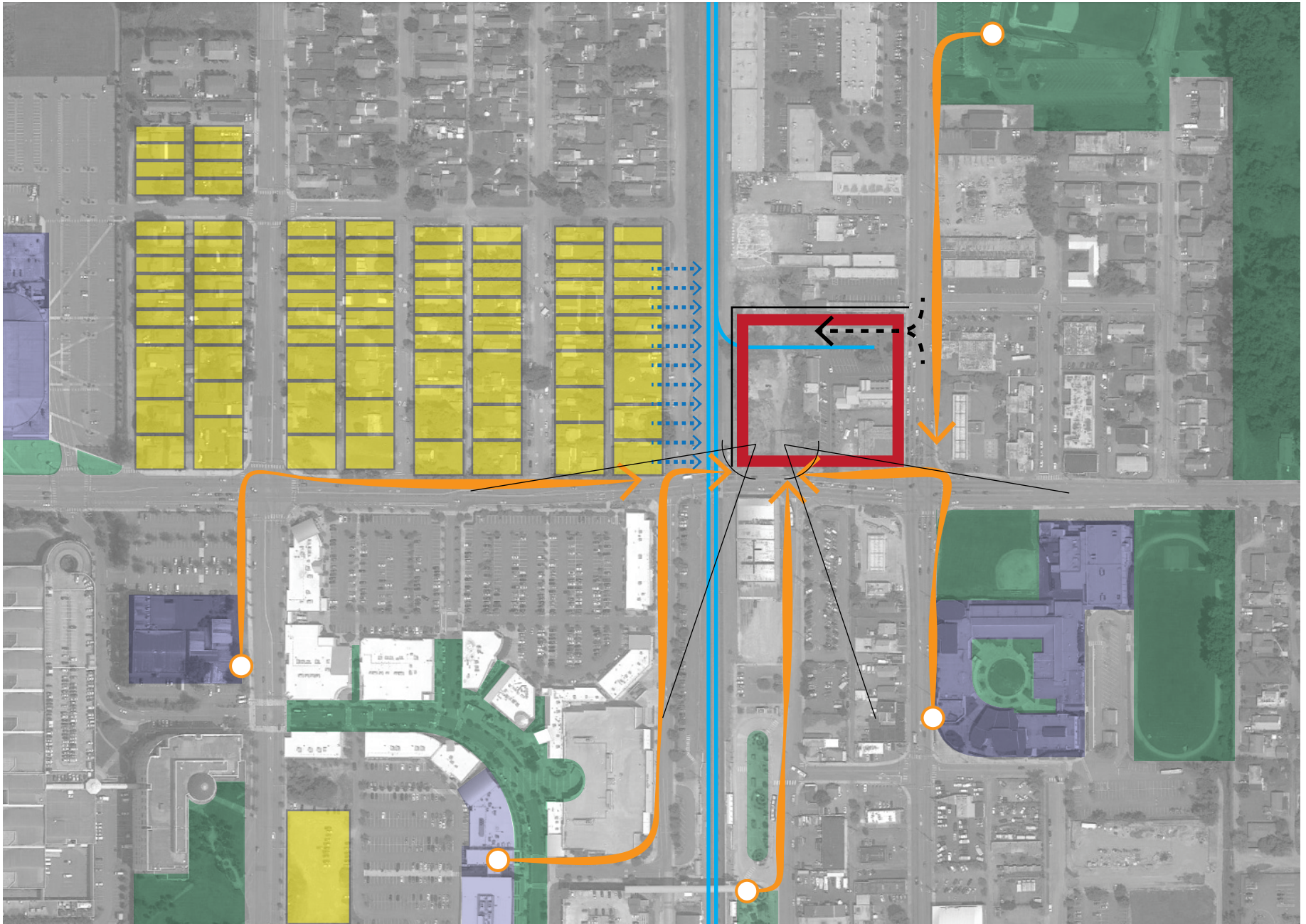


Figure 48 Site Analysis

A closer investigation of immediate site influences reveals the potential flow of pedestrian traffic as well as opportunities to accommodate vehicular access. Trucks, or other vehicles enter the site off Central Avenue at the rear of the building. Similarly, a railroad spur grants access to the conveniences of the rail line for shipping and delivery, reducing on-street traffic and extending the integration to the existing manufacturing network serviced by the same line. Views include that of the Kent Station shopping area to the southwest and Mt. Ranier in the distant southeast.

The character of the surrounding area is very mixed. Some areas are quite developed, such as Kent Station, while others have a raw and unfinished nature. In most areas, seemingly random warehouses lie vacant, sidewalks suddenly end mid-block and traffic is intimidating. Yet, in other areas, such as Kent Station, great care has been taken to provide a pedestrian friendly environment. The contrast is quite striking. The site itself, is currently undeveloped and in close enough proximity to Kent Station and the neighboring middle-school that it could be seen as an extension of their pedestrian friendly nature.

Narrative of Users

Faculty - Containing an academic component, the facility naturally encourages the development of new curriculum and staffing for the courses and training programs. The focus of the faculty is to teach and train students on the advanced manufacturing methods



Figure 49 Site Context



Figure 50 Kent Station Rail Stop



Figure 51 Site Context



Figure 52 Site Context



Figure 53 Existing Site Condition



Figure 54 Existing Site Condition



Figure 55 Kent Station Retail



Figure 56 Kent Station Retail



Figure 57 Faculty



Figure 58 Outreach Staff



Figure 59 Students

employed in the workshop. Also, integration within the larger professional industry is a valued asset. Courses are offered in classrooms as well as incorporating demonstrations and supervised hands-on training. Guest lecturers are welcome to the facility to provide insight and specialized instruction.

Outreach Staff - Additional staff, dedicated specifically to interface with the public, are available to give general information as well as provide industrial staffing services. As a link to the larger industry, the community outreach component assists in finding qualified individuals to fill vacant positions within the MIC and surrounding areas. Design staff, which may also be faculty, students or independently contracted, provide design and manufacturing services for members of the community at large. This staff provides assistance on the shop floor on an as-needed basis to ManufactureLAB members.

Students - Enrolled in either a full-time curriculum or a night course program to accommodate the working professional, students have the opportunity to learn about advanced manufacturing practices in the classroom and by using the equipment themselves. Hands-on training would be an important aspect of the program, as it would act to fill the gap in qualified, high-skill level, employees into the industry. Meeting the local manufacturers needs, as identified by the outreach program, the curriculum provides the right training as well as job placement opportunities upon graduation.

Entrepreneurs / ManufactureLAB Members - Embracing the cultural shift of the Maker

Movement, the facility provides workspace akin to a co-working environment with additional access to fabrication equipment once mandatory safety and training has been completed by the appropriate staff. Membership benefits also include consultation and/or additional services from the outreach program.

Community Members - Although the Maker Movement has great promise for personal manufacturing in the home, the limitations of such technology still exist. Material choice, size, time, and quantity are all factors that may require more robust manufacturing solutions. The ManufactureLAB is able to fill the need while maintaining economy and local accessibility. Perhaps a local business needs a limited production run of an item that cannot be commercially purchased. The ManufactureLAB could become an integral part of the industry as well as the community.

Industry Professionals - Not only does the facility serve as the go-to place to make business contacts, it is also a reaffirmation of the importance of the people involved in manufacturing and what they bring to the table. An important line of contact with the academic environment, the Industry Professional provides valuable feedback regarding the effectiveness of the program, and the curriculum is periodically modified to better prepare the individuals that will soon be in that professional capacity. Furthermore, the ManufactureLAB is an ideal environment for continuing education and exposure to new equipment and methods as the industry advances.



