Daylighting Lab Operation and Management Plan

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Report

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1.0 Abstract

This paper documents the BetterBricks Daylighting Labs of the Pacific Northwest (PNW Labs). The PNW Labs are a nationally recognized model for regional daylighting lab operation and design market transformation. Operating models of significant PNW Labs are documented in order to serve as a blueprint for those public or private entities seeking to develop and operate a local or regional daylighting resource center. The paper also articulates a step-by-step process to develop and implement services with the mission of transforming regional market demand for high-value, high-performance building design founded upon sound daylighting principles.

The PNW Daylighting Labs have been tremendously successful in promoting daylighting design and consulting with design teams to be sure that buildings perform to their potential with regard to space comfort and energy savings. Two independent reports of the affects of the PNW Daylighting Labs indicate that the labs are "…helping architects to produce better daylit buildings…" while these "…buildings seem likely to have better lighting quality, better envelope efficiency, and [are] more cost-effective..."[1]

The full range of services including project consultation and general education and training are also detailed by this report. A combination of project based education, conventionally described as consultation, as well as more general program trainings and workshops build credibility and long term relationships between design teams and a daylighting lab. The education and training activities of the daylighting labs and the other BetterBricks advising services are reported as affecting the design practices of 82% of participants according to a 2005 survey.[2]

The regional energy impact of daylighting labs can be observed by looking into the financial analysis of case studies highlighted at www.BetterBricks.com – Success Stories. Here, the average total building energy performance of these selected projects is approximately 30% better than a code baseline. If isolating electric lighting savings, this number can climb upwards of 40% in well daylit spaces with integrated lighting controls.

A regional daylighting lab plays an important and otherwise unfulfilled role within a design community. The Pacific Northwest Daylighting Lab Network provides the most successful model for promoting and assisting in the effective implementation of energy efficiency through design assistance, daylighting education and integrated design services and research.

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[1] *Lighting Design Lab – Market Progress Evaluation Report, No.4,* Energy Market Innovations, Inc., April, 2003, pg 58.

[2] *BetterBricks Training and Advising Services – Market Progress Evaluation Report,* Research Into Action, Inc. May, 2005, pg III Executive Summary.

2.0 Background

2.1 Definitions / Acronyms

BetterBricks – BetterBricks is the brand name for the Commercial Sector Initiative (CSI) of the Northwest Energy Efficiency Alliance (Alliance). The Alliance manages conservation dollars for the major utilities in Washington, Oregon, Idaho and Montana. It is also a shared funding agency for all of the Pacific Northwest Daylighting Labs (PNW Labs).

IDL – Integrated Design Lab – Boise, ID
Managed by the University of Idaho – Department of Architecture.

UW Lab - BetterBricks Daylighting Lab – Seattle, WA
The daylighting lab in Seattle managed by the University of Washington - Department of Architecture.

LDL – Lighting Design Lab – Seattle, WA
The LDL is funded by NEEA / BetterBricks and Seattle City Light, the electric utility in Seattle, and is also managed by Seattle City Light..

PNW Labs - Pacific Northwest Daylighting Labs / also referred to as the Lab Network consists of the Daylighting and Integrated Design Labs managed by the University of Washington, University of Oregon, University of Idaho, Washington State University and Montana State University. These Labs share a common funding source in the Northwest Energy Efficiency Alliance – BetterBricks program while each lab also maintains additional independent funding.

Overcast Sky Simulator – The overcast skybox / simulator is a tool used by daylighting labs to predict amount, distribution and intensity of daylight available in any given space based upon analysis of a physical architectural model. The tool is usually a cube with roughly 8' – 10' dimensions that uses a dense array of lineal fluorescent electric lights passing through a translucent diffusing membrane and infinitely reflected by mirrors to simulate the international illumination standard of brightness distribution for an overcast sky. The CIE sky standard is to have a brightness ratio 3 times as intense at the zenith than at the horizon. An overcast skybox is a close approximation of this distribution.

The tool can be used both qualitatively with photography and quantitatively with light sensitive dataloggers. The tool is often used during schematic design and design development to make architectural decisions about glazing size, type and location as well as interior color treatments, interior partition heights, window wall to core depths, window shading elements and other light modifying surfaces.

Heliodon – The heliodon is a tool used by daylighting labs to predict the amount and distribution of solar penetration in any given space based upon analysis of a physical architectural model. The

tool is typically a table roughly 3' square that has tri-directional motion to simulate time of year, time of day, and place on earth.

The tool is used qualitatively in conjunction with a bright electric light source and can be used both qualitatively and quantitatively in conjunction with the actual sun as a light source. The tool is often used during schematic design and design development to make architectural decisions about glazing size, type and location as well as interior partition heights, window shading elements and other light modifying surfaces.

2.2 Introduction

The goal of this project was to develop a physical document to assist in the creation and development of regional daylighting labs in the United States. In process toward that goal, a review and summary of the business models and activities of the Pacific Northwest Daylighting Lab Network was conducted. This document serves to outline the PNW Labs' history, funding structure, collaborative associations, and operating procedures for research and outreach.

A panel of national daylighting expert practitioners was convened to review the operations of the PNW Daylighting Labs. This occurred in Seattle, WA at the BetterBricks Daylighting Lab managed by the University of Washington Department of Architecture and co-located with the Lighting Design Lab on July 21-22 2005. This daylighting working group meeting attendance, agenda and summary are included for reference in section 3 of this paper. This exercise served to verify that the daylighting metrics, methods and facilities of the PNW Labs' are generally approved of by the national daylighting working group.

The daylighting labs in the Pacific Northwest each maintain a slightly different focus on the daylighting and integrated design process. They are decidedly the most active daylighting lab network in the United States and each can serve as excellent examples for individuals seeking to develop a lab in their region. This paper focuses on two representative labs of the PNW Lab Network. The University of Washington Lab is funded at the highest level of any of the PNW Labs while the University of Idaho Lab is younger and operates at a lower capacity. These two lab business models serve to give a good representation of the PNW Lab Network.

Due to historic university connections, the national reputation and influence of the PNW Lab Network and the success of daylighting labs funded by BetterBricks, the authors are familiar with several organizations across the United States whose efforts to develop a regional daylighting lab have become waylaid by any of several road blocks. These roadblocks revolve primarily around an inability to secure the first major piece of funding that will allow for the birth and growth of a daylighting lab. Securing funding can only happen with good background information.

This document clearly identifies a set of daylighting lab business models based upon varying funding levels, provides a tailored list of services to match each funding level and outlines research to indicate regional energy impacts associated with daylighting lab services. It goes further to

provide specific budgets, service descriptions, an example scope of work / contract agreement, plans and contact information for technical equipment and space plans.

This paper concludes with contact information for several regional labs or consultative entities that can provide further reference for groups seeking to establish a regional daylighting lab.

2.3 Answers to Common Questions

What is a daylit building?

The methods used to determine whether a building is well daylit are varied and complex and the topic of much debate. The definition offered by the authors is a building that uses daylight as its primary source of illumination. These spaces are more comfortable and productive for people because they minimize glare and provide a good connection to the outdoors. Daylit buildings are more energy efficient because they use little or no electric lighting during daylight hours and have been carefully designed to minimize envelope loads and subsequent heat gain.

What is a daylighting lab?

A daylighting lab is a facility, often associated with a university or utility where design professionals can receive expert services in the creation of well daylit buildings. The definition of a daylighting lab is continually evolving toward efforts better described as an integrated design lab. Budgets and expertise drive where the particular lab falls on this spectrum.

Why is daylight important for users and owners of buildings?

This paper does not attempt to cover this area of research. There are countless research examples documenting the benefits of daylighting to worker productivity, student test scores, reduced absenteeism, improved user health recovery rates, and the reduction of energy use in buildings.

What is integrated energy design?

In the creation of the built environment, the goal of an integrated energy design process is the synthesis of a project's climate, use, loads and systems resulting in a more energy efficient building than current best practices.

What is the difference between a daylighting lab and an integrated design lab?

An integrated design lab is simply an evolution of a daylighting lab. Typically, integrated design lab services build upon those offered by a daylighting lab. At the most basic level, an integrated design lab makes sure that the design project takes the most advantage of the daylighting services offered by making recommendations and reviewing the overlap daylighting design has on electric lighting and HVAC systems.

What is the role of daylighting in integrated energy design?

Good daylighting design is the foundation for integrated energy design and high performance & sustainable building design.

Why build a Daylighting Lab?

Good daylighting design brings diffuse ambient daylight into a building, minimizes excessive heat gain and glare, while still accomplishing the bulk of the ambient lighting requirement for the building. This demands a high level understating of an extremely variable set of sky and weather conditions, building use patterns and design methodologies. Good daylighting design requires testing based upon a solid understanding of the above variables as they are applied to each project. The necessary skills, tools and time required to accomplish this analytical evaluation of daylighting design necessitates an independent daylighting lab.

What is the role of a daylighting lab in a design community?

A daylighting lab serves to connect owners, developers, architects, engineers and the construction trades with the information necessary to design, build and manage better daylit buildings. This is best accomplished through project specific education and training.

Who typically directs a daylighting lab?

In the case of the PNW Labs, all are directed by university faculty. These faculty range in positions from the adjunct level to full professorships in the departments of architecture at the individual universities. The other most common model for a daylighting lab is one that is managed by an electric utility and directed by the utility's staff. The least common is a fully functional daylighting lab that is a private company.

Why are universities a good home for daylighting labs?

The design community can easily accept a university as a place of education and research. The university can bring credibility to the lab as well as providing additional capabilities to achieve more grant related activities. The lab staff can participate in the pedagogy of the university and positively impact the next generation of designers in areas of daylighting, lighting and energy consciousness. The university also serves to provide administration support for the activities of the lab and further supports the lab through direct salary expenses for all or part of lab staff. The labs fit well into a university's mission for outreach and continuing education.

Should a daylighting lab associated with a university be on or off campus?

Ideally, the daylighting lab has a presence downtown with its constituents. It is also beneficial if university curriculum can be taught at the lab so that there is integration with the university student body at large.

The PNW Labs vary in location as follows:

The University of Washington Lab is located off campus downtown – university classes are taught at the lab. Washington State University manages a lab in Spokane that is located near downtown in the architecture building within the satellite campus. The University of Oregon manages a lab on campus in Eugene and in the Portland satellite campus building in downtown Portland. Idaho's Lab is managed by the University of Idaho and is located off campus in downtown Boise with university curriculum taught at the Lab. Montana's Lab is located on campus in Bozeman with Montana State.

What is the role of a demand side management utility program in the operation of a daylighting lab?

Demand side management programs can serve to reinforce and supplement the efforts of a daylighting lab through directed incentives for offsetting the cost of daylighting and electric lighting integration technologies. This is often a flat rate per kilo-watt/hour of load reduction paid per square-foot/year of affected space. (such as $0.20 / kWh / SF-Year) A modestly daylit space with automated electric lighting controls might yield ~ 2.0 kWh / SF*Year in electric savings. For a 20,000 SF buildings this would mean a capital payout of [20,000 SF * (2.0 kWh/SF*Year) * $0.20] = $8,000 to help buy down the cost of lighting controls, dimming ballasts and in some cases the daylighting system by electric utilities to building owners.

3.0 Daylighting Forum Peer Review

3.1 Overview

A panel of national daylighting expert practitioners was convened to review the operations of the PNW daylighting labs in July, 2005. Three representative labs (University of Oregon - Energy Studies in Buildings Laboratory, UW BBDL-Seattle and UI IDL-Boise) each made a 30 minute presentation of their lab's approach to daylighting measurement metrics, testing and analysis methodologies, equipment and facility overview, and ended with a few recent case studies. The expert panel then discussed areas of interest or concern focusing on each lab for an additional 30 minutes. This exercise served to verify that the daylighting metrics, methods and facilities of the PNW Labs' are generally approved of by the national Daylighting Working Group.

