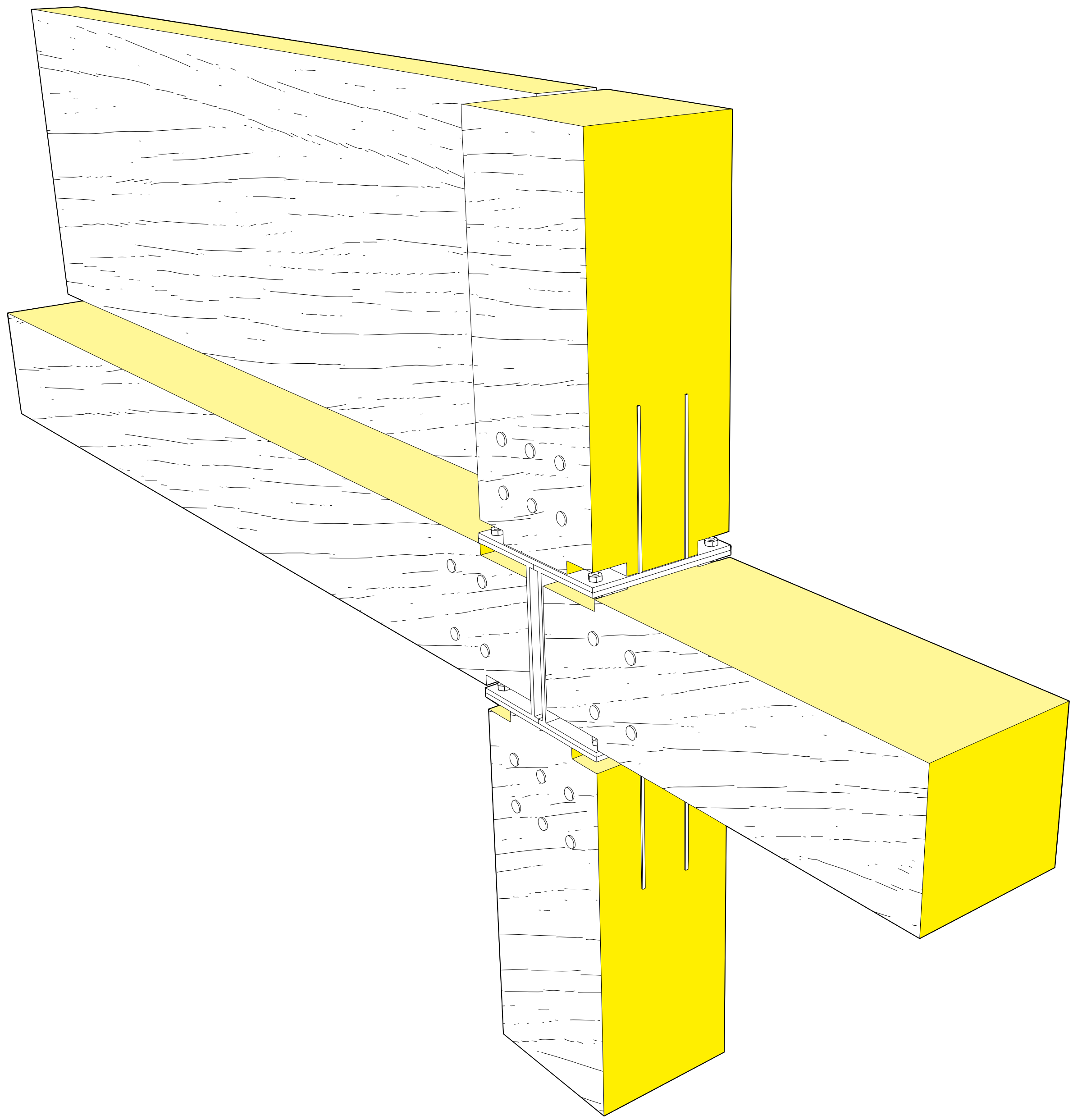


timber frame connection with structural timber in-fill panel

TIMBER CITY | WOOD TOWERS

mid-rise and high-rise construction in wood

EMERGING PROFESSIONALS TRAVEL SCHOLARSHIP | JOE MAYO


120

OPPOSITE PAGE: "*On the Spring Boards and in the Undercut. Washington bolt cutter and daughters, 1905*." by Darrius Kinsey

INTRODUCTION

In 1905 a small shop in the St. John's district of Portland, Oregon prepared for the World's Fair in honor of the 100th anniversary of Lewis and Clark's expedition. Gustav Carlson, the shop's owner, decided to laminate Northwest softwoods into a panel, which he called "3-ply veneer work." The product, a precursor of our modern plywood panel, sparked considerable interest at the fair, and soon after an industry was born [1].

Just as plywood revolutionized wood construction in the twentieth century, new innovations in wood stand to reshape our assumptions of this material in the twenty-first. In Europe thirty-story wood buildings are planned, and many mid-rise wood buildings have already been constructed within dense urban fabric. Technologies like Cross Laminated Timber and Brettstapel construction have been used to exploit the full potential of wood as a construction material.

The United States, however, has lagged behind as Europe continues to innovate and push the potential of wood construction in larger buildings.

In the Northwest wood is our vernacular. Wood is an extension of our forests and our forests are an extension of us. Wood is the natural choice for Seattle and I believe that it will be *the* material of the twenty-first century. It is unmatched in its environmental benefits, its availability, its ease of use and its beauty. It is time to learn from European examples of mid-rise and high-rise wood buildings.

A/E firms in Europe have overcome the structural and life-safety issues that limit height and areas of wood buildings. Codes are being re-written and new products are being developed. I believe now is the time to learn from the experience of these firms and become innovators ourselves. Researching modern mid-rise and high-rise wood buildings and their technologies is a natural choice for Seattle, and this is what I propose to do.

INNOVATION

Across Europe innovative new wood buildings are challenging conventional regulations and hold potential to define what true sustainable design and construction will look like in the future.

The tallest wood building currently planned is a thirty-floor tower of hybrid wood and concrete construction, the CREE (Creative Renewable Energy and Efficiency) in Dornbirn, Austria [2]. The project is designed to meet passive house standards, be carbon-neutral and energy positive (photovoltaic facade). This building is marketed as a prototype that can be exported to locations around the world.