Figure 60 Entrepreneurs



Figure 61 Community Members



Figure 62 Industry Professionals

Narrative of Spaces

Education Program

Classrooms - Technology ready classrooms enable a learning environment capable of dealing with the advanced manufacturing methods emerging in the industry. Software controlled CNC machinery is becoming more commonly used. Computer station classrooms as well as traditional classroom settings are provided. For group work or study, Active Learning Classrooms provide a sense of academic community while incorporating advanced technology and education models.

Observation Area - Meant to provide a place of oversight for the faculty and staff to monitor happenings in the shop, it also serves well as a protected area from which individuals can see demonstrations or work being produced. This doubles as a very prominent piece of the program, also serving as an informal meeting and collaboration space.

Collaboration Spaces - As collaboration is a key component to the learning experience, multiple areas for both structured and informal collaboration are provided. Intended to facilitate random encounters and cross-pollination of ideas, these spaces are integrated within the larger circulation network of the building.

Small Group/Individual areas - Just as important as collaboration, individual time to reflect allows one to focus more intently on a particular idea or problem. Space dedicated to this

process provides an easy way to separate oneself from the surrounding activity and enjoy a sense of privacy and isolation when desired.

Work Program

Co-Working Space - A largely open space, with areas for working in small groups as well as individually, provides the Entrepreneur Members with a collaborative and informal work environment. Semi-private spaces are also provided in the form of nooks or semi enclosed rooms. The flow is kept open to provide opportunity for collaboration and cross-pollination of ideas between members. The close proximity of the Outreach Center provides ease of access to additional resources and provides closer integration with the industry at large.

Outreach Center - As a resource center for the industry, the outreach center is a valuable place to make contacts and to hold meetings and events. Also functioning as an industrial staffing agency, the outreach center assists in filling the needs of the industry for qualified individuals seeking employment.

Public Interface Program

Outreach Center - Functioning as a marketing department and information center, the community outreach center provides a point of contact with the community. Filling staffing needs and providing community interaction and access integrates the ManufactureLAB with the larger community of Kent.

Retail Center - As a place to engage the public and display the work being produced in the facility, a retail center fits nicely as an extension of the Kent Station shopping center. Products commissioned by the public can be ordered and picked up at this location.

Café / Coffee Shop - Meant to be an amenity for the Faculty, Staff, Students, and Members, the Cafe' is a place to relax and get a bite to eat during those long working days. Also, accessible by the general community, it is an ideal place for meet-ups and casual networking. The facility feels accessible to the community at large if basic needs, as well as specialized manufacturing needs are met simultaneously.

Manufacturing Program

Manufacturing Bay - Open space that can be outfitted with various manufacturing equipment and updated according to advances in technology and user needs. Interchangeable lighting, raised access floors, and chase walls provide the flexibility needed in placing equipment and running necessary data and electrical lines.

Building Service Program

Delivery Bay - Direct access to the rail system allows easy loading and unloading of products and materials.

Mechanical components - Designed as self-contained units that are easily accessible, the mechanical needs can be upgraded or replaced as needed with minimal disturbance and

cost.



Figure 63 Vicinity Plan

Design Proposal

As a type of public interface with industry at large, the Kent ManufactureLAB takes deliberate measures to balance efficiency in construction/operation with the element of human occupation. This thesis is not intended to redefine the manufacturing process, but to address the physical environment in which these processes take place, making them more amenable to the occupants therein. One major factor in humanizing the industrial space is to directly address the physical scale of the programmatic areas. Another is to change the distribution of the programmatic relationships to be smaller clusters, strategically placed throughout the space. Unfettered flexibility within the volume is not the ultimate goal, yet flexible and adaptable spaces play a critical role in the overall whole. Of primary concern is the latticework of occupied spaces in, through, and around the manufacturing areas, providing identifiable, human-scaled spaces in which to interact, collaborate, and simply occupy.

Applying the Methodology

Beginning to divide the space into smaller, dedicated zones that can address differing needs

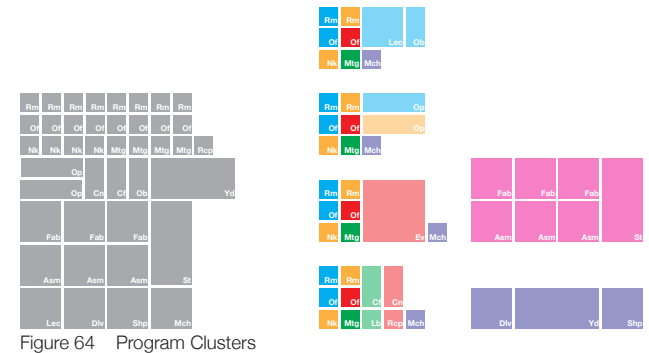


Figure 64 Program Clusters

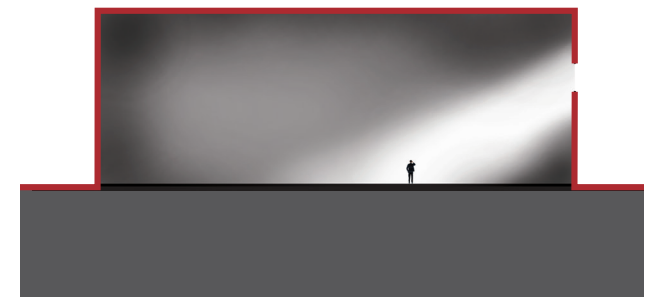


Figure 65 Human Scale Disconnect

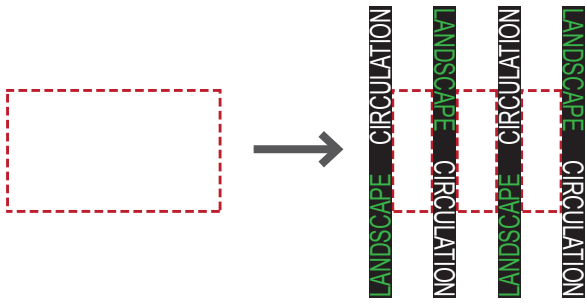


Figure 66 Landscape/Circulation Bar

and conditions, a series of circulation and landscape bars not only provide space for the logical flow of people, but also introduce the surrounding landscape directly into the confines of the work environment. Highlighting these spaces as primary zones that have a site-wide influence establishes a hierarchy of main elements and spaces between. The spaces between are what define the manufacturing bays, bounded on both sides by the primary circulation and landscape elements.

In a graduated, long term development approach to the evolution of the completed facility, in-line with the previously described Open-Building concept, each circulation/landscape bar with its accompanying manufacturing bay is constructed in a series of development phases. This approach enhances the viability of such an endeavor, providing a facility with adequate, but not superfluous, space as requirements vary and demand for additional capacity grows.

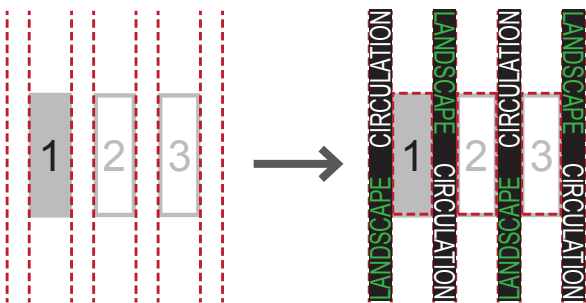


Figure 67 Manufacturing Bay Phasing

The open-building concept calls for adaptability and flexibility within a larger, more permanent support structure. This proposal extends that thinking to include the incremental expansion and adaptability of the support structure itself.