3.2 Attendance List

#	Organization	Name	Attended
1	BetterBricks / Konstrukt	Jeff Cole	Yes
2	California Energy Commission	Michael Seaman	Teleconference
3	California Lighting Technology Center (UC_Davis)	Don Aumann	Yes
4	Heshong Mahone Group	John McHugh	Yes
5	Heshong Mahone Group	Lisa Heschong	Teleconference
6	Institute of Energy and Sustainable Development	Dr. John Mardaljevic	Teleconference
7	Loisos + Ubbelohde	George Loisos	Yes
8	Loisos + Ubbelohde	Susan Ubbelohde	Yes
9	Montana State University	Tom Wood	Yes
10	National Research Council of Canada	Christoph Reinhart	Teleconference
11	PG&E Pacific Energy Center	Robert Marcial	Yes
12	PG&E Pacific Energy Center	Bill Burke	Yes
13	GreenForm	Christine Magar	Yes
14	Southern California Edison	Vireak Ly	No
15	Southern California Edison	Greg Sharp	Yes
16	The Weidt Group	Tom McDougall	Yes
17	The Weidt Group	Prasad Vaidya	Yes
18	The Weidt Group	David Ehjadi	Yes
19	University of Idaho	Ethan O'Brien	Yes
20	University of Idaho	Kevin Van Den Wymelenberg	Yes
21	University of Michigan	Mojtaba (Moji) Navvab	Teleconference
22	University of North Carolina - Charlotte	Dale Brentrup	Yes
23	University of Oregon	Terry Blomquist	Yes
24	University of Oregon	G.Z. Brown	Yes
25	University of Washington	Joel Loveland	Yes
26	University of Washington	Chris Meek	Yes
27	University of Washington	Clara Simon	Yes
28	University of Wisconsin - Milwaukee	Jim Wasley	Yes
29	Washington State University	Judy Theodorson	Yes
30	Washington State University	Ronda Mohr	No
	Part of Pacific Northwest Lab Network		
	Peer Review		

Fig. 01

3.3 AGENDA

This peer review opportunity was leveraged into a two day event where daylighting metrics, methods and facilities were then opened up for more detailed discussion. Results to follow.

Daylighting Forum - Seattle - July 21st and 22nd, 2005

The University of Idaho - Integrated Design Lab and the University of Washington - BetterBricks Daylighting Lab are compiling a working plan for the operation of new regional daylighting labs as well as developing materials to assist in the creation of new regional labs. We also see this as an opportunity for peer review of the work of the BetterBricks Daylighting Lab Network and a chance to share ideas, practices, and further develop relationships between our various labs and consultative practices. Three areas of focus are planned. 1. Metrics 2. Methods 3. Facilities

Agenda:

Thursday PM Session, July 21st:

12:00 PM - Introductions - Purpose / Goals

Show & Tell (Metrics, Methods and Facilities)
Seattle, Portland and Boise presentations limited to 30 minutes with 30 minutes for Q&A to follow.

1:00 PM - Seattle - BetterBricks Daylighting Lab Presentation / Q&A - Joel Loveland / Chris Meek - UW
2:00 PM - Portland/Eugene ESBL Lab Presentation / Q&A - Charlie Brown - UO
3:00 PM - Boise Integrated Design Lab Presentation / Q&A - Kevin Van Den Wymelenberg - UI

4:00PM - Break & Tour of Seattle Lab

*4:30 PM - Invited Presentation Regarding State of the States (CA, WA, OR) - Presented by Lisa Heschong***
*5:00 PM - Discussion on State of the States - Facilitated Session***

6:30 PM - Break For Arranged Dinner - - Location TBA
7:00 PM - Open forum for Presentations During and After Dinner
(Request time slot ahead of time- 20 to 30 minutes)

Friday AM Session - July 22nd:

8:00 AM - Coffee & Danish

8:30 AM - Metrics for Daylighting - Facilitated Discussion Session
9:30 AM - Methods for Daylight Modeling and Consultation - Facilitated Discussion Session
10:30 AM - Facilities for Daylighting - Facilitated Discussion Session
11:30 AM - Topics for the Future

*** Tentative Session*

INTEGRATED idl DESIGN LAB

BETTERBRICKS University of Idaho

Fig. 02

3.4 Significant Outcomes

- Regional daylighting labs are necessary to bring the credibility of an institution to the concepts of daylighting and to house the tools, software and expertise necessary to design quality daylighting.
- Daylighting labs should establish clear goals with funding agencies as their efforts and services relate to market penetration / transformation.
- University managed daylighting labs do not pose a significant threat to private entities because these groups are generally working with different caliber of clients. Daylighting labs are also seen as building a market demand for private sector.
- Daylighting labs should be in highly visible location and very accessible to architects.
- Lab space, tools and equipment should be very professional and well designed to build respect and trust of design community.
- This peer review panel verified that the daylighting metrics, methods and facilities of the PNW Labs are in accordance with the state of the art in the industry and serve to provide an excellent example for regional daylighting labs under development.
- Any daylighting lab must have physical modeling capabilities.
- Any daylighting lab must have a calibrated overcast sky simulator.
- Any daylighting lab must expect that funding agencies will require sound estimates for potential energy savings.
- The most important prerequisite for the development of a daylighting lab is having a qualified person or persons directing and performing the lab's activities. Based upon those attending the forum and their familiarity with particular cities a discussion lead to several locations where the absence of a daylighting lab is obvious and perceived to be desired. This is by no means an exhaustive list – it simply reflects the feelings of those members of the DWG present at the forum.
    - Milwaukee, Wisconsin
    - Minneapolis, Minnesota
    - Los Angeles, California
    - Washington, DC
    - New York, New York
    - Phoenix, Arizona
    - Atlanta, Georgia
- The second most significant prerequisite for identifying where a daylighting lab will work is to consider the electric utility market – specifically the source for electric generation, cost of generation, and electric demand growth rate. Then consider the short vs. long term expectations for demand side market impact of the prospective funding group.
- Boise, ID is a relatively small city with a conservative design community. Its developers demand low first cost driven construction and a very short timeline from design to construction and occupancy. It also has one of the nation's most inexpensive electric power supplies. Despite these perceived challenges, daylighting lab services are in high demand. Essentially, "Build it and they will come…"
- The DWG decided that follow-up meetings are necessary in order to continue to develop areas of daylighting metrics, methods and facilities further. This is especially true regarding metrics for measuring how well daylit a building is to avoid "greenwashing."

4.0 Regional Impacts of Daylighting Labs

4.1 Introduction

The impact of a daylighting lab in a design community can be significant. This impact is best assessed by researching buildings that the labs have consulted upon and speaking with the design teams that have utilized the lab's resources. By looking at the financial analysis of the case studies highlighted at www.BetterBricks.com – Success Stories – the average total building energy performance of these selected projects is approximately 30% better than a code baseline. If isolating electric lighting savings, this number can climb upwards of 40% in well daylit spaces with integrated lighting controls.

In speaking with one Senior Manager of a national grocery chain of the working relationship with the daylighting labs in October of 2005, this was offered; "The skylighting work preformed by the Daylighting Lab made us change the way we do business" - Senior Manager, Mechanical Systems Prototype Criteria / Design Group – national grocery store chain.

To answer the question 'is a daylighting lab influential to building design?' Definitely, on a project consultation by the IDL in Boise with the College of Southern Idaho for their new student recreation building, a daylighting model was completed by CTA architects and studied by the IDL. The photographic and measured results comparing the gymnasium with a skylighting design versus the space with no skylights was enough to convince the owners to incorporate the skylights. They indicated the difference was "night and day."

Similar anecdotal references are plentiful in speaking with any of the PNW Lab directors. These anecdotal findings of the regional impacts of the PNW daylighting lab network are further corroborated by the market research conducted by Energy Market Innovations in 2003, and Research into Action in 2005. A summary of each paper is included in the following pages with the full reports available for download at www.nwalliance.org

4.2 Market Progress Evaluation Summary - 2003 EMI

Lighting Design Lab – Market Progress Evaluation Report, No.4
by: Energy Market Innovations, Inc., April, 2003, 79 pages.

Full report available for download at www.nwalliance.org

The executive summary states that design teams using the daylighting lab are very happy with the services offered and claim that "better quality daylighting projects are resulting than would have resulted in the absence of the program." (EMI 2003 – pg3)

A telephone survey of 90 participants of daylighting lab consultations indicated that 79% of the time daylighting was a significant component of project consulted upon and that 76% of those interviewed indicated that the daylighting lab consultation was influential to the end design. (EMI 2003 – ppg 40-44)

The telephone survey states that those respondents who indicated the daylighting lab had an influence on the building project describe the influence in three categories as follows: (EMI 2003 - ppg 50-53)

Daylighting Lab Influence on:	Respondents who indicated an influence
Choice of Daylighting System	20%
Development of Daylighting System	**77%**
Electric Lighting	20%

Fig. 03

The EMI conclusions state, "The Daylighting Lab is helping architects to produce better daylit buildings. The resulting buildings seem likely to have better lighting quality, better envelope efficiency, and more cost-effective use of resources."

(EMI 2003 – pg 58)

4.3 Market Progress Evaluation Summary - 2005 RIA

BetterBricks Training and Advising Services – Market Progress Evaluation Report
by: Research Into Action, Inc. May, 2005, 191 pages.

Available for download at www.nwalliance.org

A telephone survey of 115 individual architects, owners and engineers, including 70 participants of daylighting lab advising services in a 2005 RIA telephone survey indicate the daylighting labs had a substantial effect on the consulted project for 83% of respondents. (RIA 2005 – Executive Summary pg. II)

The education and training activities of the of the daylighting labs and the other BetterBricks advising services are reported as affecting the design practices of 82% of participants with 53% indicating they had already applied the information received to specific projects. (RIA 2005 – Executive Summary pg. III)

The type of affect that daylighting lab consultation had on projects is described by respondents in the following categories: (RIA 2005 – pg. 97)

How did the Advice Change the Project? (each respondent could only select one)	**Daylighting Labs**
Incorporated more energy-efficient technologies or energy-efficiency into the project.	40%
Helped **refine or improve design** of the project.	**48%**
Helped convince decision-makers to use more efficient technology.	4%
Incorporated BetterBricks recommendations into the project.	8$

Fig. 04

Finally, 90% of respondents indicated that the daylighting lab services resulted in energy savings for the project consulted. (RIA 2005, pg. 98)

5.0 Daylighting Lab Business Models

5.1 Introduction

The services of a Daylighting Lab are dictated by funding and expertise. Because of obvious integration issues between daylighting, electric lighting and HVAC or passive heating cooling or ventilation systems design, the scope of services can expand or contract depending on the level of integration intended, funding available and expertise present. The list of any given daylighting lab may include only a small number or all of the services listed in the Services and Funding Matrix on pages 21 -25 of this report. A well funded lab or specialty lab may include other services beyond those included on the matrix.

5.2 Capital Outlay and Operational Budgets

The following pages of this report show potential operation and startup budgets for daylighting labs at five unique funding levels. Each funding level assumes partial cost share of the director's salary by the host university given the director will be a university architecture faculty. The five funding levels are described in detailed categories as follows: one time equipment expenses, annual equipment maintenance, annual space needs, annual salaries, annual benefits, annual operation expenses, annual indirect expense (modest at 18.7% overhead).

The five funding levels are built around logical personnel combinations detailed in each budget profile to follow. Attention was given to program offerings available at each funding level that are detailed in the Services and Funding Matrix to follow.

The five funding levels (omitting one time equipment expenses / including an annual space budget) are as follows:

Full Time Employees	**Part Time Intern** (graduate students)	**Annual Funding Total** (less university match)
Director	One	$128,000
Director + One	Two	$195,000
Director + Two	Three	$362,000
Director + Four	Four	$640,000
Director + Six	Six	$1,129,000

Fig. 05

Daylighting Lab Minimum Budget Profile
1 FTE / 1 Part-time Intern

One Time							
Start Up Expenses							
Tools		Modest	Well Equipped				
1	Overcast Sky Box	$40,000.00	$150,000.00				
1	Heliodon	$5,000.00	$40,000.00				
2	Computers	$6,000.00					
1	Projector	$2,500.00					
2	Software	$3,000.00					
1	Illuminance Meter	$1,250.00					
1	Luminance Meter	$3,500.00					
1	Laser Printer	$500.00					
1	Fax / Color Printer	$200.00					
1	Scanner	$500.00					
2	Phones	$300.00					
2	Desks	$2,000.00					
2	Desk Chairs	$1,700.00					
1	Conference Tables	$3,500.00					
15	Conference Table Chairs	$1,875.00					
		$71,825.00	**$216,825.00**				
ANNUAL							
Equipment Up Keep and Replacement							
0.15	Equipment Maintenance and Renewal	**$10,773.75**	**$32,523.75**				
AVG Eqpt Rate							
Space							
	Rent 2000 SF	$25,500.00	$37,500.00	1500	$17.00	$25.00	
	Utilities / NNN	$4,500.00	$7,500.00	1500	$3.00	$5.00	
		$30,000.00	**$45,000.00**		**$30,000.00**	**Total Annual Rent & Fees**	
SALARIES		per month		months			
Staff							
FTE 1	Lab Director [$4000/mo = $48,000]		Cost Share		$20,250.00	*0.33*	**$26,932.50**
	3 months summer	$4,500.00	$0.00	3	$13,500.00		
	9 months	$2,250.00	$2,250.00	9	$20,250.00		
					$33,750.00		
			Cost Share		$5,265.00	0.1	**$5,791.50**
Interns	RA Student Hourly@ $13.50 per hour		10				**$32,724.00 Total Share Required**
1	student(s) for 9 months @ Avg 20 hours/week	$13.50	10	39	$5,265.00		
1	student(s) for 3 months @ Avg 40 hours/week	$13.50	40	13	$7,020.00		
					$12,285.00		
					$46,035.00	**Total Direct Salary Expenses**	
EMPLOYEE BENEFITS							
	Faculty, 33%	0.33			$11,137.50		
	RA Student Hourly, 1%	0.10			$1,228.50		
	Total Benefits				**$12,366.00**	**Total Benefit Expenses**	
OPERATIONAL		per month		months			
Travel	Regional Travel for Education and Outreach	$500.00		12	$6,000.00		
Services	Long distance / Internet	$100.00		12	$1,200.00		
Services	Cell Bills	$100.00		12	$1,200.00		
Outreach	Lunches for Seminar participants	$50.00		12	$600.00		
Miscellaneous	Lab Cleaning	$50.00		12	$600.00		
Supplies	Lab Office Supplies	$50.00		12	$600.00		
Supplies	Lab Modeling Supplies	$50.00		12	$600.00		
					$10,800.00	**Total Operational Expenses**	
					$99,201.00	Subtotal	
					$18,550.59	0.187 Indirect	
					$10,773.75	Equipment Maintenance and Renewal	
TOTAL BUDGET YEAR ONE					**$128,525.34**	**Total Year One**	

Indirect Rates can vary greatly from institution to institution and from on campus to off campus. This shows a typical off campus outreach rate. This is as much as three times less than some on campus research rates. The lower rate was chosen since there is an additional "overhead" rate shown for equipment upkeep.