The Barents Secretariat building, a seventeen-storey wooden cultural center in Kirkenes, Norway, designed by Oslo-based Reiulf Ramstad Architects, is also planned as a pilot project for innovative wood construction [3]. The building will house the Barents Secretariat as well as a library, a theater and space for artists, researchers and students. Not only will the building be a symbol for sustainable construction, it will also act as a "center for cooperation" between Russians, Finns, Swedes, Saamis and Norwegians [3].

Wood knits a common thread between the cultures.

Murray Grove, a nine storey residential building in Hoxton, London designed by Waugh Thistleton Architects has already been completed out of Cross Laminated Timber (CLT) [4]. Because of the panel's off-site fabrication and ease of use, the construction time was compressed from 66 weeks for a concrete building to 49 weeks. Not only this, but all the units were purchased after one hour and fifteen minutes of being on sale [4]. Waugh Thistleton's web site claims that there is 100 percent satisfaction among the tenants.

ABOVE LEFT: **The CREE's timber frame and timber concrete floor system** [2]

ABOVE: **Sequential diagrams of the CREE's modular construction** [2]

In addition to these projects, several six and seven-story timber buildings, many in rich urban settings such as Berlin and Zurich, have been completed.

Feilden Clegg Bradley Studio's Woodland Trust Headquarters in Grantham, UK uses wood in a completely new way by suspending precast concrete elements from a CLT roof structure. The two materials work in unison as a single structural element. The intermitent concrete panels provide thermal mass to regulate the building's internal temperature, while the CLT structure provides cost efficiency, meets environmental goals and is a beautiful finish material.

The advantages of using a natural, local, carbon-reducing material are abundant. Beyond the unique sensual appeal of wood, these buildings require fewer trades, reduce construction time, overall costs, and have the potential to be truly carbon-neutral if not carbon-negative.

In the midst of cascading environmental crisis, now is the time to re-examine wood construction as a sustainable material that, as proved by many European examples, can be used safely in high-rise and mid-rise urban applications, such as Seattle.

ABOVE LEFT: **The 17-story timber Barents Secretariat building** [3]

ABOVE CENTER: **The 9-story Murray Grove, London** [4]

ABOVE: **The 7-story Esmarchstrasse 3, inserted into the dense urban fabric of Berlin**

THE LOCAL GREEN

The Great Northwest is an environment rich in forests and timber. Our forested natural resources are indeed what most people imagine when speaking of the region.

The use of timber as a means of construction goes back to the native inhabitants of what is now Seattle, the Duwamish, who used timber and cedar planks to construct longhouses in their villages [5]. These seminal buildings were a true expression of the Northwest and stood in harmony with the environment. Later, lumber created the first boom in Seattle and Henry Yesler, with his steam-powered saw mill, became the city's first millionaire [5].

The history and mythology of timber and mighty trees runs deep here, and keeping this connection strong is part of Seattle's identity.

The Wood Materials & Engineering Laboratory at Washington State University in Pullman is an example of the deep connection between material and place. As one of the premiere laboratories for wood construction, the lab researches new ways of building with wood, as well as testing performance and design methodologies. Through innovation, wood can remain a vital part of our region's long history and tradition.

Wood is an emotive material. It roots us in place and soothes us. It has, as Matteo Thun describes, a "high-touch rather than high-tech quality." [7]

However, wood is not only sensually appealing, but also a material with enormous environmental benefits. In a total life cycle assessment of CO2 production, wood outperforms other common construction materials. See Chart 1 and Chart 2 for a comparison of CO2 emmissions for wood as compared with other building materials.

ABOVE: Reconstruction of Chinook-style cedar plankhouse at the Ridgefield National Wildlife Refuge [6]

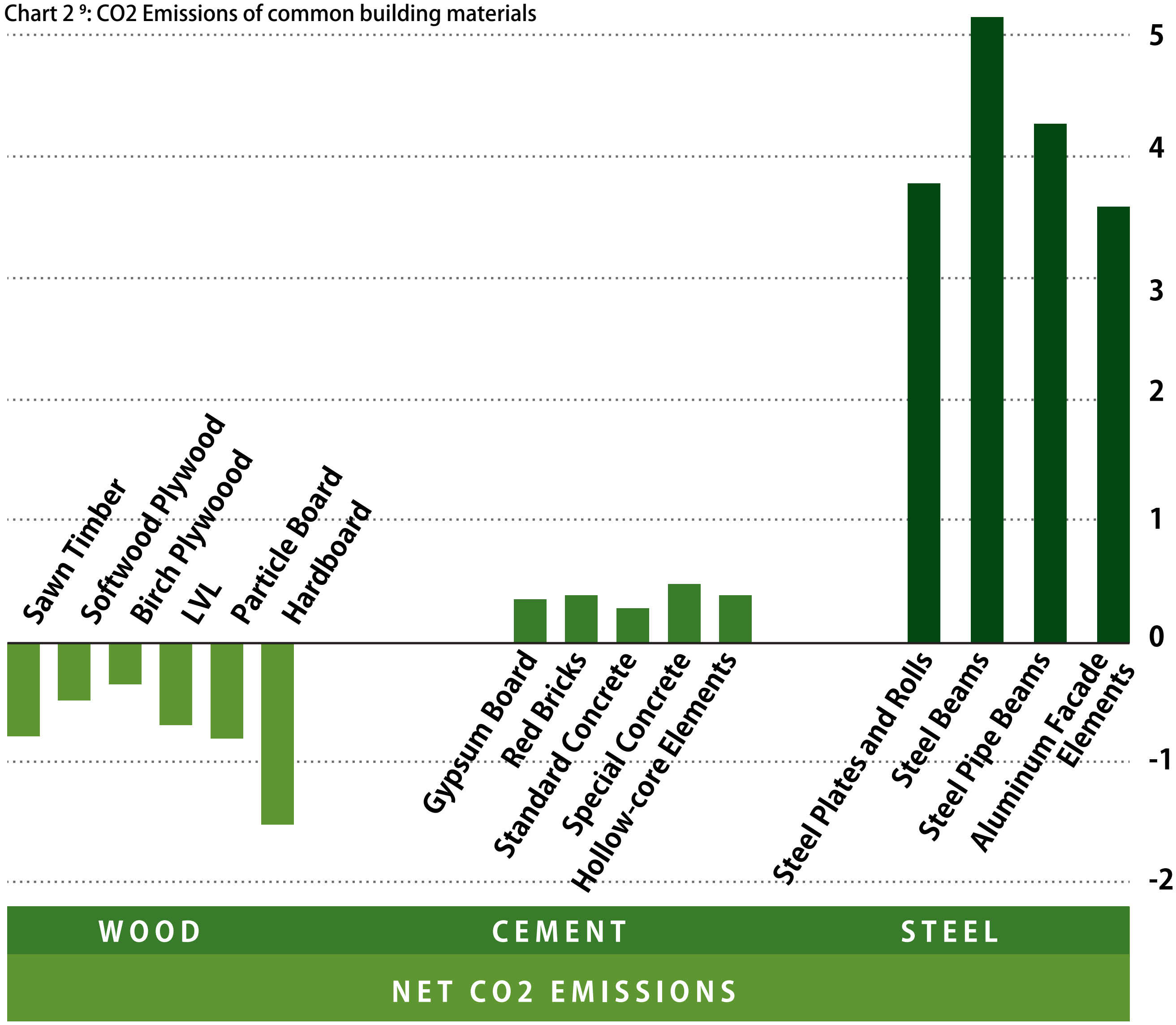
ABOVE LEFT: Washington's forests from Yellow Aster Butte