Scaling Down

Applying the same logic at a variety of scales, the investigation is broken down into various building components, each with its own spatial characteristics and contribution to the whole. The landscape/circulation bars give a rhythm to the overall site. The bars themselves provide

an area in which landscape can play a primary role in the character of the interior space, being drawn into the building perimeter. Such close proximity to other functions provides opportunity to engage, visually and physically, with the immediate site, thereby blurring the distinction between interior and exterior space.

Within the support structure of the landscape/circulation bar, secondary infill layers begin to define additional spaces, creating identifiable and functional sub-areas that can take on a more specific purpose and program. These secondary layers are implemented in such a way to highlight the distinction and separation from the host support “framework.” Ideally, the sub-spaces created by the addition of secondary infill layers are expected to have a shorter lifecycle of use than that of the support structure. The secondary infill could be replaced or upgraded as circumstances and needs see fit in order to keep pace with advances in technology and changes in preference. Designing with this process in mind allows greater opportunity for adaptation at minimal cost and disturbance.

The secondary infill layers have varying degrees of permanence within themselves. Modules, being self contained units, are able to be rearranged relatively easily. Tertiary interior finishes and exterior cladding are designed to be demountable and interchangeable.

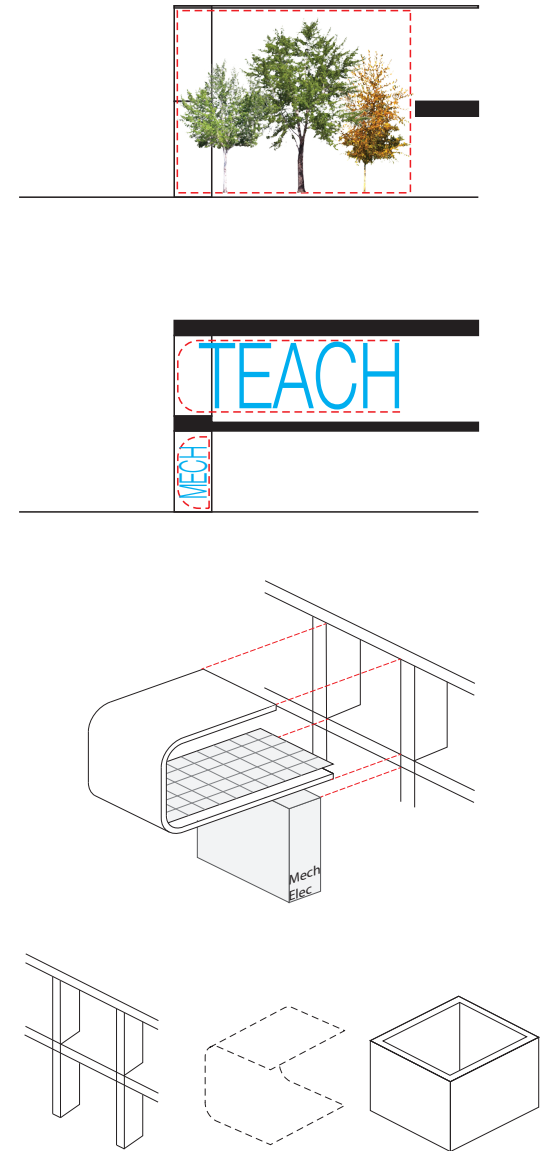


Figure 68 Building Elements Framework

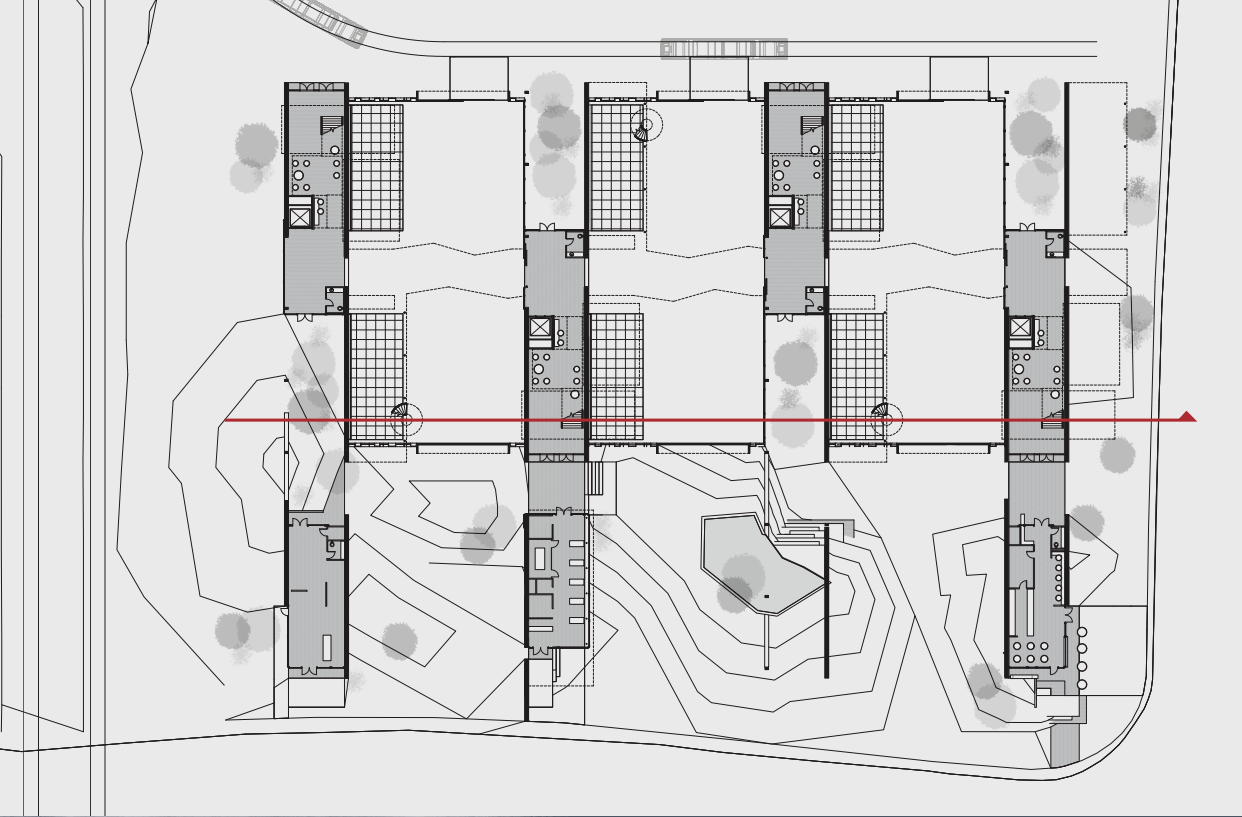


Figure 69 - Exterior Perspective - South Façade



Figure 70 - Section Perspective - East West

Humanizing Site

The proposed design is illustrated as if all three phases were completed, in order to provide a comprehensive understanding of how the expanded areas relate to one another. The landscape/circulation bars are expressed as the most permanent, and therefore most prominent, components of the design. Bounded by heavy concrete walls, embedded in the earth, the bars are in-filled with various elements to create a variety of spatial experiences and places for interaction. The heavy wall breaks down to allow the landscape to enter into the building, placing the occupants and the manufacturing process in direct contact with the surroundings. Functioning also as light-wells, the glazed separation between the manufacturing bay and the landscape allows natural light to pour into the space, while also mitigating direct solar penetration. The heavy walls act also as the primary support for the additional program elements of the building. At one end of the fabrication bay the co-working spaces and classrooms are embedded within the walls as modules projecting out into the fabrication bay. On the opposite end, the wall folds over to form a platform on which additional, but smaller, modules for collaboration and individual study are placed. The area in the manufacturing bay underneath these elements are treated with an in-fill layer of adjustable ceiling, wall and floor panels that provide a convenient means for adapting to new workspace conditions.