Fig. 06

Daylighting Lab Minimum Budget Profile
2 FTEs / 2 Part-time Interns

One Time

Start Up Expenses							
Tools		Modest	Well Equipped				
v	Overcast Sky Box	$40,000.00	$150,000.00				
1	Heliodon	$5,000.00	$40,000.00				
4	Computers	$12,000.00					
1	Projector	$2,500.00					
4	Software	$6,000.00					
1	Illuminance Meter	$1,250.00					
1	Luminance Meter	$3,500.00					
1	Laser Printer	$500.00					
1	Fax / Color Printer	$200.00					
1	Scanner	$500.00					
4	Phones	$600.00					
4	Desks	$4,000.00					
4	Desk Chairs	$3,400.00					
1	Conference Tables	$3,500.00					
15	Conference Table Chairs	$1,875.00					
		$84,825.00	$229,825.00				

ANNUAL

Equipment Up Keep and Replacement							
0.15	Equipment Maintenance and Renewal	$12,723.75	$34,473.75				
AVG Eqpt Rate							
Space				SF			
	Rent	$38,250.00	$56,250.00	2250	$17.00	$25.00	
	Utilities / NNN	$6,750.00	$11,250.00	2250	$3.00	$5.00	
		$45,000.00	$67,500.00		$45,000.00	Total Annual Rent & Fees	
SALARIES		per month		months			
Staff							
FTE 1	Lab Director [$4000/mo = $48,000]		Cost Share		$20,250.00	*0.33*	$26,932.50
	3 months summer	$4,500.00	$0.00	3	$13,500.00		
	9 months	$2,250.00	$2,250.00	9	$20,250.00		
					$33,750.00		
FTE 2	Lab Technical Staff	$3,750.00	$0.00	12	$45,000.00		
			Cost Share		$11,700.00	0.1	$12,870.00
Interns	RA Student Hourly@ $13.50 per hour		10				$39,802.50 Total Share Required
2	student(s) for 9 months @ Avg 20 hours/week	$15.00	10	39	$11,700.00		
2	student(s) for 3 months @ Avg 40 hours/week	$15.00	40	13	$15,600.00		
					$27,300.00		
					$61,050.00	Total Direct Salary Expenses	
EMPLOYEE BENEFITS							
	Staff 1, 33%	0.33			$11,137.50		
	Staff 2, 33%	0.33			$14,850.00		
	RA Student Hourly, 1%	0.10			$2,730.00		
	Total Benefits				$28,717.50	Total Benefit Expenses	
OPERATIONAL		per month		months			
Travel	Regional Travel for Education and Outreach	$1,000.00		12	$12,000.00		
Services	Long distance / Internet	$100.00		12	$1,200.00		
Services	Cell Bills	$200.00		12	$2,400.00		
Outreach	Lunches for Seminar participants	$75.00		12	$900.00		
Miscellaneous	Lab Cleaning	$100.00		12	$1,200.00		
Supplies	Lab Office Supplies	$75.00		12	$900.00		
Supplies	Lab Modeling Supplies	$75.00		12	$900.00		
					$19,500.00	Total Operational Expenses	
					$154,267.50	Subtotal	
					$28,848.02	0.187	Indirect
					$12,723.75	Equipment Maintenance and Renewal	
TOTAL BUDGET YEAR ONE					$195,839.27	Total Year One	

Indirect Rates can vary greatly from institution to institution and from on campus to off campus. This shows a typical off campus outreach rate. This is as much as three times less than some on campus research rates. The lower rate was chosen since there is an additional "overhead" rate shown for equipment upkeep.

Fig. 07

Daylighting Lab Minimum Budget Profile
3 FTEs / 3 Part-time Interns

One Time

Start Up Expenses

Tools		Modest	Well Equipped
1	Overcast Sky Box	$40,000.00	$150,000.00
1	Heliodon	$5,000.00	$40,000.00
6	Computers	$18,000.00	
2	Projector	$5,000.00	
6	Software	$9,000.00	
2	Illuminance Meter	$2,500.00	
1	Luminance Meter	$3,500.00	
1	Laser Printer	$500.00	
1	Fax / Color Printer	$200.00	
1	Scanner	$500.00	
6	Phones	$900.00	
6	Desks	$6,000.00	
6	Desk Chairs	$5,100.00	
2	Conference Tables	$7,000.00	
30	Conference Table Chairs	$3,750.00	
1	Server + Network	$10,000.00	$50,000.00
		$106,950.00	**$251,950.00**

ANNUAL

Equipment Up Keep and Replacement

0.15	Equipment Maintenance and Renewal	**$16,042.50**	**$37,792.50**

AVG Eqpt Rate

Space

				SF			
	Rent	$51,000.00	$75,000.00	3000	$17.00	$25.00	
	Utilities / NNN	$9,000.00	$15,000.00	3000	$3.00	$5.00	
		$60,000.00	**$90,000.00**		**$60,000.00**	**Total Annual Rent & Fees**	

SALARIES

		per month		months			
Staff							
FTE 1	Lab Director		Cost Share		$20,250.00	*0.33*	**$26,932.50**
	3 months summer	$4,500.00	$0.00	3	$13,500.00		
	9 months	$2,250.00	$2,250.00	9	$20,250.00		
					$33,750.00		
FTE 2	Lab Technical Staff Daylighting	$3,750.00	$0.00	12	$45,000.00		
FTE 3	Lab Technical Staff Energy Systems	$3,750.00	$0.00	12	$45,000.00		
			Cost Share		$20,475.00	0.1	**$22,522.50**
Interns	RA Student Hourly@ $13.50 per hour		10				**$49,455.00 Total Share Required**
3	student(s) for 9 months @ Avg 20 hours/week	$17.50	10	39	$20,475.00		
3	student(s) for 3 months @ Avg 40 hours/week	$17.50	40	13	$27,300.00		
					$47,775.00		
					$171,525.00	**Total Direct Salary Expenses**	

EMPLOYEE BENEFITS

	Staff 1, 33%	0.33	$11,137.50
	Staff 2, 33%	0.33	$14,850.00
	Staff 3, 33%	0.33	$14,850.00
	RA Student Hourly, 1%	0.10	$4,777.50
	Total Benefits		**$30,765.00**

Total Benefit Expenses

OPERATIONAL

		per month	months	
Travel	Regional Travel for Education and Outreach	$1,500.00	12	$18,000.00
Services	Long distance / Internet	$200.00	12	$2,400.00
Services	Cell Bills	$300.00	12	$3,600.00
Outreach	Lunches for Seminar participants	$100.00	12	$1,200.00
Miscellaneous	Lab Cleaning	$150.00	12	$1,800.00
Supplies	Lab Office Supplies	$100.00	12	$1,200.00
Supplies	Lab Modeling Supplies	$100.00	12	$1,200.00
				$29,400.00

Total Operational Expenses

Indirect Rates can vary greatly from institution to institution and from on campus to off campus. This shows a typical off campus outreach rate. This is as much as three times less than some on campus research rates. The lower rate was chosen since there is an additional "overhead" rate shown for equipment upkeep.

$291,690.00	Subtotal
$54,546.03	0.187 Indirect
$16,042.50	Equipment Maintenance and Renewal
TOTAL BUDGET YEAR ONE **$362,278.53**	**Total Year One**

Fig. 08

Daylighting Lab Minimum Budget Profile
5 FTEs / 4 Part-time Interns

One Time

Start Up Expenses

Tools		Modest	Well Equipped
1	Overcast Sky Box	$40,000.00	$150,000.00
1	Heliodon	$5,000.00	$40,000.00
9	Computers	$27,000.00	
2	Projector	$5,000.00	
9	Software	$13,500.00	
1	Computation Fluid Dynamics Software	$5,000.00	$25,000.00
2	Illuminance Meter	$2,500.00	
2	Luminance Meter	$7,000.00	
1	Color Laser Printer	$1,000.00	
2	Laser Printer	$1,000.00	
1	Fax / Color Printer	$200.00	
2	Scanner	$1,000.00	
9	Phones	$1,350.00	
9	Desks	$9,000.00	
9	Desk Chairs	$7,650.00	
3	Conference Tables	$10,500.00	
45	Conference Table Chairs	$5,625.00	
1	Server + Network	$10,000.00	$50,000.00
		$152,325.00	**$357,325.00**

ANNUAL

Equipment Up Keep and Replacement

0.15	Equipment Maintenance and Renewal	**$22,848.75**	**$53,598.75**

AVG Eqpt Rate

Space

				SF			
	Rent	$76,500.00	$112,500.00	4500	$17.00	$25.00	
	Utilities / NNN	$13,500.00	$22,500.00	4500	$3.00	$5.00	
		$90,000.00	**$135,000.00**		**$90,000.00**	**Total Annual Rent & Fees**	

SALARIES		per month		months			
Staff							
FTE 1	Lab Director		Cost Share		$24,750.00	*0.33*	**$32,917.50**
	3 months summer	$5,500.00	$0.00	3	$16,500.00		
	9 months	$2,750.00	$2,750.00	9	$24,750.00		
					$41,250.00		
FTE 2	Lab Technical Staff Daylighting	$4,250.00	$0.00	12	$51,000.00		
FTE 3	Lab Technical Staff Energy / Mechanical	$5,000.00	$0.00	12	$60,000.00		
FTE 4	Lab Technical Electrical / Lighting Design	$4,000.00	$0.00	12	$48,000.00		
FTE 5	Lab Administrator	$2,500.00	$0.00	12	$30,000.00		
			Cost Share		$31,200.00	0.1	**$34,320.00**
Interns	RA Student Hourly@ $13.50 per hour		10				**$67,237.50 Total Share Required**
4	student(s) for 9 months @ Avg 20 hours/week	$20.00	10	39	$31,200.00		
4	student(s) for 3 months @ Avg 40 hours/week	$20.00	40	13	$41,600.00		
					$72,800.00		
					$303,050.00	**Total Direct Salary Expenses**	

EMPLOYEE BENEFITS			
	Staff 1, 33%	0.33	$13,612.50
	Staff 2, 33%	0.33	$16,830.00
	Staff 3, 33%	0.33	$19,800.00
	Staff 4, 33%	0.33	$15,840.00
	Staff 5, 33%	0.33	$9,900.00
	RA Student Hourly, 1%	0.10	$7,280.00
	Total Benefits		**$83,262.50** **Total Benefit Expenses**

OPERATIONAL		per month	months	
Travel	Regional Travel for Education and Outreach	$2,000.00	12	$24,000.00
Services	Long distance / Internet	$400.00	12	$4,800.00
Services	Cell Bills	$400.00	12	$4,800.00
Outreach	Lunches for Seminar participants	$200.00	12	$2,400.00
Miscellaneous	Lab Cleaning	$250.00	12	$3,000.00
Supplies	Lab Office Supplies	$200.00	12	$2,400.00
Supplies	Lab Modeling Supplies	$200.00	12	$2,400.00
				$43,800.00 **Total Operational Expenses**

Indirect Rates can vary greatly from institution to institution and from on campus to off campus. This shows a typical off campus outreach rate. This is as much as three times less than some on campus research rates. The lower rate was chosen since there is an additional "overhead" rate shown for equipment upkeep.