Chart 1 [8]: CO2 Emissions of steel and concrete compared to wood,
from CORRIM (Consortium for Research on Renewable Industrial Materials)

A life-cycle assessment summary for whole houses framed with wood, steel or concrete. The data are the total environmental impacts of steel or concrete compared to the wood option. From CORRIM.

Impact compared to wood...	Steel	Concrete
Embodied energy (GJ)	+17%	+16%
Global warming potential (CO2 kg)	+26%	+31%
Air emission index (index scale)	+14%	+23%
Water emission index (index scale)	+312%	0%
Solid waste (total kg)	-0.90%	+51%

Chart 2 [9]: CO2 Emissions of common building materials



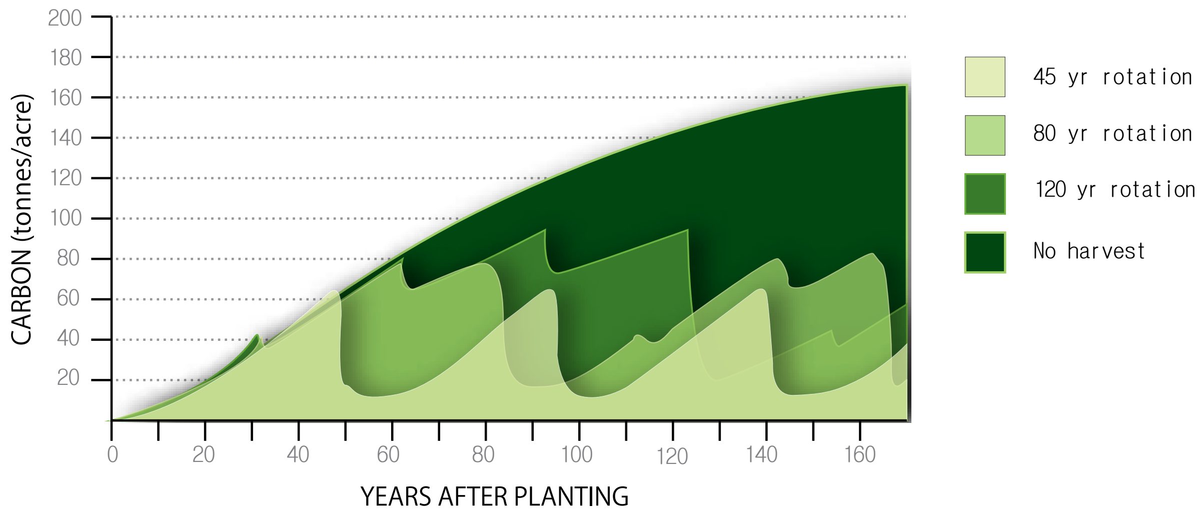


Chart 3: Various carbon sequestration potentials for Northwest Douglas Fir harvests [11]

To achieve carbon neutrality, wood can play a big role for several reasons. First, forests grow from light, soil, air and water, making the use of lumber one of the simplest solutions for construction material. No environmentally devastating mining or extraction processes are used with lumber, and with the continued growth of the Forest Stewardship Council (FSC) and sustainable forestry, the harvesting of timber is continuing to become more environmentally benign.

Wood comes from our forests which sequester carbon and help regulate the earth's natural systems. It has been shown that a pound of wood will sequester 1.47 pounds of carbon and replace it with 1.07 pounds of oxygen [10]. Moreover, when wood is converted to lumber products, it retains much of its carbon content rather than releasing it into the atmosphere [12]. Finally, at the end of its life cycle, wood can be returned to the earth as soil for new life or consumed as biomass for heating and energy.

The use of wood has a regenerative effect on the environment and is a true cradle-to-cradle material. In the face of deteriorating ecosystems, species collapse and global warming, wood's use in more building types must be further explored.