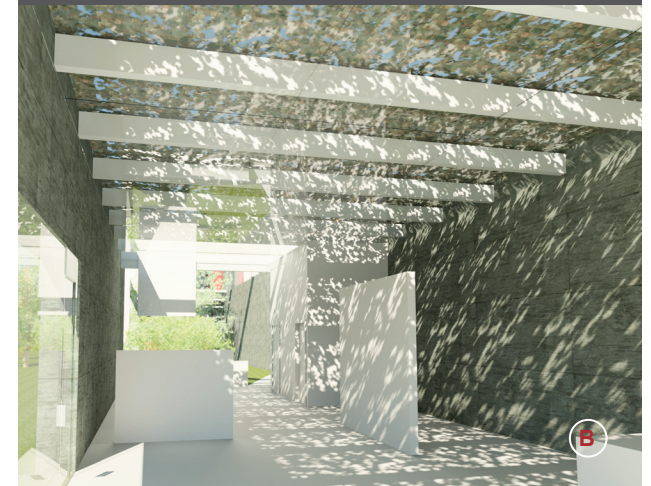


Figure 71 Interior Perspective - Retail Pavilion



Figure 72 Exterior Perspective - Café Pavilion

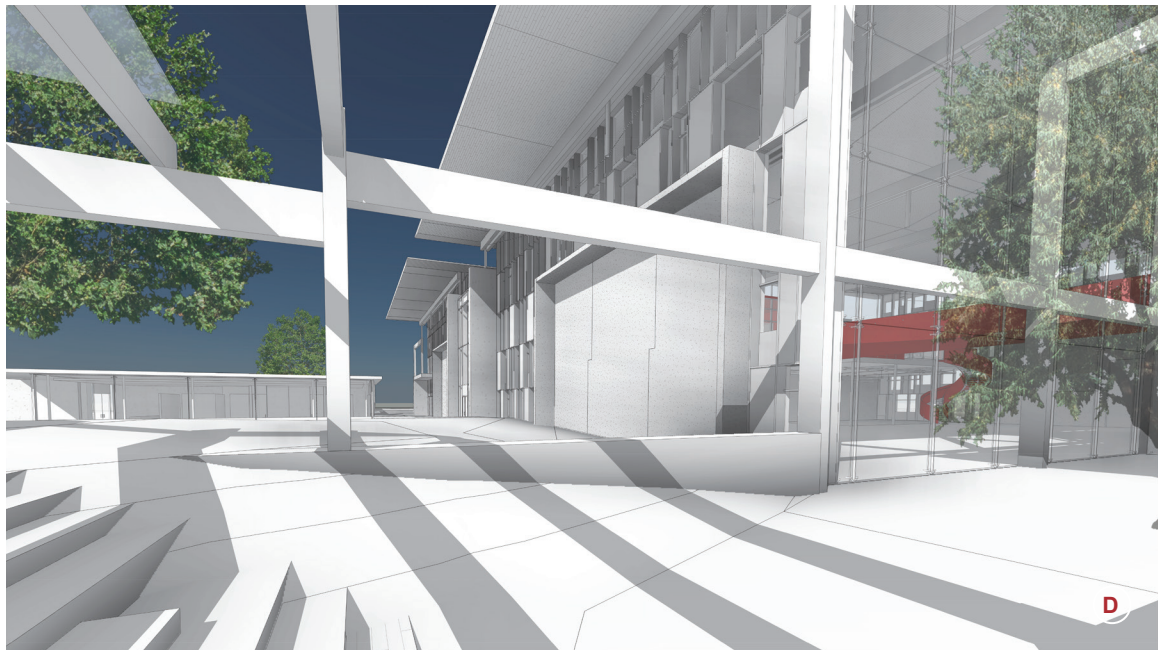


Figure 73 Exterior Perspective - Landscape Pavilion

The walls extend throughout the site to define individual pavilions acting as the area of public engagement. Each possessing a slightly different character, the pavilions define various activities along the site and serve their respective programmatic functions. At the corner, the Café draws in the general public as well as serves the building's occupants. A second pavilion is expressed as an extension of the building's structural Frame. The walls defining the perimeter of the pavilion are engulfed by the surrounding topography creating a publicly accessible green space. The community outreach center, allowing its wall to extend directly to the sidewalk, is the main point of contact with the community. Lastly, the retail pavilion allows for an exchange of goods and is closest to the nearby Kent Station shopping center.