$520,112.50	Subtotal
$97,261.04	0.187 Indirect
$22,848.75	Equipment Maintenance and Renewal
$640,222.29	**Total Year One**

TOTAL BUDGET YEAR ONE

Fig.09

Daylighting Lab Minimum Budget Profile
7 FTEs / 6 Part-time Interns

One Time

Start Up Expenses - Tools / Hardware

		Modest	Well Equipped
1	Overcast Sky Box	$40,000.00	$150,000.00
1	Heliodon	$5,000.00	$40,000.00
13	Computers	$39,000.00	
3	Projector	$7,500.00	
13	Software	$19,500.00	
1	Computation Fluid Dynamics Software	$5,000.00	$25,000.00
3	Illuminance Meter	$3,750.00	
2	Luminance Meter	$7,000.00	
1	Oversize Color Plotter	$3,500.00	$10,000.00
1	Color Laser Printer	$1,000.00	
3	Laser Printer	$1,500.00	
1	Fax / Color Printer	$200.00	
2	Scanner	$1,000.00	
13	Phones	$1,950.00	
13	Desks	$13,000.00	
13	Desk Chairs	$11,050.00	
4	Conference Tables	$14,000.00	
60	Conference Table Chairs	$7,500.00	
1	Server + Network	$10,000.00	$50,000.00
	Demonstrations	$50,000.00	$150,000.00
		$241,450.00	**$552,950.00**

ANNUAL

Equipment Up Keep and Replacement

0.15	Equipment Maintenance and Renewal	**$36,217.50**	**$82,942.50**

AVG Eqpt Rate

Space

				SF		
	Rent	$127,500.00	$187,500.00	7500	$17.00	$25.00
	Utilities / NNN	$22,500.00	$37,500.00	7500	$3.00	$5.00
		$150,000.00	**$225,000.00**		**$150,000.00**	**Total Annual Rent & Fees**

SALARIES

		per month		months			
Staff							
FTE 1	Lab Director		Cost Share		$31,500.00	*0.33*	**$41,895.00**
	3 months summer	$7,000.00	$0.00	3	$21,000.00		
	9 months	$3,500.00	$3,500.00	9	$31,500.00		
					$52,500.00		
FTE 2	Lab Technical Staff Daylighting	$5,500.00	$0.00	12	$66,000.00		
FTE 3	Lab Technical Staff Energy / Mechanical	$7,000.00	$0.00	12	$84,000.00		
FTE 4	Lab Technical Electrical / Lighting Design	$5,500.00	$0.00	12	$66,000.00		
FTE 5	Lab LEED/Charrette Facilitator	$5,500.00	$0.00	6	$33,000.00		
FTE 6	Lab Energy Modeler	$5,500.00	$0.00	12	$66,000.00		
FTE 7	Lab Administrator	$3,000.00	$0.00	12	$36,000.00		
			Cost Share		$53,820.00	0.1	**$59,202.00**
Interns	RA Student Hourly@ $13.50 per hour		10				**$101,097.00 Total Share Required**
6	student(s) for 9 months @ Avg 20 hours/week	$23.00	10	39	$53,820.00		
6	student(s) for 3 months @ Avg 40 hours/week	$23.00	40	13	$71,760.00		
					$125,580.00		
					$529,080.00	**Total Direct Salary Expenses**	

EMPLOYEE BENEFITS

Staff 1	0.33	$17,325.00
Staff 2	0.33	$21,780.00
Staff 3	0.33	$27,720.00
Staff 4	0.33	$21,780.00
Staff 5	0.33	$10,890.00
Staff 6	0.33	$21,780.00
Staff 7	0.33	$11,880.00
RA Student Hourly, 1%	0.10	$12,558.00
Total Benefits		**$145,713.00** **Total Benefit Expenses**

OPERATIONAL

		per month	months	
Travel	Regional Travel for Education and Outreach	$4,000.00	12	$48,000.00
Services	Long distance / Internet	$1,000.00	12	$12,000.00
Services	Cell Bills	$1,000.00	12	$12,000.00
Outreach	Lunches for Seminar participants	$500.00	12	$6,000.00
Miscellaneous	Lab Cleaning	$500.00	12	$6,000.00
Supplies	Lab Office Supplies	$500.00	12	$6,000.00
Supplies	Lab Modeling Supplies	$500.00	12	$6,000.00
				$96,000.00 **Total Operational Expenses**

Indirect Rates can vary greatly from institution to institution and from on campus to off campus. This shows a typical off campus outreach rate. This is as much as three times less than some on campus research rates. The lower rate was chosen since there is an additional "overhead" rate shown for equipment upkeep.

$920,793.00	Subtotal
$172,188.29	0.187 Indirect
$36,217.50	Equipment Maintenance and Renewal

TOTAL BUDGET YEAR ONE **$1,129,198.79** **Total Year One**

Fig. 10

5.3 Services and Funding Matrix

The following is a breakdown of services offered at various funding levels. The light green indicates that the service is achievable in a very limited capacity at the given funding level, the medium green indicates a moderate capacity for a given service and a given funding level and the dark green indicates the service can be completed at a high capacity at the given funding level. The following charts break down the services of a fully integrated design lab into subcategories by typical design project phase. Generally, lower level funding places higher priority on service activities early in the design process. This makes the largest impact for time and resources allocated.

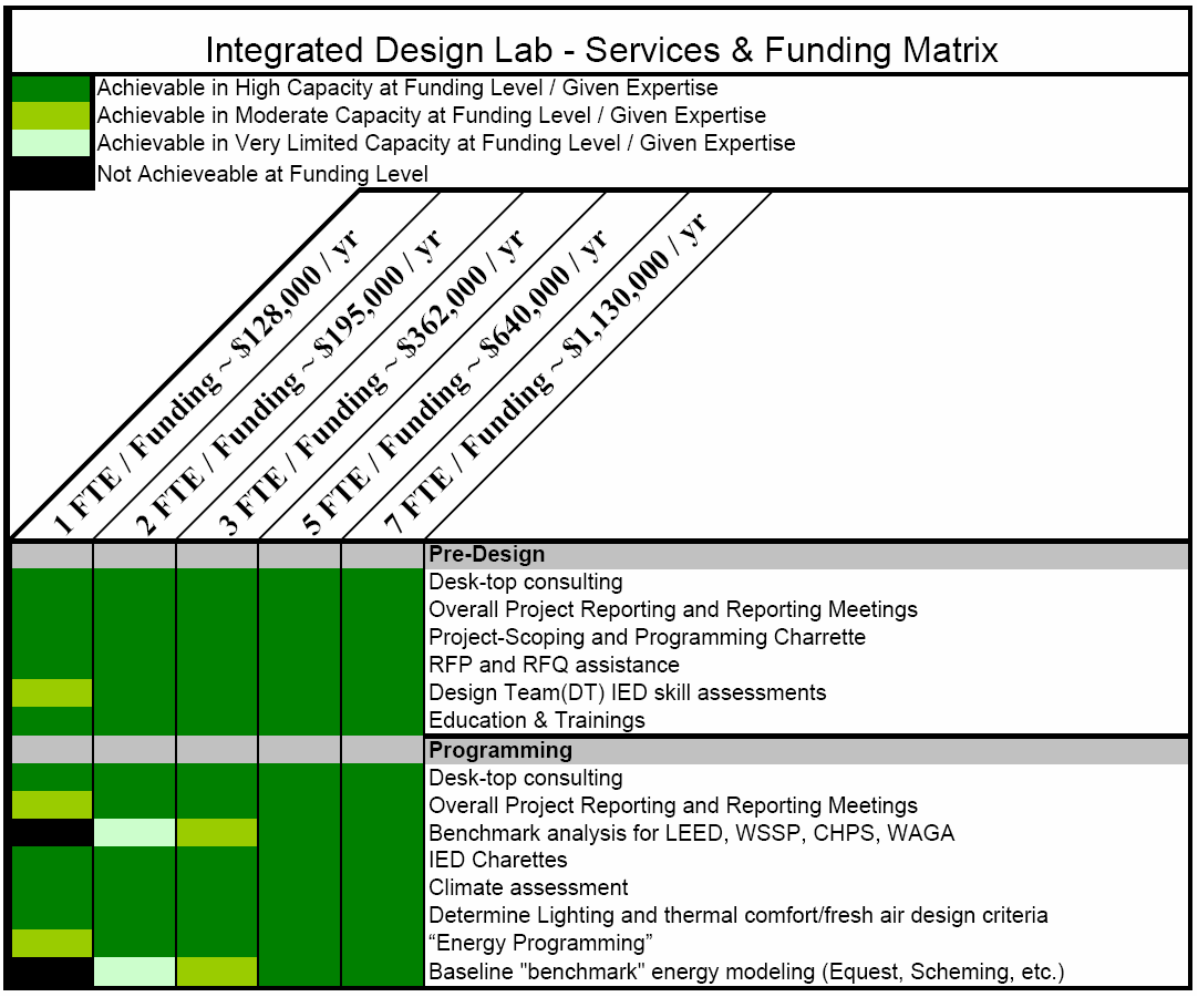

Fig. 11

Integrated Design Lab - Services & Funding Matrix

- Achievable in High Capacity at Funding Level / Given Expertise
- Achievable in Moderate Capacity at Funding Level / Given Expertise
- Achievable in Very Limited Capacity at Funding Level / Given Expertise
- Not Achieveable at Funding Level

1 FTE / Funding ~ $128,000 / yr	2 FTE / Funding ~ $195,000 / yr	3 FTE / Funding ~ $362,000 / yr	5 FTE / Funding ~ $640,000 / yr	7 FTE / Funding ~ $1,130,000 / yr	**Schmatic Design**
					Desk-top consulting
					Overall Project Reporting and Reporting Meetings
					Benchmark compliance checks for LEED, WSSP, CHPS, WAGA etc. (not to include compliance submittals)
					Site analysis and design for daylight, sun control and air flow
					Wind tunnel analysis: Physical model assessments of exterior wind pressure patterns
					"Bulk" aperture and thermal mass analysis for daylighting and ventilation/cooling
					Schematic analysis and design for lighting, air flow and energy performance (Equest, DOE2, Energy10, Ecotect, Scheming, etc.
					Parametric Daylight Lab analysis: Digital and physical model assessments of daylight quality(glare) and quality
					Parametric Energy assessments of major building issues, orientation, bldg. depth, glazing area and shading etc.
					Space by space lighting schematics, sources, fixtures, surfaces and controls etc
					Review 90% SD's

Fig. 12

Integrated Design Lab - Services & Funding Matrix

- Achievable in High Capacity at Funding Level / Given Expertise
- Achievable in Moderate Capacity at Funding Level / Given Expertise
- Achievable in Very Limited Capacity at Funding Level / Given Expertise
- Not Achieveable at Funding Level

1 FTE / Funding ~ $128,000 / yr	2 FTE / Funding ~ $195,000 / yr	3 FTE / Funding ~ $362,000 / yr	5 FTE / Funding ~ $640,000 / yr	7 FTE / Funding ~ $1,130,000 / yr	**Design Development**
					Desk-top consulting
					Overall Project Reporting and Reporting Meetings
					Benchmark compliance checks for LEED, WSSP, CHPS, WAGA etc. (not to include compliance submittals)
					Wind tunnel analysis: Physical model assessments of exterior wind pressure patterns and interior airflow
					Daylight Lab analysis: Digital and physical model assessments of daylight distribution and sun control
					Parametric Energy assessments (building the large scale energy model ie. DOE2)
					Electric Lighting scheme alternatives
					Daylighting / Lighting integration controls
					Parametric analysis of energy savings & LCA from daylight and electric light integration
					Schematic loads and HVAC systems optimization & LCA
					Review 90% DD's

Fig. 13

Integrated Design Lab - Services & Funding Matrix

- Achievable in High Capacity at Funding Level / Given Expertise
- Achievable in Moderate Capacity at Funding Level / Given Expertise
- Achievable in Very Limited Capacity at Funding Level / Given Expertise
- Not Achieveable at Funding Level