INDUSTRY

The Northwest has a history of wood as a means of construction, a work force skilled in its use, and an entire timber industry that benefits from its use and innovation. The Canadian Wood Council notes:

> *The potential for Cross Laminated Timber systems to compete with concrete and steel construction in North America is significant, most notably in mid-rise multi-family and specific non-residential low-rise construction projects in the short-term and mid-rise non-residential construction in the medium-term. This is due to many economic and building performance factors but also the increasing focus on environmental sustainability and related objectives of reducing the carbon footprint of buildings. Leading edge architects and engineers are already interested in utilizing CLT and it is important to find ways to maintain this enthusiasm and grow the momentum [13].*

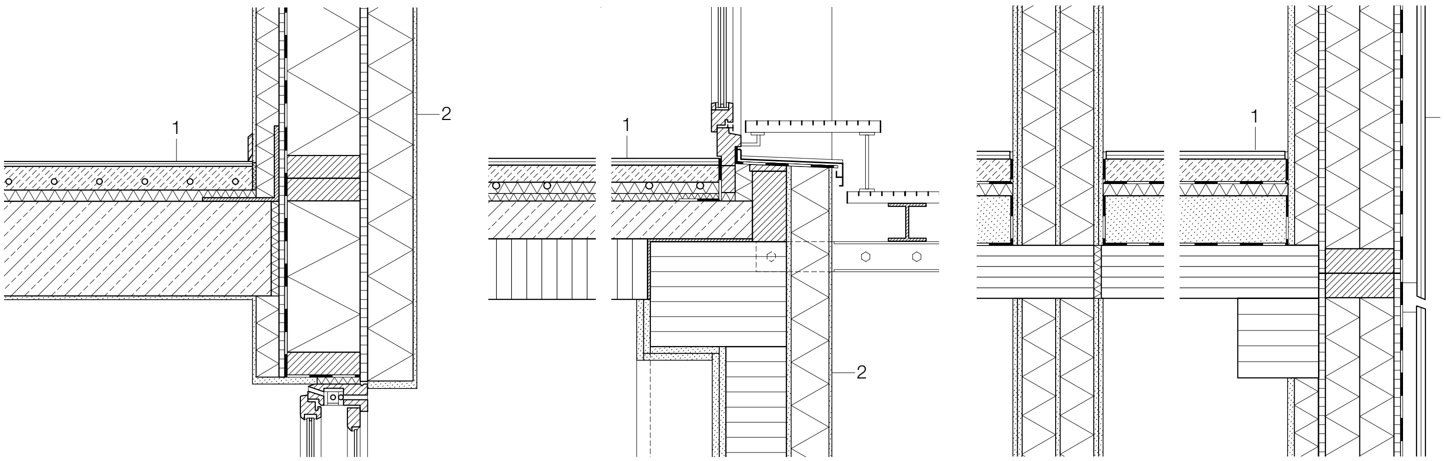
An established and plentiful building material, timber has great potential in larger building types. Architect Hermann Kaufman, the winner of the 2010 *Spirit of Nature Wood Architecture Award*, explains

Germany, Austria and Switzerland have all passed new regulations or are currently reviewing new laws, so that wood engineering is no longer at a disadvantage, while guaranteeing clients a high level of safety. Furthermore, modern methods of fire engineering allow for building even large complexes - such as residential, office or commercial buildings - exclusively of wood [14].

Seattle already has a tradition in hybrid wood and concrete mid-rise construction, but the city can go further. With the code allowing a maximum of five floors of wood construction over two floors of concrete, it is clear the city recognizes the importance of wood construction as a viable urban approach. However, what if we could build up to seven stories with no concrete plinth? What if we could safely build wood buildings taller than seven stories? What materials, technologies and testing would be required to acheive this? These are the type of questions that drive my research.

There is a cost savings and labor savings inherent with wood construction. These savings can be multiplied with the possibility of larger buildings, while benefiting the environment and creating jobs and new industry at the same time. Considering new imperatives like Cascadia's Living Building Challenge and Seattle's goal of being the first carbon-neutral city, it is a natural step to research new developments in wood construction and implement the best of these advances. This is what my travel scholarship work will address in detail.

ABOVE: **Cross Laminated Timber during construction**



RESEARCH TOPIC

The proposed topic of research is the use of wood construction in mid-rise and high-rise buildings. This research will focus on the following areas:

1. **Code Analysis**

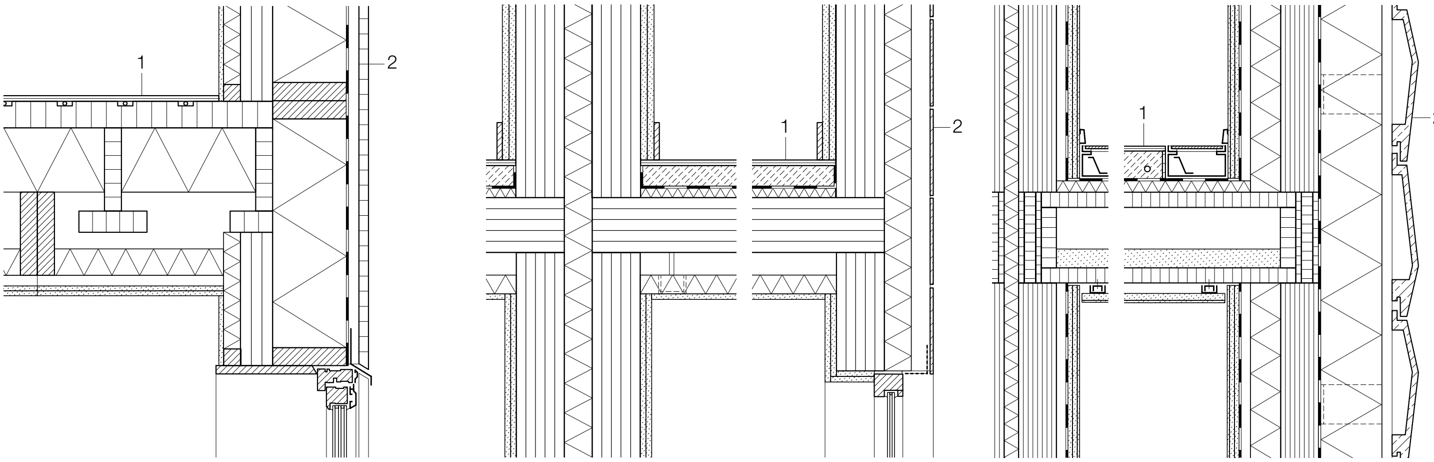
- Understand local and select international codes relating to wood construction and fire and life safety.
    - Assess current Seattle code regulations regarding maximum heights and areas for multistory residential, office and academic buildings of wood construction. This will entail a detailed analysis of the current Seattle code and meeting with Seattle code experts.
    - Assess codes for international cities (see itinerary) that have completed or are currently planning prototypical multi-story, all-timber buildings that, while failing to meet the Seattle code, have been successfully implemented in their city or region.