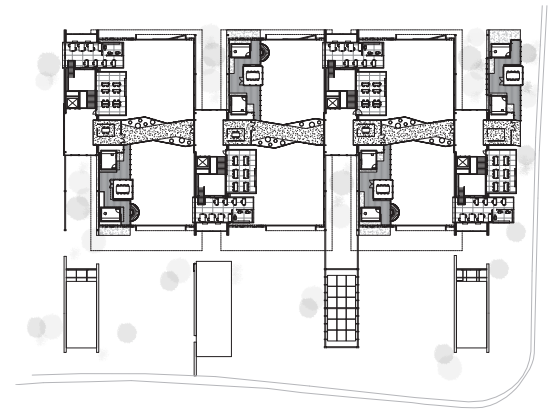


Figure 74 Perspective View Key - Level 2

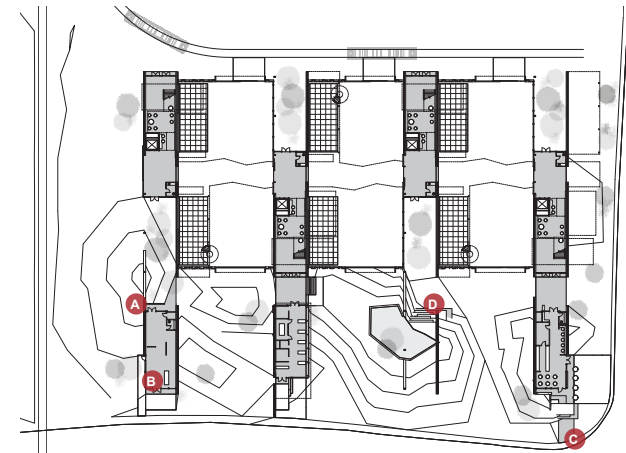


Figure 75 Perspective View Key - Level 1

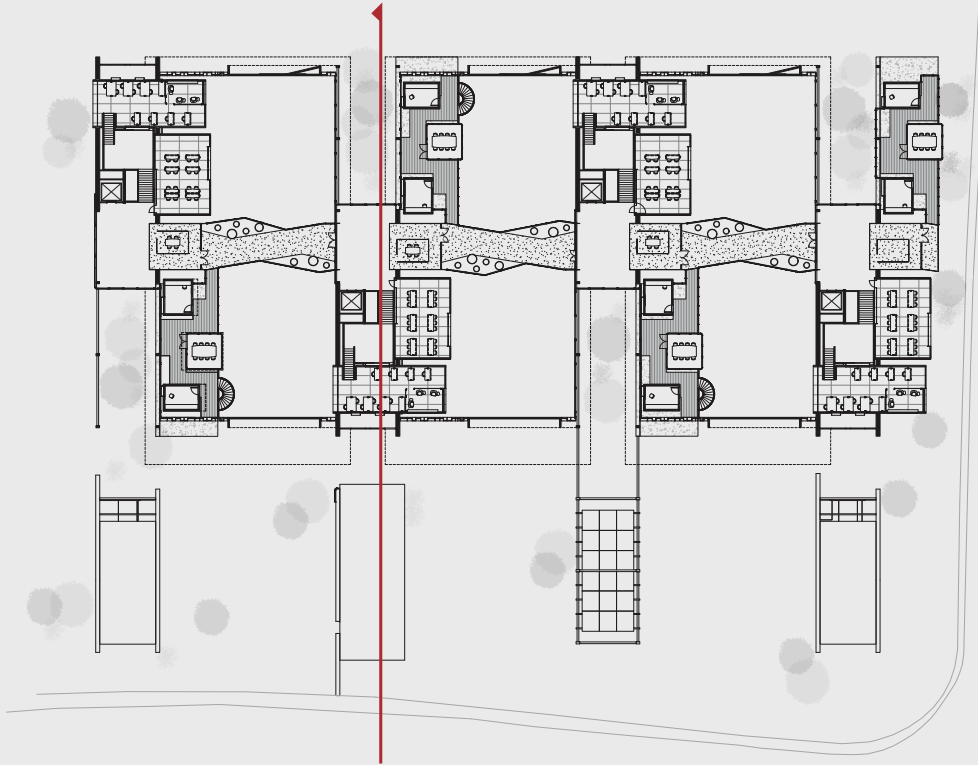


Figure 77 Interior Perspective - Circulation Bar Entry



Figure 76 Section Perspective - North South

Humanizing Flow

Viewing the sectional relationships throughout the Community Outreach pavilion and adjoining circulation bar, a variety of scale and spatial zones can be seen. The entry foyer is bounded overhead by the co-working module. One can continue underneath the stairs to inhabit more intimate gathering spaces, appropriate for various small groups, or ascend to the enlarged landing at mid-level, allowing access to the co-working module as well as space to gather with acquaintances. Continuing up to the second floor, the landscape is prominently reintroduced and acts as a landing point for the secondary circulation between manufacturing bays. Interconnecting the various circulation bars, a continuous bridge spans the length of the manufacturing floor. Highlighted in red, as with the other circulation elements, the bridge is a unifying element throughout the facility, running the entire length, punctuated by intermittent nodes where spontaneous collaboration can occur within the glass meeting nooks. Expanding at certain points along the path the bridge provides space to gather with others in passing while also becoming a vantage point from which the entire fabrication floor can be observed. From below, the bridge serves as a way-finding element, demarcating a zone for pedestrian travel and providing a sense of overhead protection, reducing the vertical scale of the fabrication floor along the primary circulation path.