1 FTE / Funding ~ $128,000 / yr	2 FTE / Funding ~ $195,000 / yr	3 FTE / Funding ~ $362,000 / yr	5 FTE / Funding ~ $640,000 / yr	7 FTE / Funding ~ $1,130,000 / yr	Contract Documents
					Desk-top consulting
					Overall Project Reporting and Reporting Meetings
					Benchmark compliance checks for LEED, WSSP, CHPS, WAGA etc. (not to include compliance submittals)
					Wind tunnel analysis: Physical model assessments of interior airflow
					CFD analysis of interior airflow
					FINALIZING Daylighting schemes: Digital and physical model assessments of daylight distribution and sun control
					FINALIZE building components: i.e fenestration systems (window frames, glazing, shading systems) interior surface selection and thermal mass)
					FINALIZING Electric Lighting scheme (lamp, ballast, fixture systems)
					FINALIZING Daylgihging / Lighting integration controls (lighting controllers, DDC's etc.)
					FINALIZING integrated air flow, cooling, heating, HVAC systems and controls (heat recovery, demand control ventilation, DDC's etc
					Review 50% CD's
					FINAL Parametric Energy assessments w/ large scale energy modeler ie. DOE2
					FINALIZE energy model conservation prediction v. initial conservation targets
					FINALIZE LCA & utility conservation incentives
					Review 90% CD's

Fig. 14

Integrated Design Lab - Services & Funding Matrix

- Achievable in High Capacity at Funding Level / Given Expertise
- Achievable in Moderate Capacity at Funding Level / Given Expertise
- Achievable in Very Limited Capacity at Funding Level / Given Expertise
- Not Achieveable at Funding Level

1 FTE / Funding ~ $128,000 / yr	2 FTE / Funding ~ $195,000 / yr	3 FTE / Funding ~ $362,000 / yr	5 FTE / Funding ~ $640,000 / yr	7 FTE / Funding ~ $1,130,000 / yr	
					Construction
					CA site visits
					Review construction submittals
					Review final commissioning plan
					Post-Occupancy
					Monitoring selected buildings for comfort conditions
					Field Reports of selected completed projects
					Monitoring selected buildings for energy use as compared to energy models
					Operations and Maintenance
					Develop operations proceedures for new building proceesses and technologies

Fig. 15

6.0 Lab Development Process

6.1 Funding Sources

It is essential for the birth and growth of a daylighting lab to secure a substantial piece of funding for a period of at least two years by a single dedicated agency. This is likely a utility or a state office of energy. This funding is used as seed money to develop tools, acquire space and pay the first staff members of the daylighting lab. The PNW Lab Network has benefited greatly from the strong Pacific Northwest ethic for sustainability, high level of support from local university departments of architecture and the presence of the Northwest Energy Efficiency Alliance. The Alliance's BetterBricks program provides the cornerstone funding for most of the PNW Labs. This has facilitated each lab's ability to expand and sharpen their services offered as well as opened the door for additional financial support from other regional and national groups.

Utilities – Utilities pay a lab directly and/or indirectly through a regional energy efficiency alliance or similar entity via demand side management or conservation monies received from rate payers. At the IDL, Idaho Power is an excellent partner and supports the Lab directly with a contract specific to Idaho Power service territory as well as indirectly through the Northwest Energy Efficiency Alliance and the BetterBricks program.

Universities – It is of the opinion of these authors that a university's department of architecture and/or engineering should carry some of the burden for supporting staff salaries. The lab will likely achieve other grant work, build a better connection among university staff, students and the design community. It will also bring a good deal of positive public relations to the university and design community alike.

Architects – Pay partial or full fees to lab **AFTER** the lab is well established and the services are in **HIGH** demand.

Engineers– Pay partial or full fees to lab **AFTER** the lab is well established and the services are in **HIGH** demand.

Major Corporations / City / County– Pay partial or full fees to lab **AFTER** the lab is well established and the services are in **HIGH** demand. This will most likely occur only after a beneficial working relationship has been established with the lab. The corporation will see the benefits of daylighting and integrated design and desire to keep forwarding their business practices.

Energy Service Corporations (ESCO) – The Integrated Design Lab in Boise is beginning to see interest from large ESCOs for professional services from the Lab.

State Energy Office – This varies greatly by state. In Idaho, the State Division of Energy has limited funding as part of their relationship with Rebuild America. They have financially supported key pieces of the IDL's development and continue to provide in-kind matching and extensive logistical and coordination support.

6.2 Example Scope of Work / Contract Agreement

As the daylighting lab formation team has earned the interest of a primary funding source a scope of work and list of services will need to be identified. The following is the scope of work between Northwest Energy Efficiency Alliance and the University of Idaho, Department of Architecture for their first contract period form January 2004 – December 2005 for the development and operation of an Integrated (daylighting) Design Lab. Note: Item V is the formal scope of work while items I-IV provide a background and explanation of goals, progress indicators and initial strategies.

Scope of Work / Contract Agreement

Integrated Design Lab

Between the

Funding Agency

and

University of Idaho Department of Architecture

I. Purpose

The University of Idaho, Department of Architecture and the Northwest Energy Efficiency Alliance (the Alliance) propose to establish an Integrated Design Lab (IDL) in Boise. Other partners in this effort include Idaho Power Company and the Idaho Department of Water Resources Energy Division.. The purpose of the IDL would be to raise awareness about sustainable, high performance buildings and about local resources to assist in their design, construction, operation and maintenance.

University of Idaho (”the Contractor”) will coordinate closely with the Alliance’s Commercial Sector Initiative, otherwise known as BetterBricks. BetterBricks technical and training services help connect building professionals with the information, tools, training and consultation needed to design and construct high performance buildings. These buildings can bring significant financial and employee performance benefits to those who develop, own, and operate them. One of the biggest of these benefits is lower operating costs achieved through improved energy efficiency and system design.

The addition of a local BetterBricks presence in Boise to serve Idaho and eastern Oregon for integrated design services and education outreach will significantly help market transformation in the region. The University of Idaho connection will contribute a location of neutrality for design professionals, as well as a greater resource/research perception. Collaboration with and support from the Alliance and other partners will add immeasurable depth to the outreach offerings. Local partners will extend, then expand, the capabilities, resources, and contacts of the program.

II. Goals

The goals of the project are to:

1) Develop relationships with local design professionals through direct personal outreach.
2) Raise awareness of key energy-efficiency and sustainable design and construction concepts for commercial buildings through the Boise Lab.
3) Facilitate the use of existing Alliance/BetterBricks resources by local design teams and building professionals.
4) Provide some energy-efficiency and integrated daylighting consulting in Idaho and eastern Oregon.
5) Offer graduate level seminars to students in integrated design topics and involve them in research and consulting activities through hands-on IDL activities in the form of student and professional projects, thus making a positive affect on the next generation of designers.

III. Progress Indicators

- Staff hired.
- 10 trainings per year.
- 15 consults per year.
- 2 advisory committee meetings per year.

IV. Initial Strategies

For the first years of lab activities, we propose to extend the successes of the other regional labs funded by the Alliance. We have learned that support for daylighting catalyzes further interests in quality energy-effective decisions in electric lighting and HVAC systems design. The well-documented experience of four years of work by the BetterBricks Daylighting Lab - Seattle (BBDL-Seattle) indicates that market transformation can begin with good daylighting design that incorporates early modeling of whole-building energy performance.

Daylighting represents a significant opportunity for energy savings and increased productivity in commercial buildings. Building science research indicates that people are more comfortable and productive in buildings that are specifically designed to accommodate the use of daylight as a source of workplace illumination. Additionally, the vast majority of commercial and institutional space is either directly under a roof or within twenty-five feet of an exterior wall. Thus, there is a large potential for energy efficiency in new and existing commercial space where daylighting catalyzes the integration of design concepts for integrated whole-building energy efficiency.

Through partnerships in addition to the Alliance, the Contractor proposes to enhance the IDL with daylight model capabilities. This is critical to engage design teams, because architects feel that daylight modeling visibly portrays architectonic ideologies and form that are otherwise difficult to convey to clients. Through the use of the IDL, clients and users will be able to “see” the strategies, experience the positive effects, and justify the daylighting design decisions.

The integration of assistance from other Alliance supported services such as the BBDL-Seattle, Lighting Design Lab (LDL), and mechanical system Advisors at the Boise IDL will compliment the offerings. The University of Idaho will provide these consultants with some equipment, advertisement for seminars, and meeting space for consultation when required.

The Contractor proposes, also, to provide local assistance and coordination for other BetterBricks Initiatives such as the High Performance Schools Initiative, support local eco-charrettes sponsored by BetterBricks, and assist in marketing BetterBricks services in the region. The lab is also proposed to be a location for lab partners Idaho Power Company and the Idaho Energy Division to conduct outreach and education for energy conservation.

V. Scope of Work

Task 1a. Project Management

The Contractor will provide project management for Idaho and eastern Oregon IDL. The Contractor will finalize the facility schedule, outreach schedule and class offerings, including budget for all tasks listed. Project management will also include the management of, billing support for, and summary reporting for all tasks.

- **Project Management**

The Contractor shall provide project management and is responsible for coordinating all activities related to the project. Project management shall also include the management of, billing support for, and summary reporting for all tasks listed on the project plan and for coordinating the work of any and all project subcontractors.

Activities:

1. Provide project management
2. Hire a half-time IDL director, matched by a half-time architecture lecturer as outlined in the draft budget, and secure a location for the IDL in association with the Contractor
3. Facility development and scheduling.
4. Outreach and scheduling that ensures the Idaho market is being reached
5. Coordinate, manage, provide billing support for, and report any and all sub-contracting activities related to the project.
6. Coordinate all in-kind contributions to the IDL.
7. Deliver the project at or under budget.
8. Deliver work products in a timely fashion.

Deliverables
1. Staff hired within 1 month of contract signing.
2. Notification to the Alliance when non University of Idaho in-kind donations secured.
3. Proposals or rate sheets for sub-contractors, if appropriate.

- **Reporting**

The contractor is responsible for providing timely and accurate reports that will facilitate proper documentation and management of the project.

Activities:
1. Contractor will develop and submit timely monthly reports including:
   - Progress Report (refer to Exhibit C for format and information required) on activities and deliverables as related to this schedule and budget;
   - Financial Report (refer to Exhibit B-1 for format and information required) of all expenditures made in the performance of this project, and providing reasonable detail on expenses and projected expenses by quarter;
2. At the end of the project, the Contractor shall prepare a year end summary report which summarizes results achieved in the project tasks as related to the project's goals, project progress indicators and long term market impact.
3. The Contractor shall provide data for the evaluation effort as is reasonably required.

Deliverables
1. Up to 24 monthly reports, depending on date of contract signing.
2. One final report
3. Modest amount of data for evaluation, as needed.

- **Coordination**

BetterBricks has established a network of technical information providers to assist regional market actors in building, operating and maintaining energy efficient buildings. In order to accomplish this goal, the Contractor will work closely with other BetterBricks Training and Technical Services. In addition, the contractor will coordinate with other local, regional, and national groups and organizations that are promoting energy-efficient, sustainable or high performance buildings.

Key partnerships for the Contractor include the BetterBricks Training and Technical Support contractors (Better Bricks Daylighting Labs, the Lighting Design Lab, BetterBricks mechanical advisors), Idaho Power Company, and the Idaho Energy Division. Careful cooperation and collaboration with these groups is essential to a well-functioning program. Messages, materials and contacts shall be freely shared to ensure consistency throughout the region. In addition, occasional meetings will be held to facilitate communication and cooperation.

Activities:
1. Coordinate and communicate regularly with the Alliance, its contractors, and evaluation.
2. Participate in approximately four meetings with the Alliance staff and other Alliance commercial buildings contractors.
3. Participate in approximately monthly target market team meetings.
4. Refer projects as appropriate to the Daylighting Lab, Lighting Design Lab and BetterBricks Advisors, etc.
5. Attend a limited number of other meetings upon the request of the Alliance

Deliverables:
1. Four BetterBricks meetings, if requested.
2. 12 target market team meetings.

- **Marketing**

Any materials (paper or electronic) designed and developed under this contract for use by the Contractor for marketing purposes or information dissemination (i.e. announcements of classes, website, case studies, technical papers) must be reviewed for reference to the Alliance and the use of the Alliance logo in draft format and approved by the Alliance in advance to publication and/or distribution.

The intent of the comprehensive BetterBricks marketing program is to leverage the skills and resources of other BetterBricks contractors and partners. The Contractor is responsible for coordinating with the BetterBricks marketing team in the graphical development of materials.

All marketing materials should support the BetterBricks branding efforts. The Alliance will also be recognized in all materials.

Activities:
1. Provide content and copy for all materials to the BetterBricks graphic design contractors for layout.
2. Draft templates and / or materials for review and approval by the Alliance.
3. Final templates and / or materials.
4. Prepare and deliver final brochures, templates, etc including hard copies, electronic, and web site versions; color and grayscale (for faxing).

Deliverables:
1. Content and copy for each marketing piece.
2. Presentation template.
3. Final draft for Alliance approval.
4. Final materials delivered to the Alliance (hard copies, quantity to be determined depend on the type of material, and an electronic version, PDF, for posting on the Alliance Project Coordination website).