This will entail meeting with architects, engineers and local city code experts in foreign cities to understand:

a. The fire and life safety challenges of mid-rise/high-rise timber buildings

b. Technology and construction challenges of mid-rise/high-rise timber buildings

c. How these challenges were met (i.e., variances, new code amendments, testing of materials fire performance, etc.), and lessons learned



ABOVE: **Timber construction details for various European mid-rise projects** [7]

2. **Construction Technologies**

- Explore different wood construction types/hybrid construction types for mid-rise/high-rise timber buildings.
  - This will be accomplished through site visits of completed/planned projects, meeting with architects and other members of the building profession and visiting innovative timber manufacturing companies and research organizations (see itinerary).

3. **Catalogue of Details**

- Develop a set of typical details/ approaches for mid-rise/ high-rise wood construction that addresses fire safety and constructability.
  - These approaches will be framed by research and comparison of codes and construction technology (see items 1 and 2)
  - The catalogue will show a variety of timber precedents as well as highlight opportunities for Seattle.
  - This catalogue will be available as a pamphlet, web site and gallery show at the AIA Seattle office. Innovative timber materials/samples will also be showcased at the gallery.
  - This catalogue, available to the public, will be a resource to encourage the city to expand the current code, and provide the knowledge for architects and contractors to use innovative wood technologies to create more sustainable buildings.

PROPOSED ITINERARY

1. **Seatle to Pullman, WA**

- Wood Materials & Engineering Laboratory, WSU
  - Contact: Mike Wolcott, Distinguished Professor, Wood Materials and Engineering *

  Airfare: ~$150

1. **Seattle to London**

- Waugh Thistleton Architects (designers of Murray Grove)
- Techniker Structural Engineers (engineers of Murray Grove)
  - Contact: Matthew Wells, Techniker *

- Feilden Clegg Bradley Studios (architects of The Woodland Trust Headquarters)
  - Contact: Matt Vaudin, FCBStudios *

  Airfare: ~$1,000
  Hostel: ~$40/night for 4 nights
  Food: ~$50/day for 4 days

2. **London to Oslo**

- RRA-Reiulf Ramstad Arkitekter (designers of Barents Secretariat building)
  - Contact: Atle Leira, RRA *

  Airfare: ~$250
  Hostel: ~$40/night for 2 nights
  Food: ~$50/day for 4 days

ABOVE: **Forested land in the Northern Hemisphere** [14]

3. **Oslo to Berlin**

- Arup, Berlin (engineers of the CREE)
  - Contact: Jan Wurm and Tim Göckel, Timber Competence Team*
- Kaden Klingbeil Architects (designer of Esmarchstrasse 3 and others)
  - Contact: Jan Wurm's friend at Kaden Klingbeil *

Airfare: ~$300
Hostel: ~$40/night for 3 nights
Food: ~$50/day for 4 days

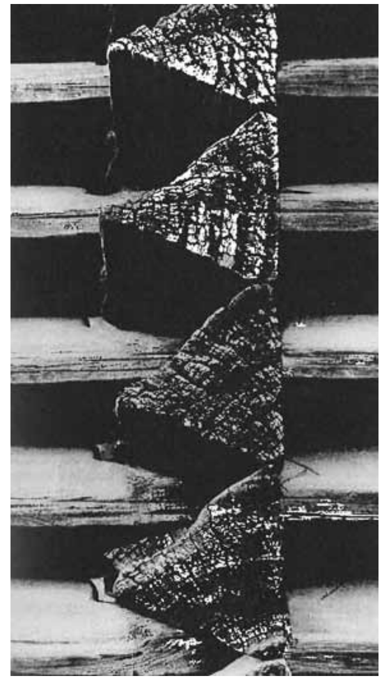
4. **Berlin to Austria**

- The CREE GmbH in Bregenz
- Hermann Kaufmann ZT GmbH in Schwarzach (designer of Cultural studios and others)
- KLH, Cross Laminated Timber and Timber products Manufacturer in Murau

Transportation: ~$60 per day for 4 days
Accommodations: ~$100/night for 3 nights
Food: ~$50/day for 4 days

Print 20 copies of Catalogue of Details: ~$500
Materials for gallery show: ~$200
Estimated total cost: ~$4,000

* *See Appendix for e-mail correspondence*

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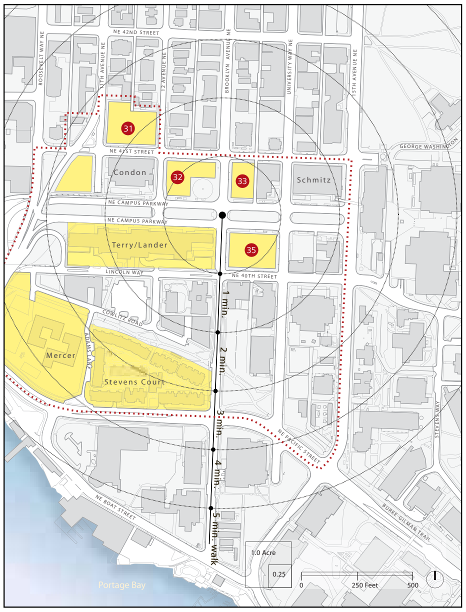
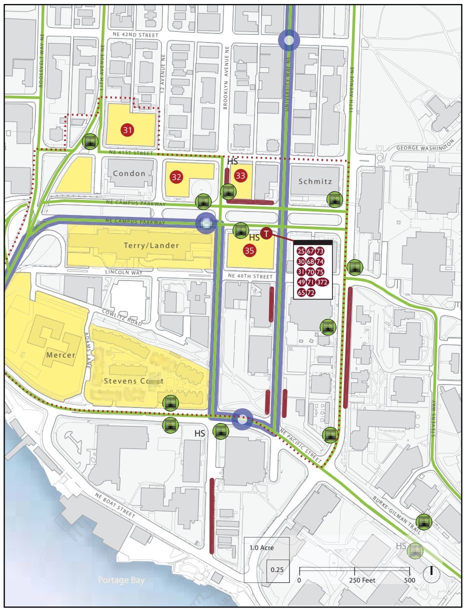
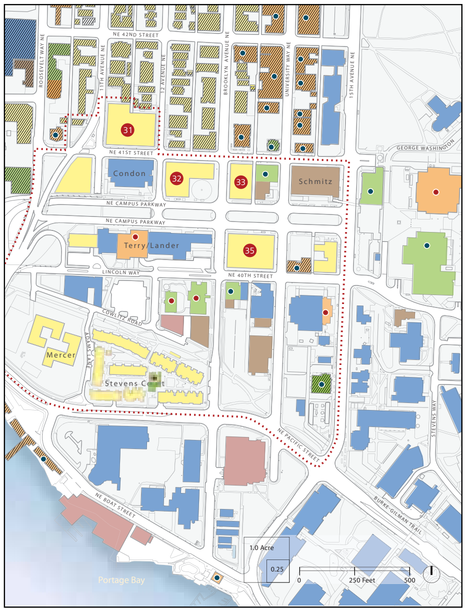
WORK IMAGES >