Figure 78 Interior Perspective - Circulation Bar Landing

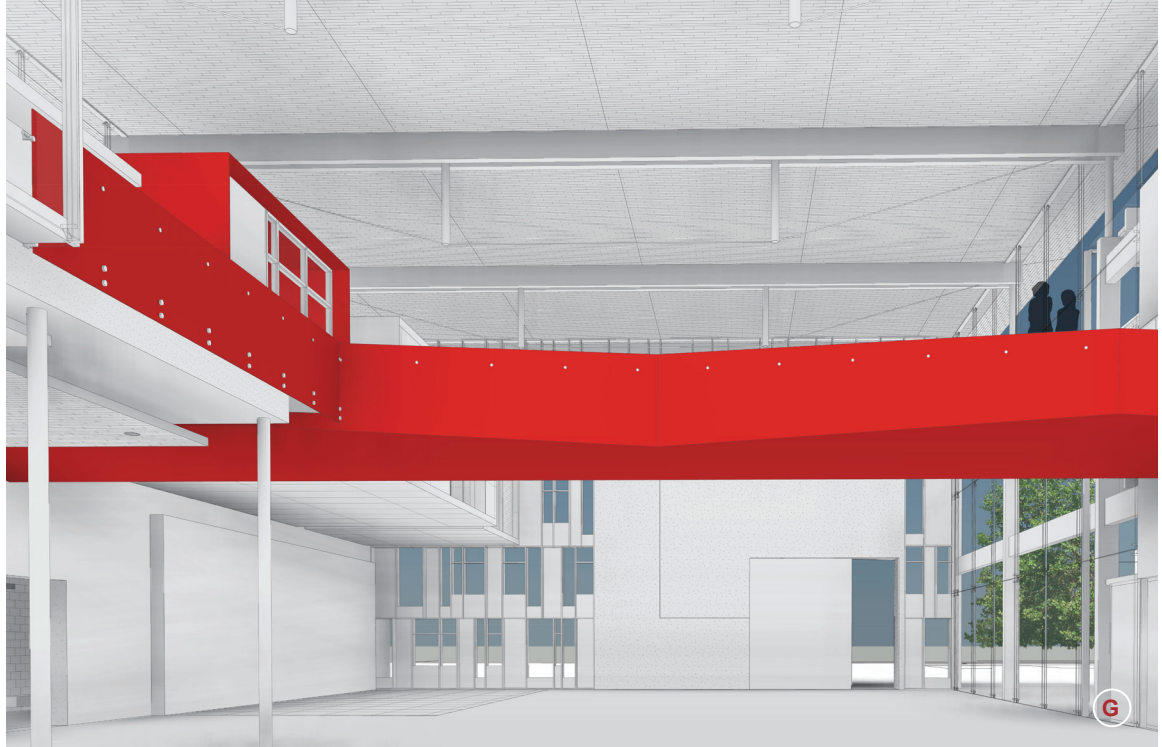


Figure 79 Interior Perspective - Manufacturing Bay

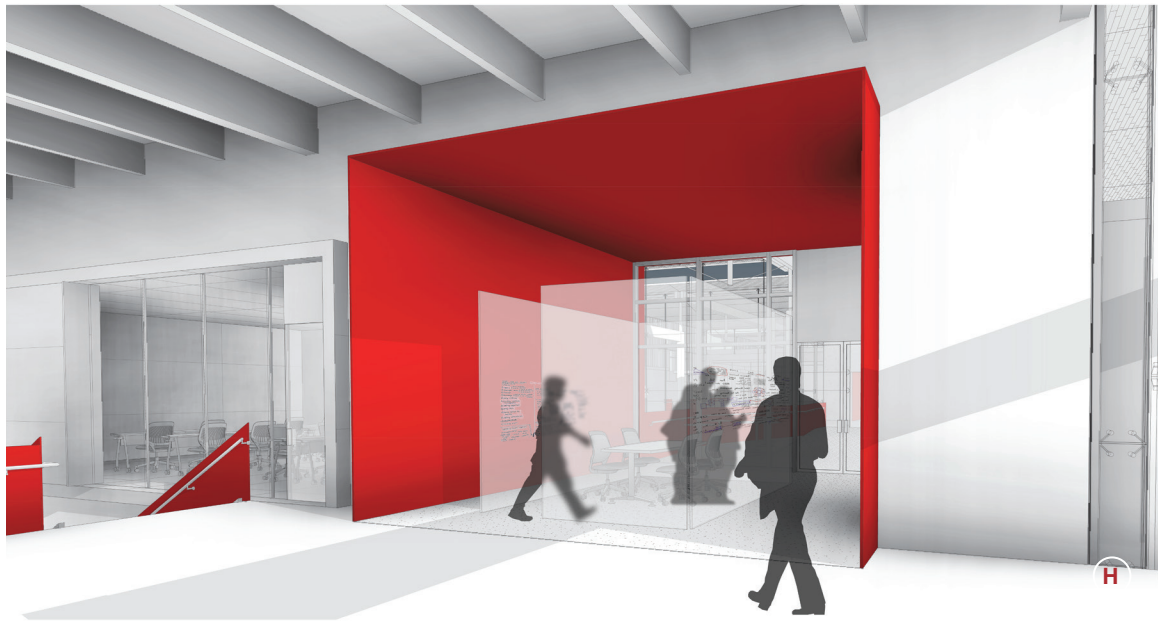


Figure 80 Interior Perspective - Collaboration Node



Figure 81 Interior Perspective - On Top of Bridge

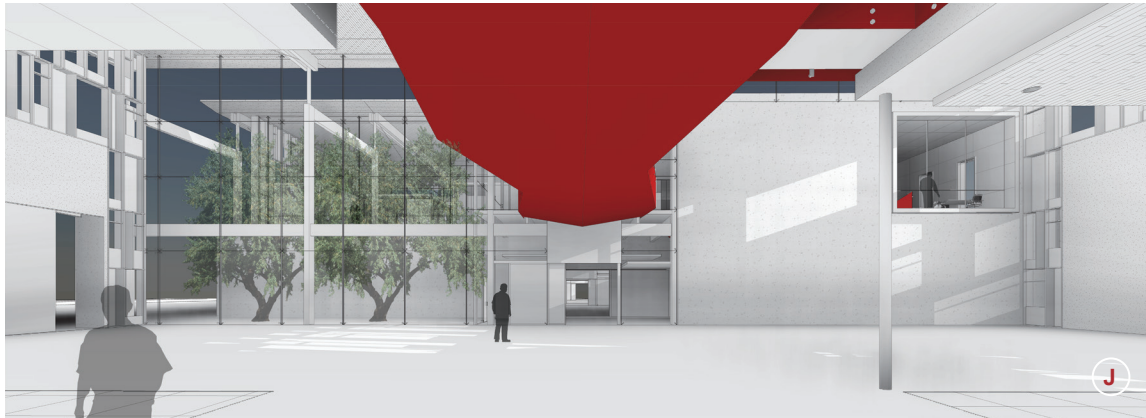


Figure 82 Interior Perspective - Under Bridge

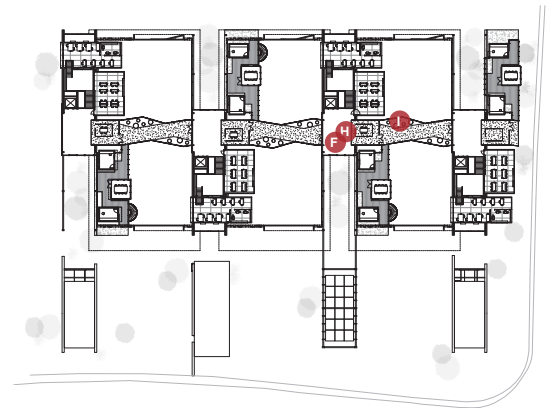


Figure 83 Perspective View Key - Level 2

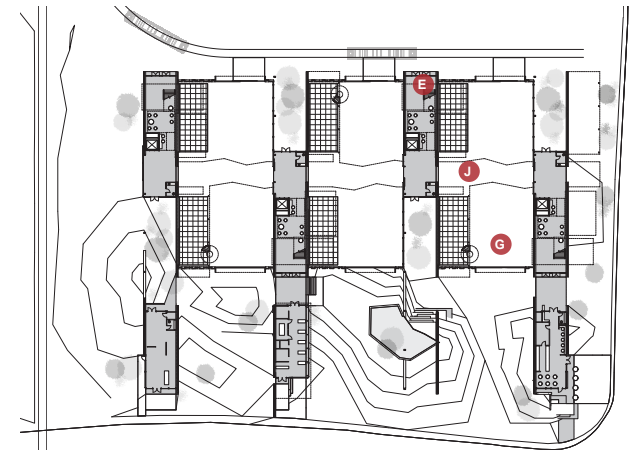


Figure 84 Perspective View Key - Level 1



Figure 85 Interior Perspective - Overlooking Manufacturing Bay



Humanizing Place

The individual program elements further reduce the scale and provide a more confined environment for one to inhabit without compromising the visual connection to the whole, being able to observe the layering of space throughout the building. The co-working module is an open work environment with a semi-enclosed meeting space for small groups. Openings at the ends of the module allow direct observation of both adjoining fabrication bays. Smaller windows admit light passing through the exterior façade as well as the circulation bar over which it spans. The classrooms similarly protrude over a portion of the fabrication bay and are anchored by the circulation bar. Providing connection to the whole while also creating defined and purposeful space humanizes the experience and creates a feeling of belonging within the program elements.

Continuing the reduction in scale, smaller modules placed on the concrete platform, provided by the folding of the circulation bar wall, are arranged in a way as to create gathering spaces along the circulation path. The freestanding modules are ideal for small group collaboration or individual study and reflection. Visual connection to the landscape elements introduced into the workspace provides naturally lit spaces and a sense of openness. The enclosure of the smaller modules also provides the opportunity for privacy, allowing individual work and study. In contrast to the large scale and bustling collaboration within the overall facility, the confined, pensive nature of the solitary spaces, accentuated by framed views of the landscape, can be a welcome and humane repose.