Task 1B. Education & Outreach

The Contractor will support the current Alliance sponsored strategy that is geared toward building personal relationships with Idaho market actors. The contractor will coordinate education and outreach programs that rely heavily upon existing BetterBricks services and education programs. Presentations, materials and contacts will be shared within the BetterBricks network. The selected contractor will help local market actors build daylighting and integrated design knowledge by providing training seminars and "brown bag" style lunches in the Idaho and eastern Oregon. Furthermore, the contractor will coordinate with Idaho Power Company and Idaho Energy Division on additional outreach and education offerings.

Activities

1. Over the next two years, participate in at least 20 trainings in Idaho or eastern Oregon. This might be a brown bag lunch at an architect's office or in an event sponsored by another entity (such as the Idaho Energy Conference, or local AIA meeting).

Deliverables

1. Summary information for 20 trainings input into online BetterBricks database.

Task 1C. Consulting

The Contractor will integrate with and expand the current BetterBricks consulting network and provide a local contact for the greater range of existing BetterBricks services and advisors. In coordination with BetterBricks, the contractor will provide design assistance and modeling services in the southern Idaho and eastern Oregon area. This will involve regular communications with architecture and engineering firms, and large institution managers, so that a trusting relationship is developed and design professionals feel comfortable securing consulting services from the Boise IDL. It is anticipated that Idaho High Performance Schools will be a focus of at least the first year of activities.

Activities:

1. Provide advice to Idaho design teams on building projects. This may include direct technical services or links to other BetterBricks Technical Services.

Deliverables:

1. Summary information and activities for 30 projects entered into online BetterBricks database.

Task 1D. Advisory Committee

The Contractor will develop an advisory board to help give direction to education and consulting activities. The Board will be composed of at least 6 design professionals, Idaho Power, IDWR Energy Division, and the Alliance.

Activities:

1. Identify key individuals and extend invitation
2. Provide meeting agendas and advisory committee work plans.
3. Convene advisory committee meetings.

Deliverables:

1. Four advisory committee meetings.

VI. EVALUATION

The Contractor shall maintain records of deliverables provided in the tasks above as accomplished through the term of this Contract, and for any same deliverables provided in a three-year period following the completion of this Contract. The Contractor and their subcontractors agree to cooperate in future evaluations by talking with Alliance evaluation contractors and providing, or providing access to, appropriate data.

---------- End of example scope of work / contract agreement. ----------

Fig. 16

6.3 Physical Space Requirements

Program space requirements for 1 FTE / $128,000 annual funding / 1500 SF

A daylighting/integrated design lab needs an appropriate location to house the operations and services necessary for local outreach and to facilitate market transformation. These labs should be located in a downtown setting (ideally a storefront) for high visibility. A location near several architects' offices is good for relationship building. It is often the case that multiple sources of funding will be necessary to meet the needs of any lab for any given service territory. Splitting the space lease demand from the operational budget is an effective way to manage expenses.

Obviously, the lab space needs will be greatly dependant upon the funding level, employees hired, equipment required and specific services offered based upon that funding level. A basic model for space requirements has been provided to assist in the programming exercise.

The IDL-Boise Model / Space Requirements (1 FTE / $128,000 annual funding / 1500 SF)

1. Ground Floor – Retail Type Space to ensure walk by traffic, high visibility and good public exposure.
2. Ceiling height of 14' – 16' in at least 200 SF of overall space for overhead type heliodon.
3. 1500 SF
    a. Exhibit/source materials area: 150sf
    b. Overcast sky: 150sf
    c. Heliodon: 150sf
    d. Reception: 50sf
    e. office area: 250sf
    f. Meeting space: 400sf
    g. Model making Work table: 100sf
    h. Storage: 100sf
    i. + Circulation/toilets: 10-15%
4. Heliodon Power Draw 20 AMP circuit. (Varies)
5. Overcast Sky Box Power Draw (3) 20 AMP circuits. (Varies)

6.4 Example Space Plans

The following are examples of space layouts that incorporate the minimum space requirements suggested in section 6.3.

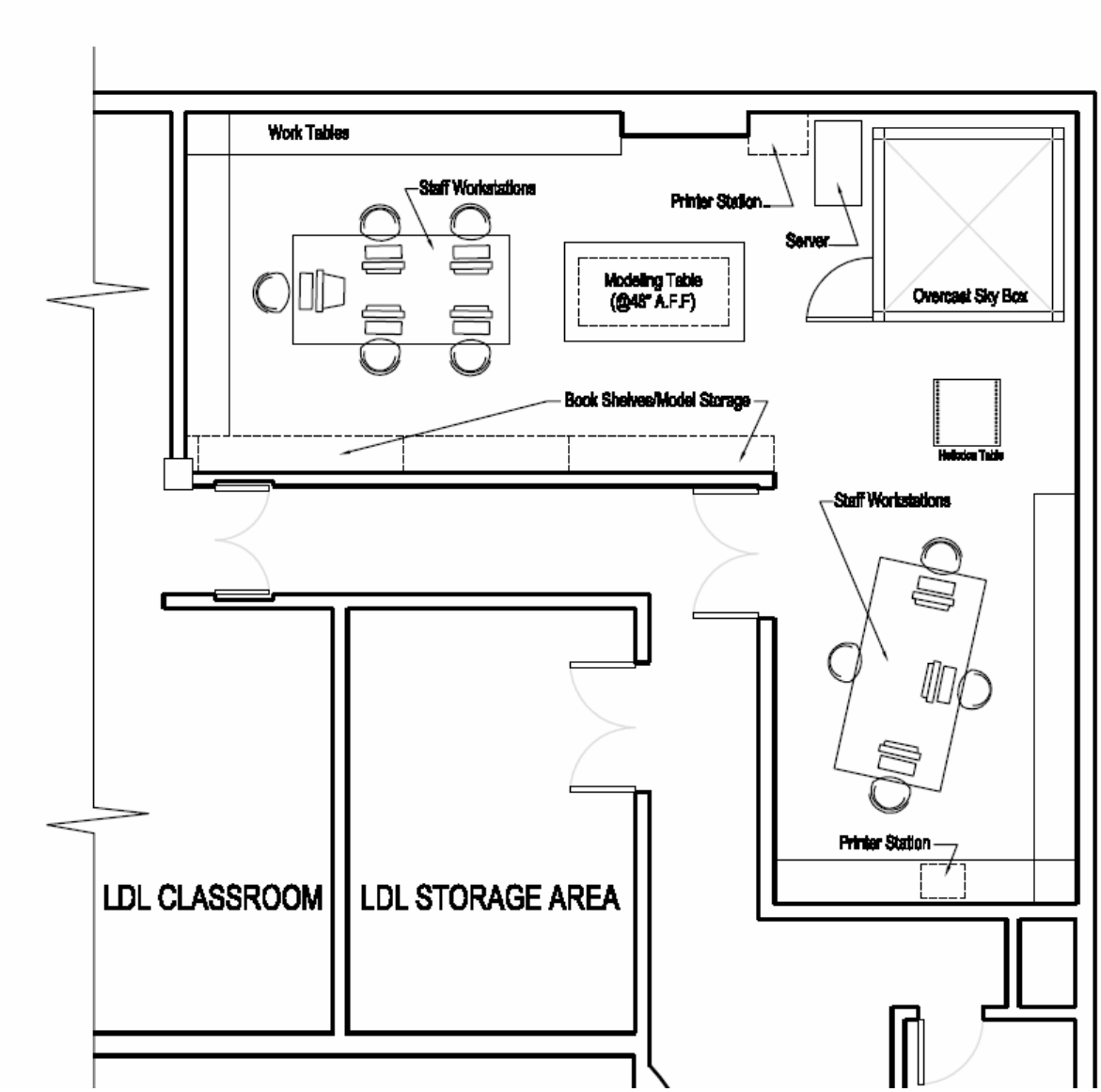

Fig. 17

This drawing shows the layout of the BetterBricks Daylighting Lab - Seattle managed by the University of Washington and co-located with the Lighting Design Lab in downtown Seattle, WA. The UW Lab is able to minimize the financial burden of support spaces by co-locating with the LDL. They share conference rooms, classrooms, a lobby, storage and restroom facilities.

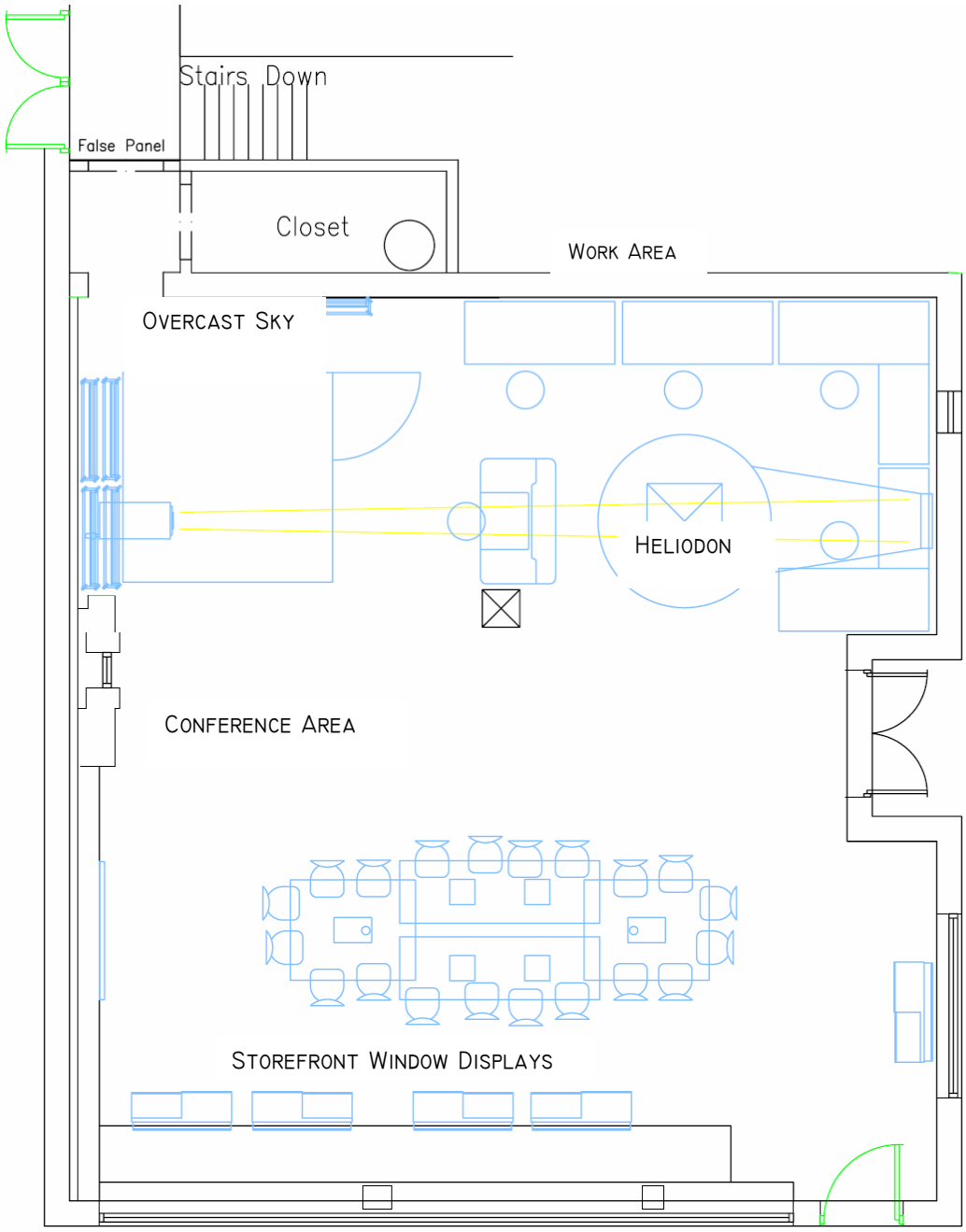

Fig. 18

The IDL-Boise is housed in a storefront space of a historic building in the heart of downtown Boise. It has approximately 1400 SF of usable floor space.