Welded steel
structure, 2009







University of Washington Student Housing Phase I, Mahlum

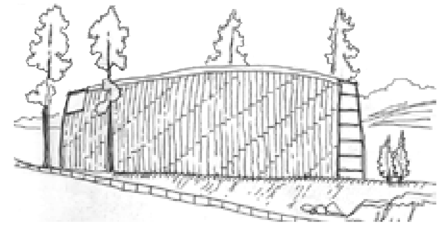
Above are urban planning diagrams and building renderings. I worked on all phases of this project and spent a great deal of time exploring building massing, materiality, facade composition, interior planning and interior details.

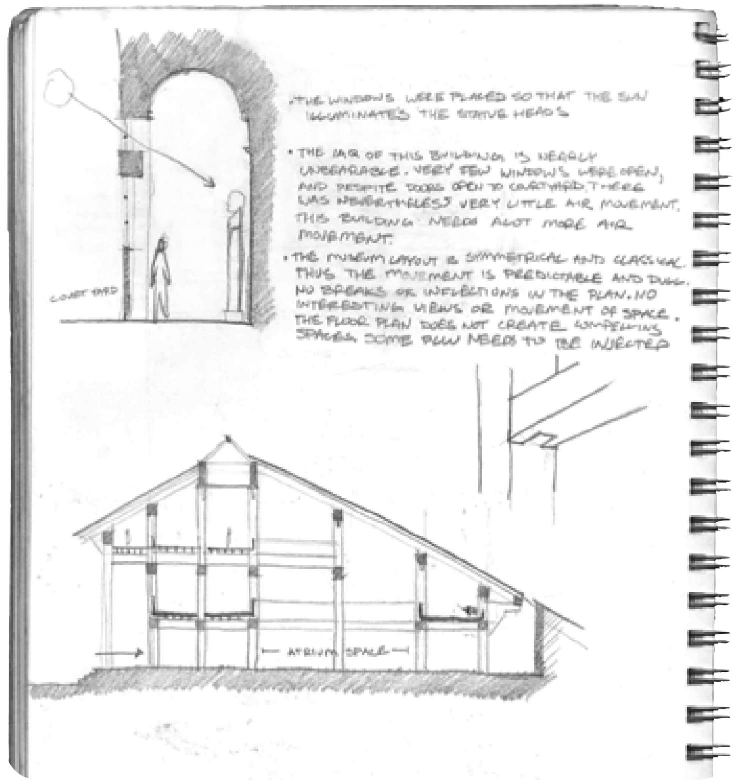
- The four buildings of the project are five stories of wood construction over two stories of concrete, otherwise known as "The Seattle Special." There is a strong presence of this building type in Seattle. What might the future hold for innovations with this building type?

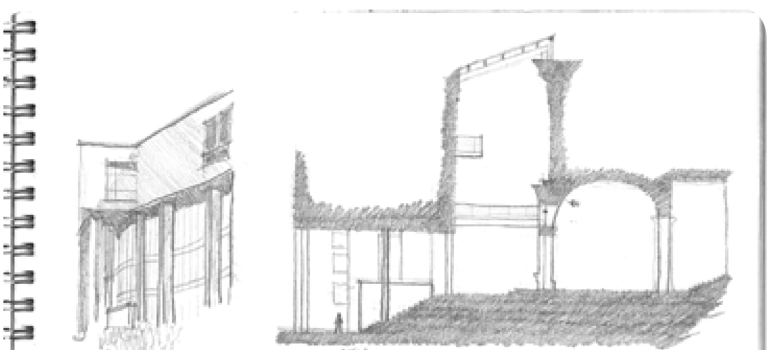

LA SCARPA

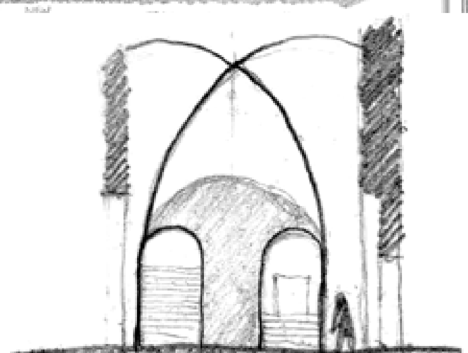
Editor for the School of Architecture and Allied Arts, University of Oregon