Figure 86 Interior Perspective - Co-Working Module



Figure 87 Interior Perspective - Co-Lab Module



Figure 88 Interior Perspective - Classroom Module



Figure 89 Interior Perspective - Personal Study Module

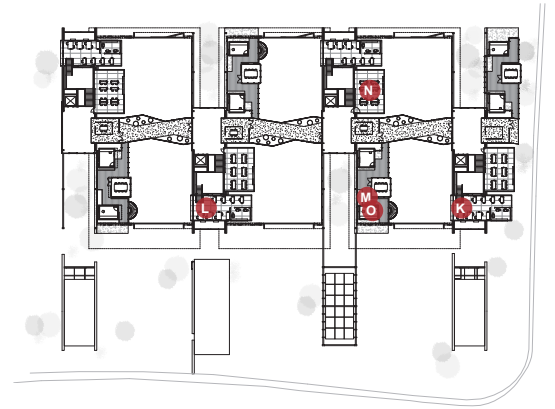


Figure 90 Perspective View Key - Level 2

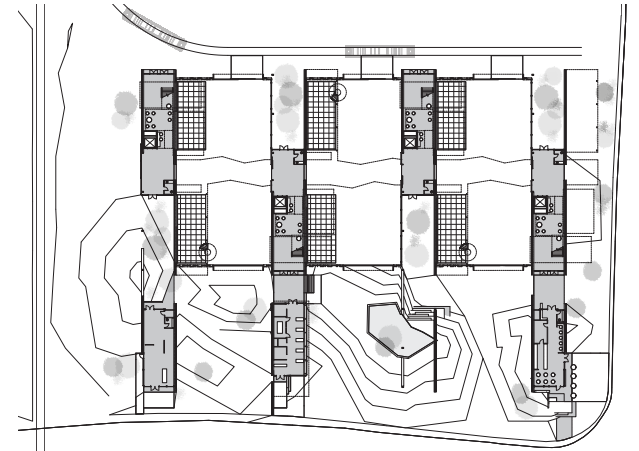


Figure 91 Perspective View Key - Level 1



Section 1

West Elevation

Figure 92 Transverse Section 1 & West Elevation



Figure 93 Transverse Section 2 & East Elevation

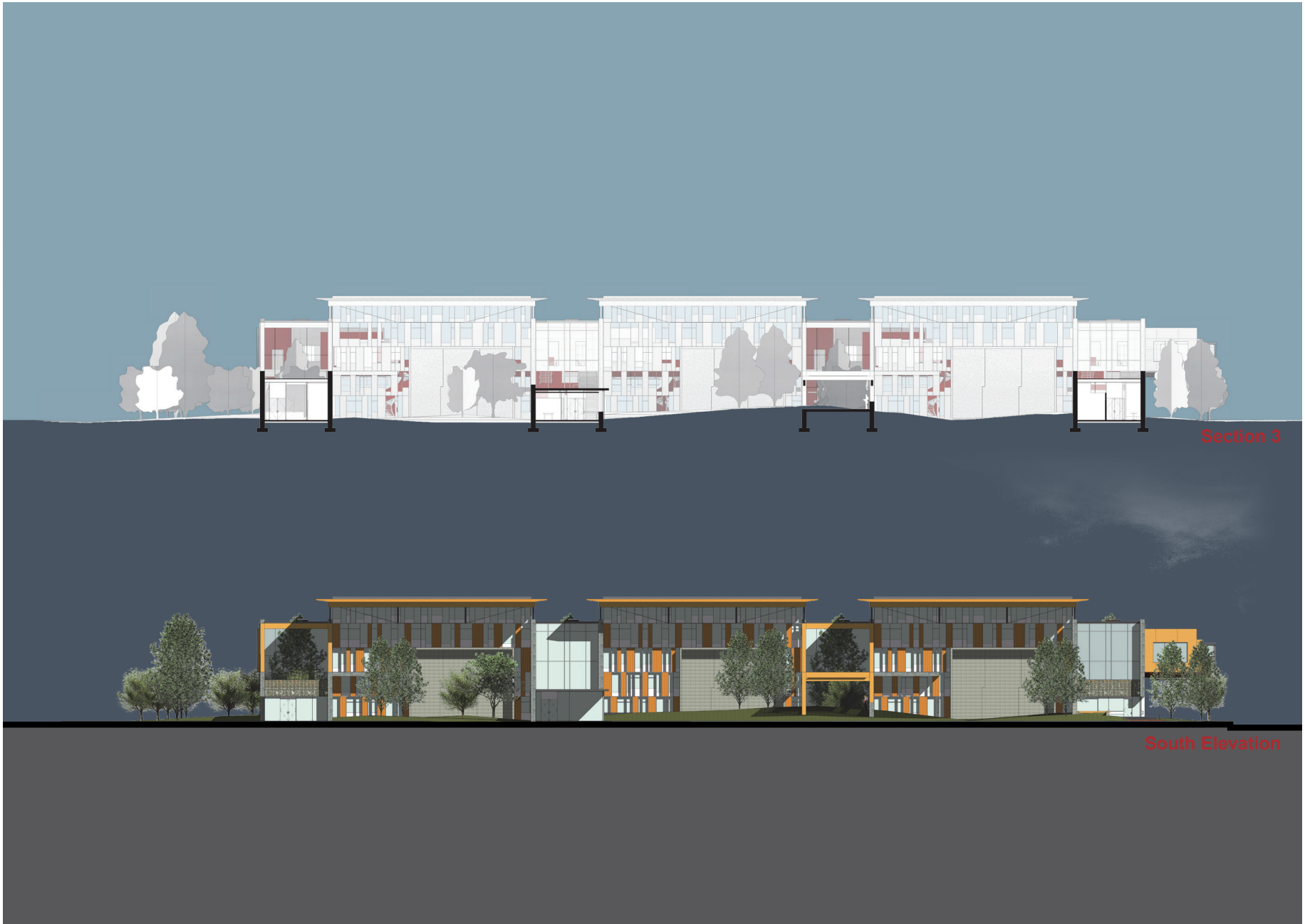


Figure 94 Longitudinal Section 3 & South Elevation



Figure 95 Longitudinal Section 4 & North Elevation

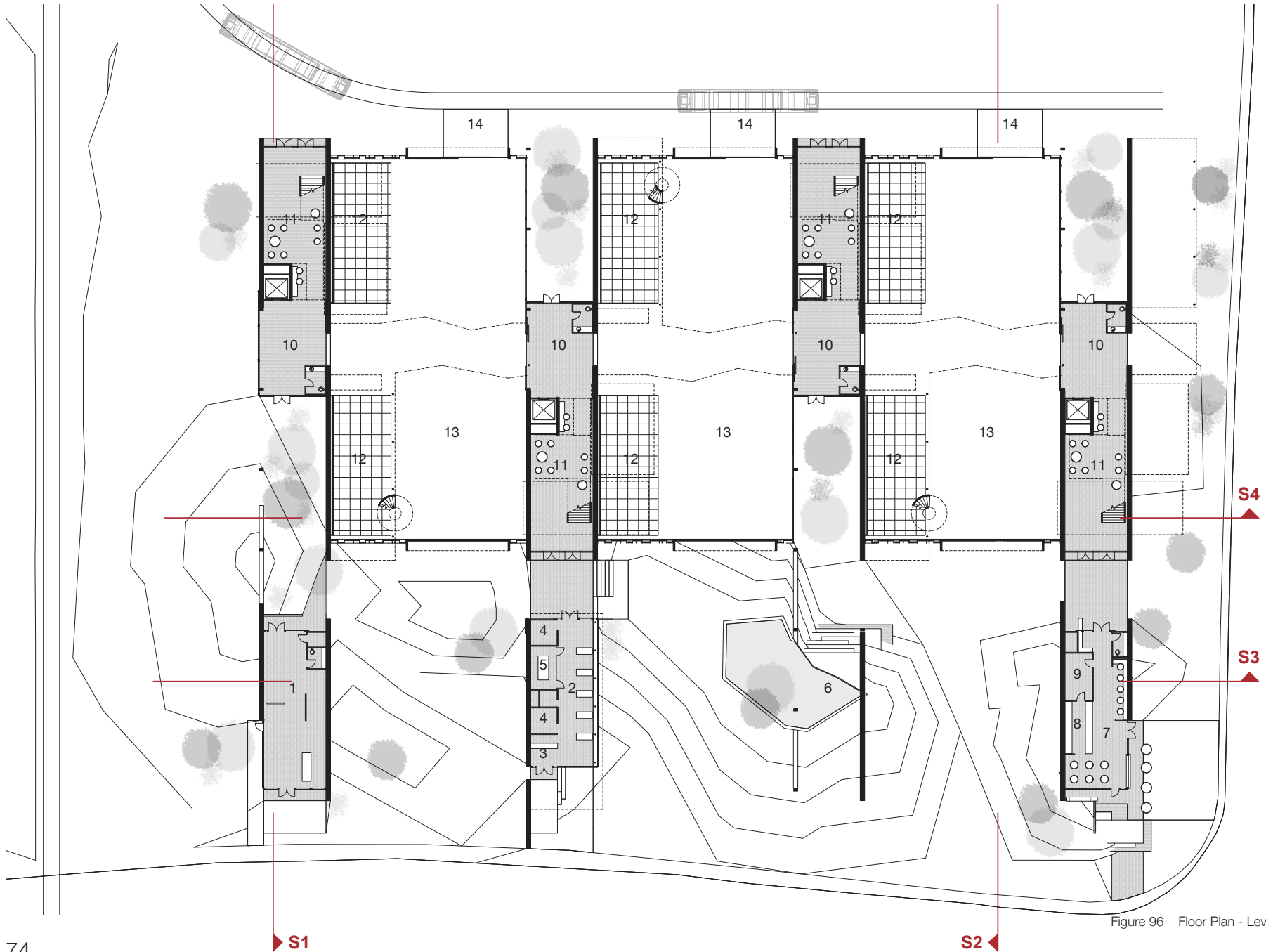


Figure 96 Floor Plan - Level 1

Manufacturing Facility

- 10. Circulation Node
- 11. Informal Gathering
- 12. Adaptable Manufacturing Space
- 13. Manufacturing Bay
- 14. Rail Shipping/Receiving
- 15. Co-Working Module
- 16. Classroom Module
- 17. Co-Lab Collaboration Space
- 18. Private Study Module
- 19. Conference Module
- 20. Circulation Bridge

Pavilions

- 1. Retail Pavilion
- 2. Community Outreach Center
- 3. Reception
- 4. Office
- 5. Conference Room
- 6. Landscape Pavilion
- 7. Café Pavilion
- 8. Service Counter
- 9. Kitchen

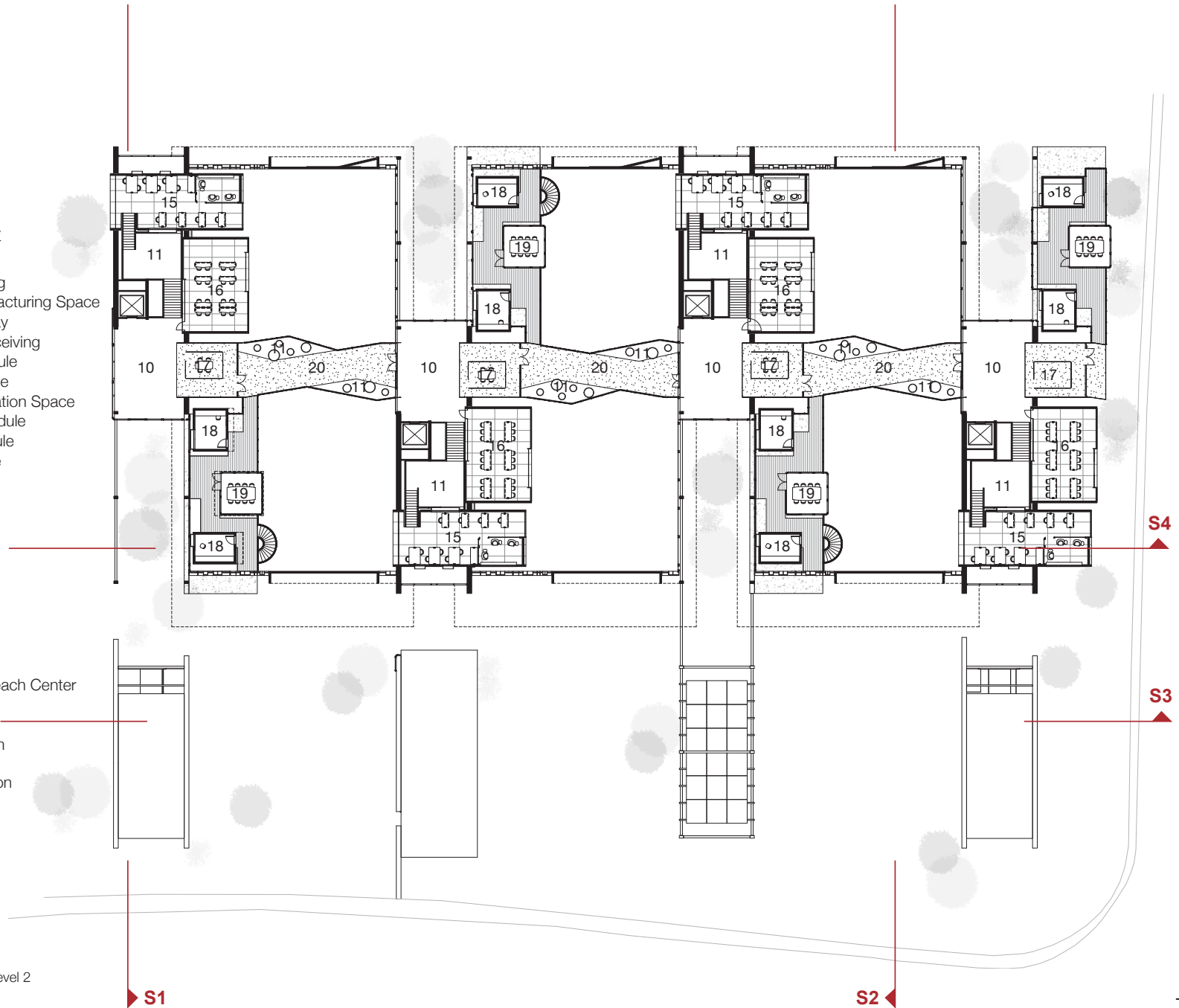


Figure 97 Floor Plan - Level 2





Figure 98 Section Perspective - East West through Bridge

Conclusions

With opportunity and discovery continually on the horizon, one can almost take for granted the here and now. The relentless advancement of technology has inspired and facilitated countless innovations, making our lives all the more diverse in possibility and convenience. Advanced manufacturing, in conjunction with education, research and collaboration, has the potential to spur new innovations. Servicing all areas of society, the industry of manufacturing embodies deep rooted consequences in its success or failure.