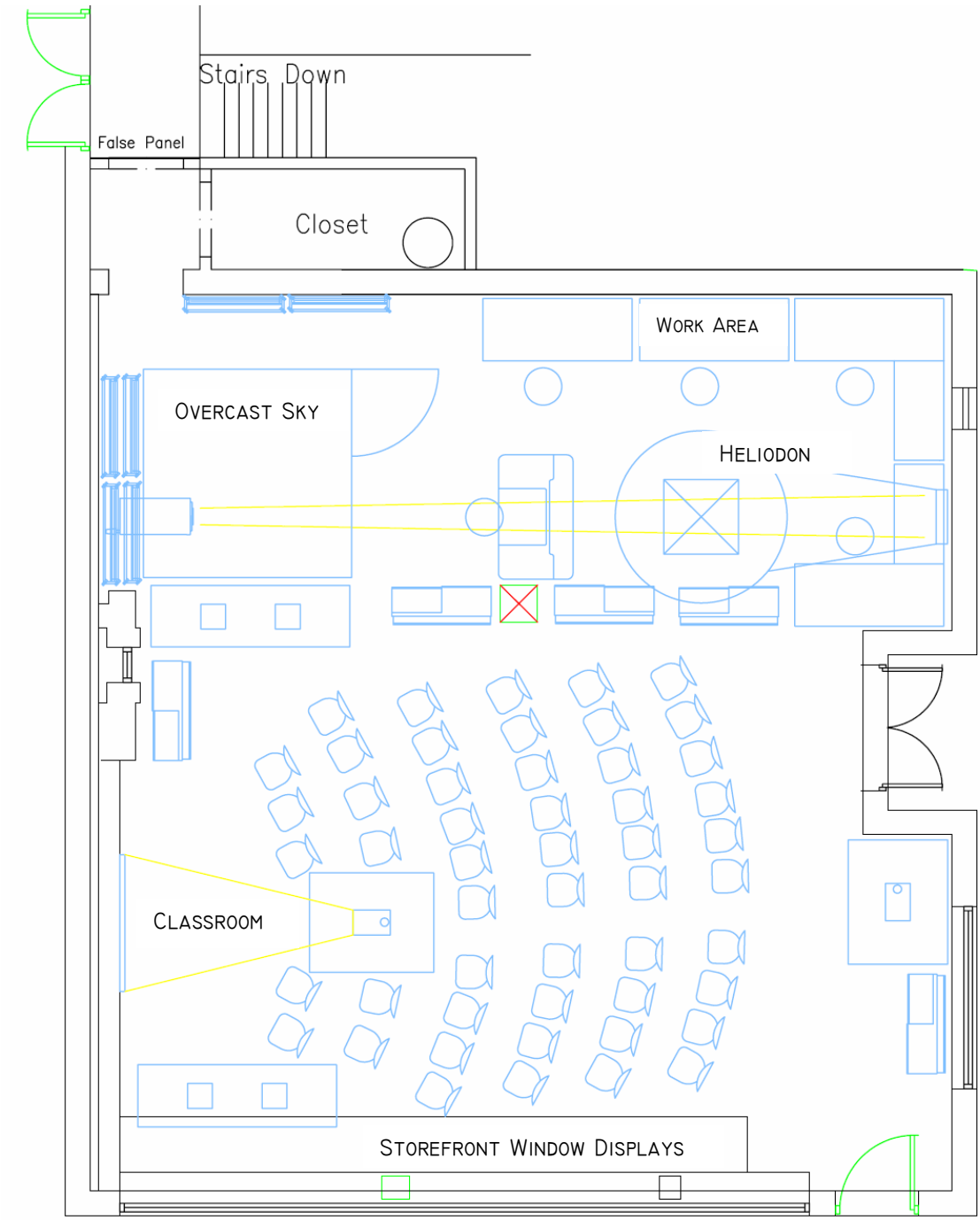

Fig. 19

To get the most out of limited space the IDL-Boise utilizes a multifunctional space that can be set up as a conference room for small to medium sized meetings or a classroom for educational and training activities.

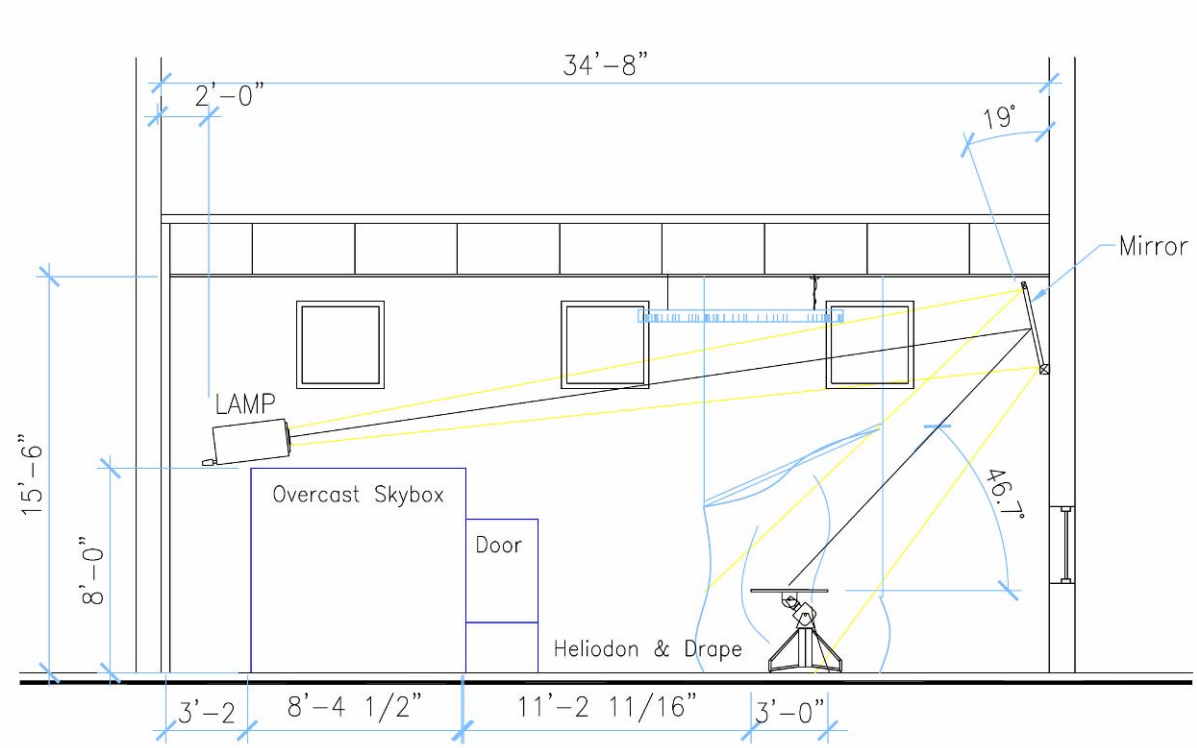

Fig. 20 Section of IDL – Boise for heliodon / Sky Simulator Configuration

Fig. 21 The drape around the heliodon shown in the section above is yet to be installed in this photograph. This perspective shows path of heliodon lamp.

Photographs of IDL – Boise

Fig. 22

Fig. 23

Fig. 24

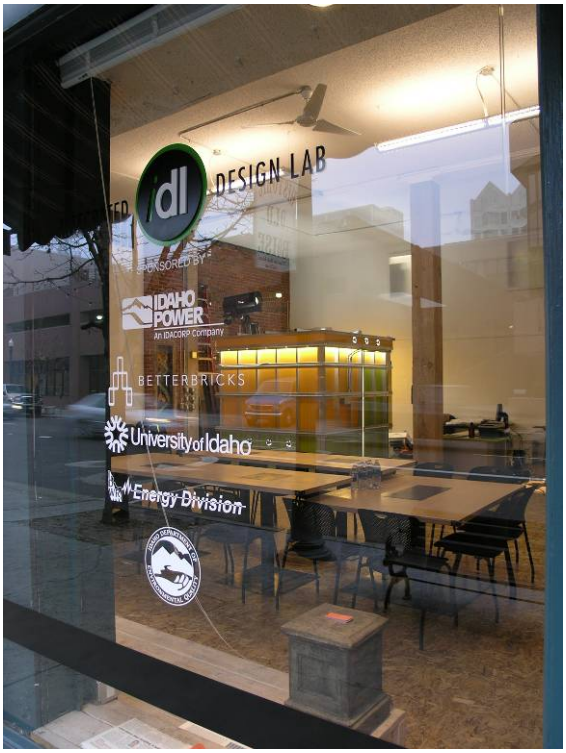

Fig. 25

Fig. 26

6.5 TECHNICAL EQUIPMENT SPECIFICATIONS

6.5A HELIODON DRAWINGS

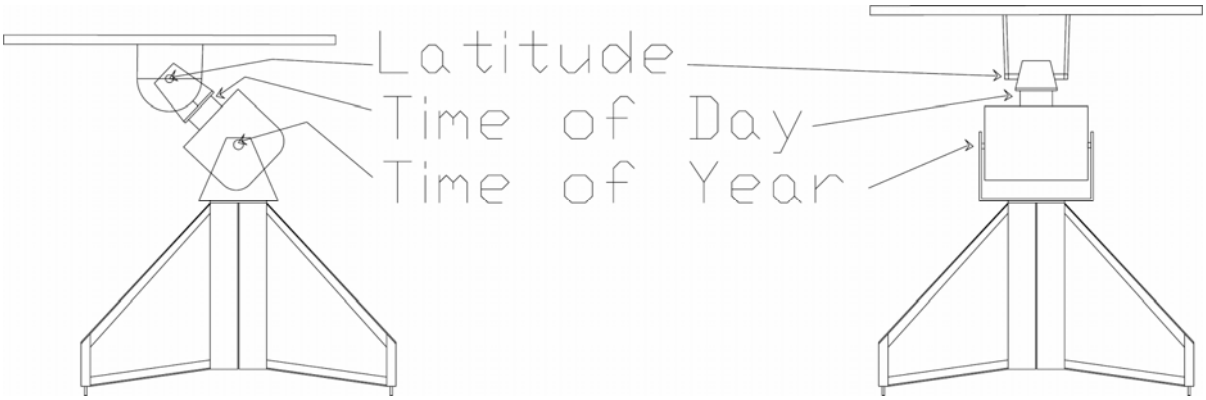

Fig. 27

These drawings are for a computer controlled - automated heliodon. Drawings courtesy of Northwest Custom Design & Fabrication Inc. (Craig Cornwall)

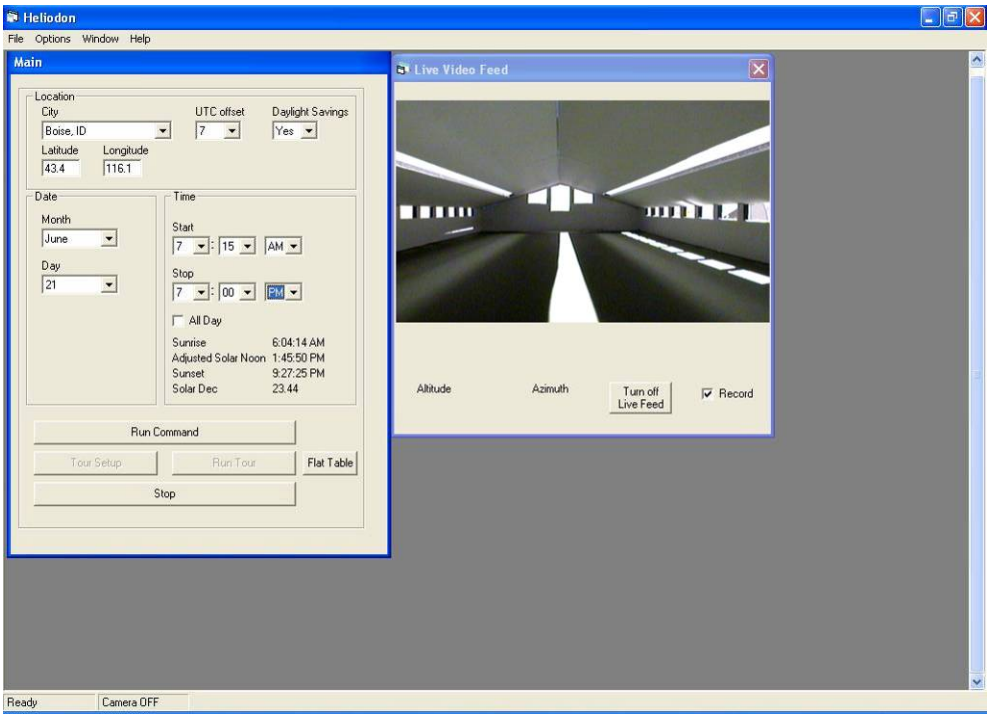

Fig. 28 The Graphic User Interface has been designed for logical heliodon functionality. Software Development by Adam Stoelting Development. (Adam Stoelting)

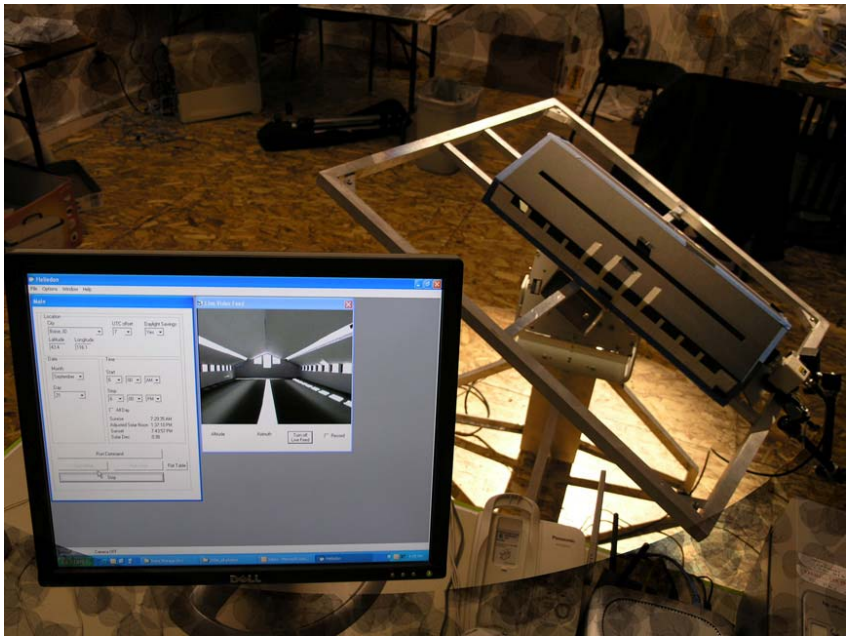

Fig. 29 Showing computer graphic user interface in the foreground with live video capture and physical model in the background on the heliodon.