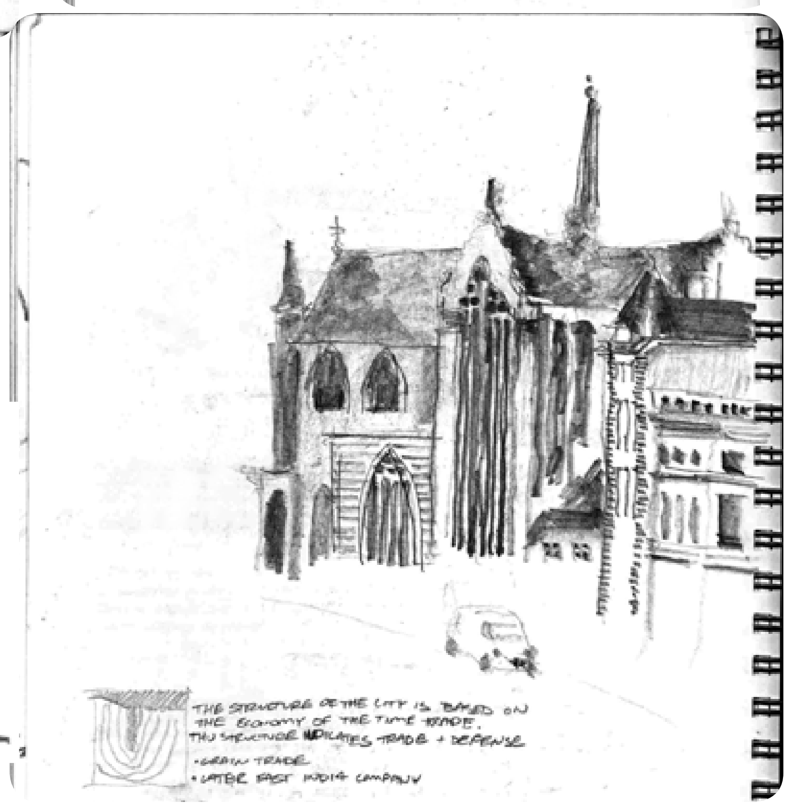
I have a love of all things graphic, and especially love the opportunity to combine images with words. I think this is extremely powerful. This position taught me about organizing space on the page, balancing words, images and content.





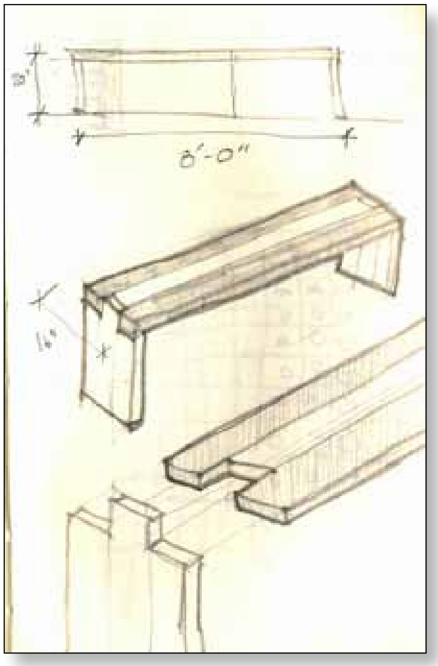


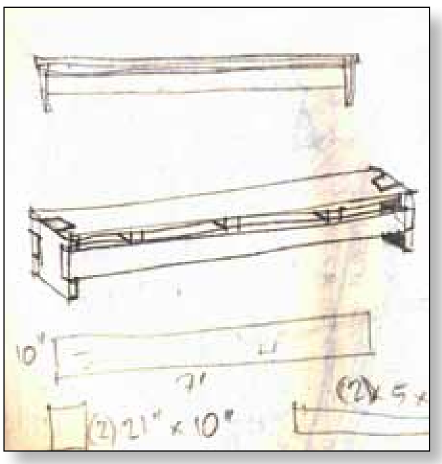




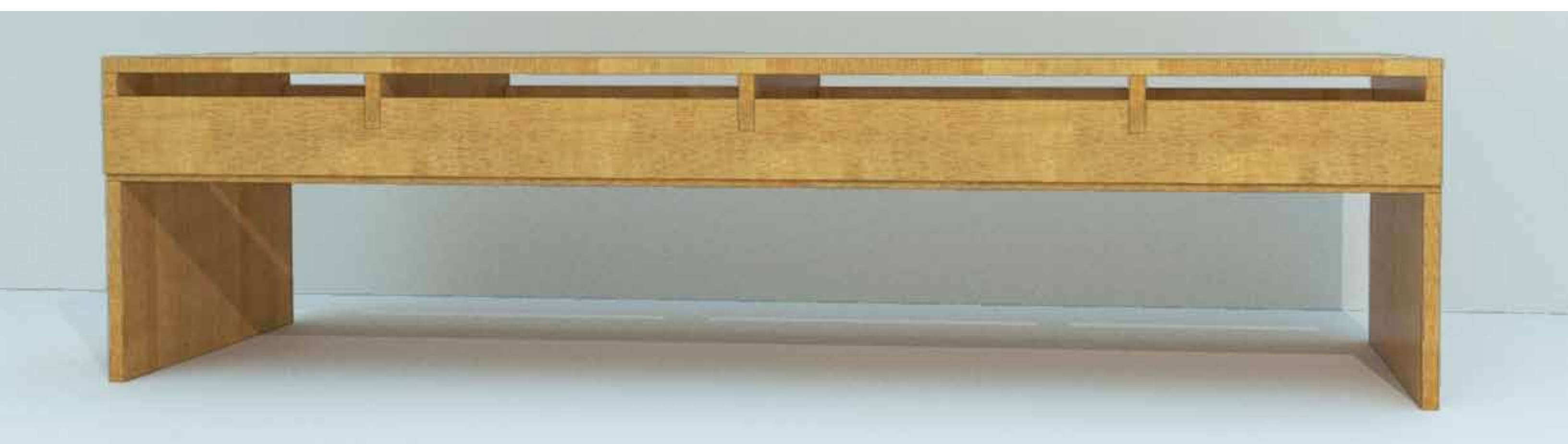
Sketchbook, Europe 2006

There is no better way to learn to see than to sketch what is around us. These sketches are from Scandanavia and the Netherlands.