The constant push to do more with less in a shorter time frame is ingrained in our modern world view. A twenty-four hour workday is possible by means of automation and machinery. Although, where does this mindset leave the human(e) component of work in the modern age? Of what value is the physical presence of people in an increasingly computerized and mechanized environment? Today, through remote access and electronic networking, people are able to work from almost anywhere at any time. Technically speaking, physical proximity to the process of making is no longer a requirement; therein lies the paradox. What is the “process of making” if not involving direct interaction with what is being made? The meaning and learning from such acts are manifest through the physical process itself.

Why is it that children are so fascinated with the idea of making things? My children, being ages five and two, are full of energy and brimming with creative ideas, as all children are. Constantly rushing out to explore the world (neighborhood), or finding anything within reach that they can tie, glue, stick together, open, tear, or “beautify” with permanent marker, they are constantly learning by doing. There is no substitute for the understanding that is gained through such actions. I argue that there is equally as much to glean from the creative process as there is from the object being produced. The fluidity of concept, gradually becoming more refined, the open-endedness of myriad possibilities and configurations, spurs the innovative thinking that genuinely enriches life. Flexible and open-ended does not expressly mean generic and non-specific.

So too, the “generic” spaces in which we manufacture objects can become spaces in which we nurture the process, full of “specific” human experiences and life. The proposed design for the Kent ManufactureLAB is merely one of many possibilities that could be produced within the same framework. It would be expected that multiple variations could exist within the same facility, operating interdependently with one another. The spaces in which process occurs can and should accommodate the many different possibilities that are surely to be explored. There is no “one-size-fits-all” for people, process or place. Consequently the design of our built environment, at all levels, should follow suit.

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