Fig. 30 Showing heliodon with physical model and camera set up.

6.5b Overcast Sky Simulator Drawings

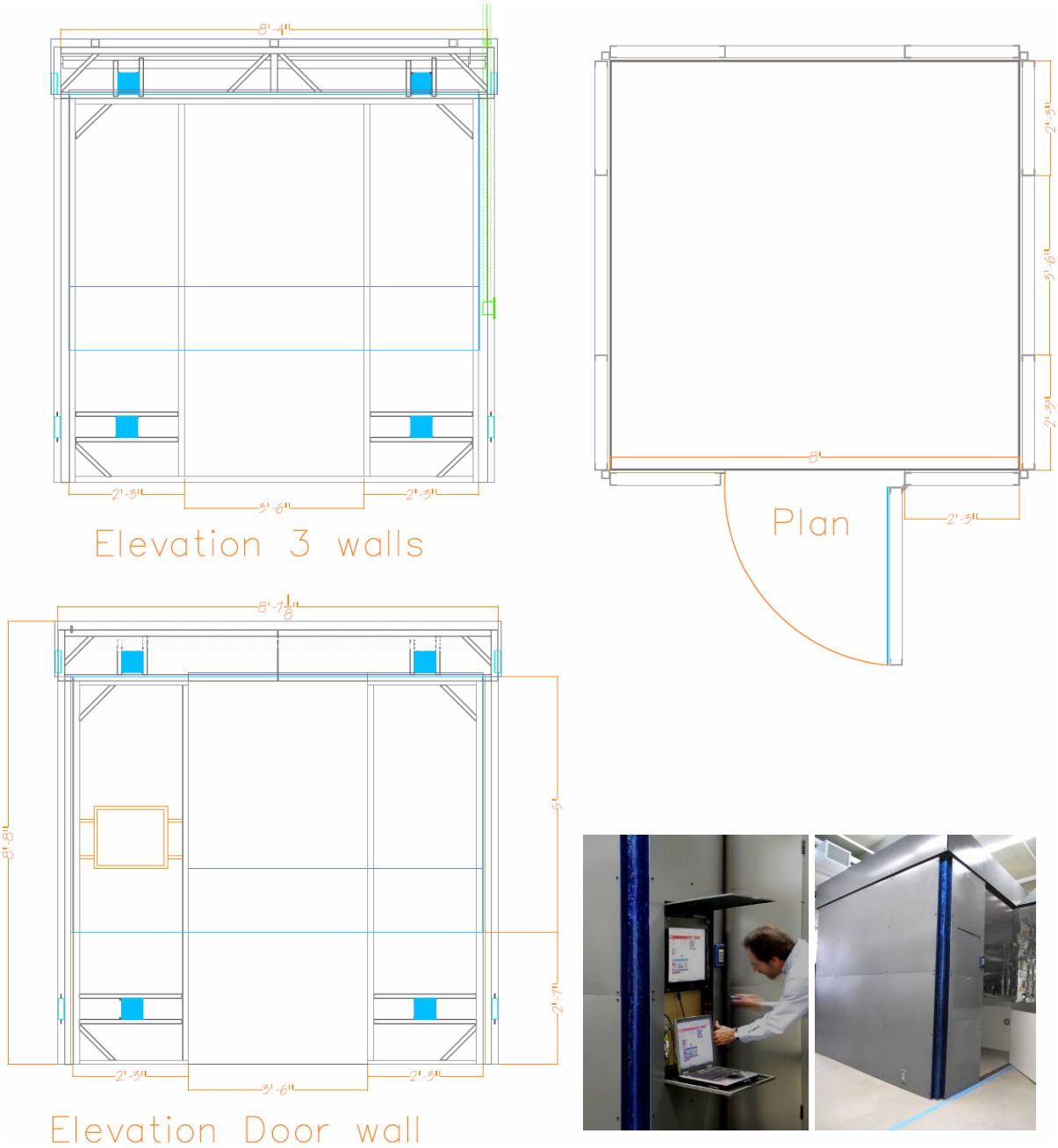

Fig. 31

Fig. 32

Drawings and photographs courtesy of Northwest Custom Design & Fabrication Inc. (Craig Cornwall)

6.5c PURCHASING LISTS / VENDORS

Equipment	Vendor / Type	Contact
Heliodon	Northwest Custom Design & Fabrication Inc.	Craig Cornwall – 208.713.1154
Overcast Skybox	Northwest Custom Design & Fabrication Inc.	Craig Cornwall – 208.713.1154
Skybox Data Logger	Omega / OMB-DAQ 56 (option 1)	www.omega.com
Skybox Data Logger	Campbell Scientific (option 2)	www.campbellsci.com
Skybox Photocells	Li-Cor / LI-210 SA (Count 10)	http://www.licor.com/env/PDF_Files/210sa.pdf
Illuminance Meter	Minolta– T 10	http://kmpi.konicaminolta.us/eprise/main/kmpi/content/ISD/ISD_Category_Pages/industriallightmeters
Luminance Meter	Minolta– LS 100 or LS 110	

Fig. 33

Software	Purpose / *Time Intensity*	Contact
Lumen Micro / Lumen Designer	Basic Lighting Rendering & Measurement / Low – *Medium-high*	www.lighting –technologies.com
AGI 32	Lighting Rendering & Measurement – more detail available / *Medium - high*	www.agi32.com
Radiance	Advanced Lighting Rendering and Measurement / High	www.radsite.lbl.gov/radiance/
Energy Scheming	Schematic Loads Analysis / *Low to Medium-high*	www.darkwing.uoregon.edu/~esbl/
eQuest	Parametric Energy Modeling / *Low to High*	www.doe2.com
Eco-tect	"Holistic" basic environmental design tool / Medium	www.ecotect.com
AutoCAD	Primarily for intake of drawings & performing area calculations and space measurements / NA	www.autodesk.com
Adobe Creative Ste.	Graphic editor, Graphic Layout / NA	www.adobe.com
Adobe Premier	Video editing / NA	www.adobe.com

Fig. 34

6.6 Advisory Group / Key Relationships

Developing an advisory group is important for several reasons. A good advisory group will help to form and focus the direction of the daylighting lab. The advisory group will also be important in the successful operation of the lab and can serve to establish important partnerships for funding as well as service coordination. The advisory group of the Integrated Design Lab has key members for each of the following agencies or disciplines:

Architect(s) - Small Firm
Architect(s) - Large Firm
Mechanical Engineer(s)
Electrical Engineer(s)
State Department of Energy
Electric Utility Commercial Conservation Manager
Electric Utility Commercial Incentive Coordinator
Energy Consultant
Code Official
Division of Public Works Conservation Manager
Electric Lighting Representatives / Retailers
University – Department of Architecture Chair
University – Architecture Professor

6.7 Employees / Position Descriptions

The lab director's salary will depend upon experience and job description. The model established in the PNW Labs is that the lab director is also a professor of architecture at a local university. The university typically pays 50% of the director's salary which allows them to teach half time. This split position (50% professor and 50% lab director) is a good model of market transformation – teaching the next generation of young architects the principles of daylighting and the importance of daylight model studies.

A position description for a lab director would likely include:

- Training in architecture at the graduate level.
- Demonstrated experience with daylight consultation as it relates to visual comfort, energy use and electric lighting integration.
- Some experience in energy modeling, electric lighting design, lighting controls and general project management.
- University teaching experience.

The model established by the PNW Lab Network further promotes market transformation through the employment of interns or work study students. The Daylighting Lab in Seattle has as many as 8-10 part time work study students employed between 8-20 hrs per week. These students work with local design teams on real projects and have high success rates landing jobs with these firms as they graduate.

A position description for graduate student interns would likely include:

- Enrollment in host university's department of architecture or engineering
- Demonstrated skill as a designer via submitted portfolio/excellent graphic ability
- Demonstrated interest in daylighting research
- Capacity with relevant computer software

For labs with funding to hire additional support beyond intern graduate students, a second technical expert is helpful. The pay will be based upon funds available and the skills set of the technical expert. This person is ideally a full time employee that will assist in the day to day activities of the lab and will also serve as a project manager on some projects.

A position description for a Technical Expert would likely include:

- Training in architecture at undergraduate level.
- Demonstrated technical experience in required discipline.
  (Electric Lighting, Energy Modeling, Daylighting, Mechanical Systems Design, etc…)

7.0 Contact Information

7.1 Pacific Northwest Lab Network

Integrated Design Lab | Boise, Idaho
Operated by the University of Idaho – Department of Architecture
Director: Kevin Van Den Wymelenberg, Assistant Professor of Architecture
Phone: 208.724.9456
Email: kevinv@uidaho.edu

BetterBricks Daylighting Lab | Seattle, Washington
Operated by the University of Washington – Department of Architecture
Director: Joel Loveland, Professor of Architecture
Phone: 206.616.6566
Email: daylight@u.washington.edu

Energy Studies in Buildings Lab | Portland, Oregon
Operated by the University of Oregon – Department of Architecture
Director: G.Z. Brown, Professor of Architecture
Phone: 503.725.2930
Email: terryb@uoregon.edu

Energy Studies in Buildings Lab | Eugene, Oregon
Operated by the University of Oregon – Department of Architecture
Director: G.Z. Brown, Professor of Architecture
Phone: 541.346.5647
Email: terryb@uoregon.edu

Daylighting Lab | Spokane, Washington
Operated by Washington State University – Interdisciplinary Design Institute
Director: Judy Theodorson, Adjunct Faculty of Architecture
Phone: 509.358.7964
Email: jtheodorson@wsu.edu

Integrated Design Lab | Bozeman, Montana
Operated by the Montana State University – Department of Architecture
Director: Tom Wood, Professor of Architecture
Phone: 406.994.4717
Email: twood@montana.edu

7.2 Other Daylighting (or similar) Labs

Pacific Energy Center | San Francisco, California
Operated by Pacific Gas & Electric Company
Director: Jim Chace
Architectural Program Coordinator: Bill Burke
Phone: 415..973.9951
Email: wxb0@pge.com

California Lighting Technology Center | Davis, California
Operated by the University of California - Davis
Director: Michael Siminovitch, PhD
Associate Director: Konstantinos (Kostas) Papamichael, PhD
Phone: 530.757.3495
Email: kpapamichael@ucdavis.edu

Lighting + Energy Technology Lab | Charlotte, North Carolina
Operated by the University of North Carolina – Department of Architecture
Director: Dale Brentrup, Professor of Architecture
Phone: 704.687.2664
Email: dabrentr@email.uncc.edu

Facilities Simulation Laboratory| Ann Arbor, Michigan
Operated by the University of Michigan – College of Architecture & Urban Planning
Director: Mojtaba (Moji) Navvab, Associate Professor of Architecture, PhD
Phone: 734.936,0228
Email: moji@umich.edu

Lighting Research Center| Troy, New York
Part of Rensselaer Polytechnic Institute
Director: Mark Rea, PhD
Phone: 518.687.7100
Email: leslir@rpi.edu

Loisos + Ubbelohde Associates | Oakland, California
Private Practice
Principal: George Loisos
Principal: Susan Ubbelohde, Associate Professor of Architecture
Phone: 510.547.4199
Email: L+U@coolshadow.com

The Weidt Group | Minnetonka, Minnesota
Private Practice
Contact: David Eijadi
Contact: Tom McDougall
Phone: 952.938.1588
Email: info@twgi.com

8.0 List of Figures