Welded steel table with birch/beech top, 2009

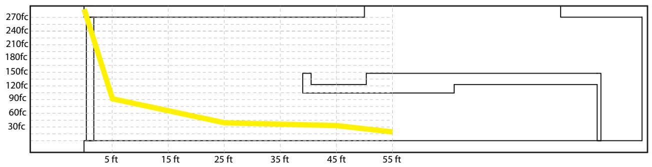


Above: Concept sketches and rendering for table currently under construction, red oak, 2010

Metal and Woodworking, Pratt and Wood Construction Center

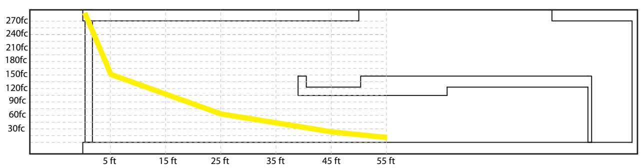
In my free time I've been experimenting with materials and how to work with them with my hands. Although still a beginner, there is a sense of calm and peace when I'm in the shop. Very different than sitting in front of a computer. Hopefully these pieces are just a modest beginning to a real understanding of craft.

Test 1: Light Shelves

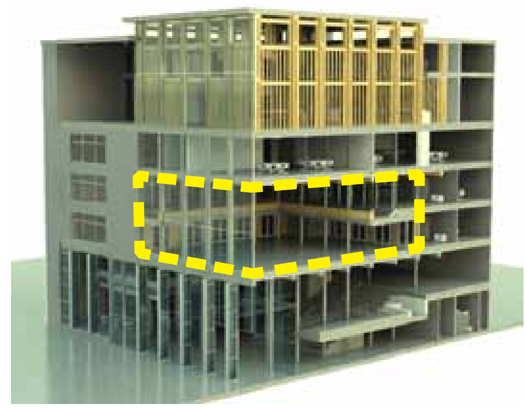


Section through room showing daylight levels in footcandles

Test 2: Medium Density Louvers + Fins

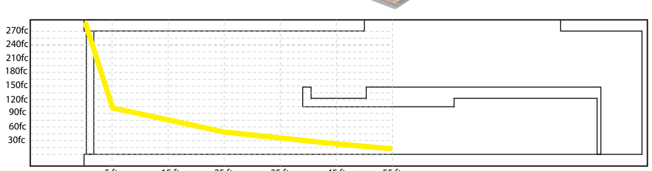


Section through room showing daylight levels in footcandles

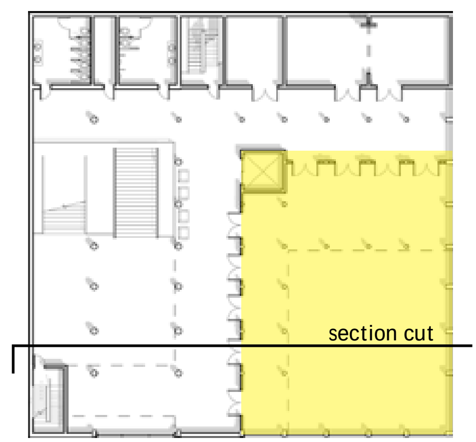


Section showing space studied

Test 3: High Density Louvers + Fins



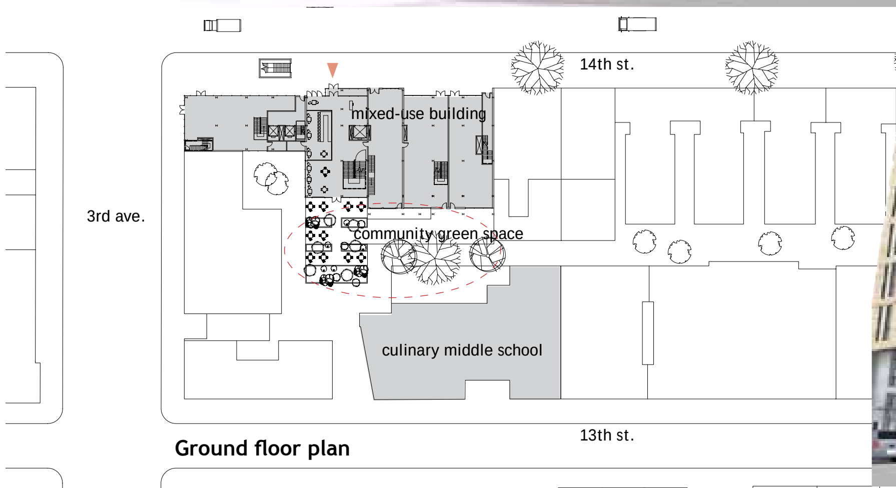
Section through room showing daylight levels in footcandles



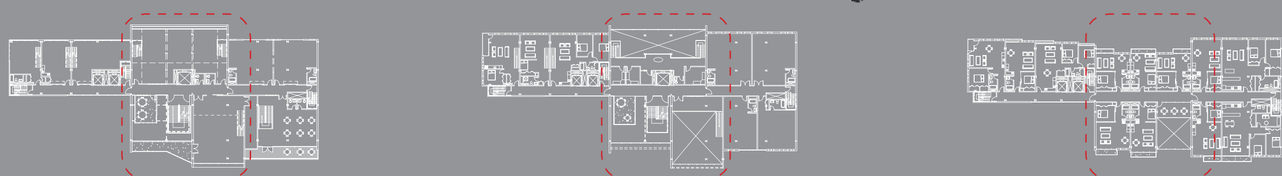
Plan showing where daylight section is cut

Daylight Research, University of Oregon's Baker Lighting Lab

This research looked at how to shade large portions of glass on the south and east facades of a studio project. Daylighting tests used 1/4" physical model placed inside Baker Lighting Lab's artificial sky. The artificial sky mimics the sky under overcast conditions. Light sensors are placed inside the model at various points to obtain daylight factors for points within the room. The amount of daylight is then plotted sectionally across the room.



Ground floor plan



Level 2 Level 3 Level 7

Terminal Studio, Howard Davis, University of Oregon

This project, mixed <use> greens, is a mixed-use building in the lower east side of New York City. "Community" framed preliminary design discussions, such as how do public and private spaces interact and how far can the public penetrate into a building that is both public and private? Acting as a continuation of 14th street,

Cross Section

the public is invited to participate in the first five levels of the building. The central portion of the building contains common community work spaces and are flanked by live/work apartments. The concept is to stimulate interaction between the inhabitants of the building and those who work there. A true mixed-use building.