FY13 URO Seed Grant Application
Form Must be Typed

Seed Grant Application Cover Page

PRINCIPAL INVESTIGATOR:

Name:	Bruce Haglund	Title:	Professor
Department:	Art & Architecture	Email:	bhaglund@uidaho.edu

ADDITIONAL INVESTIGATORS:

Name:		Title:	
Department:		Email:	
Name:		Title:	
Department:		Email:	

Amount Requested: $12,000

Proposal Title: **Design, Build, Test, and Instrument a Prototype Artificial Sky**

PROPOSAL CHECKLIST:

XX Abstract
XX Narrative (2 single-spaced pages)
XX Budget Page
XX Biographical Data
XX Publications/Exhibits/Performances (5 years)
XX Proposals Submitted/Funded (5 years)
n/a Summary of Previous Seed Grant(s)
n/a Applicable animal/human requests for approval are attached

Has seed grant previously been awarded? ☐ Yes **XX** No

ELIGIBILITY:

☐ Early career faculty establishing scholarly program (5 years or less employment at UI)
XX Established faculty transitioning into a new scholarly area

ABSTRACT

Design, Build, Test, and Instrument a Prototype Artificial Sky

This proposal seeks funding to design, build, test, and instrument a prototype low-energy artificial sky. Preliminary work on the project has been unfunded (including a UI Seed Grant application last year). Last semester 20 graduate students in a lighting research seminar, using scale model skies, explored the design options for creating a passive low-energy artificial sky that uses the natural sky as the light source. They discovered two viable options, one that offers improvement in light distribution and quality as well as lower energy use than electrically lighted artificial skies.

With seed grant support we will design and build a full-scale prototype (~10′ x 10′) of this improved sky for temporary installation near AAN and eventual re-installation at our new interdisciplinary design laboratory on campus in Moscow—a hands-on research project for a group of architecture and interior design students. The prototype sky will become a lasting instrument for succeeding cohorts of faculty and students to use in their design studio work, research, and (potentially) consulting.

Our results will be disseminated widely via conference paper presentations and journal articles to the academic and professional design communities in the United States and internationally.

Anticipated start date: 1 July 2012; expected date of completion 31 August 2013.

NARRATIVE

Design, Build, Test, and Instrument a Prototype Artificial Sky

Context: To avoid the most catastrophic effects of global climate change, it is imperative that we reduce the amount of carbon dioxide equivalents (CO_{2e}) released into our atmosphere. In the United States, energy use in buildings accounts for almost half of these emissions. One of the more viable strategies for reducing such energy use, and thus carbon emissions, is to take advantage of natural daylight to replace and reduce electric lighting during daytime hours. Successful daylighting strategies reduce energy loads, both electrical (by turning off or dimming lights) and cooling (by reducing waste heat generated by electric lighting). The U.S. Government reports that about 55% of the typical office or school's energy use is for lighting and 23% for heating and cooling. Effective daylighting benefits the building owner/user by reducing energy costs, the occupants by improving productivity and reducing absenteeism, and society by reducing carbon emissions. In addition to visual assessment of and for architectural quality, daylighting schemes for both new and existing buildings must be tested for light levels, light distribution, and glare before the building is actually built or remodeled in order to achieve highly successful results. This type of testing is also valuable in architectural education where students can verify the fitness of their proposals for building designs. The design, testing, and re-design of their projects provide opportunities to gain practical skills applicable in their professional careers as well as experience with research methodology.

Testing physical scale models of architectural spaces is an accurate means to evaluate daylighting schemes for buildings. An effective daylighting model allows the designer to record and compare daylight aperture design options quickly and accurately. Useful comparisons can be achieved only under reliably consistent sky conditions. The natural sky poses a problem: Natural skies are dynamically variable, not only from day-to-day, but minute-to-minute, defeating the principle of consistency required for accurate comparisons. This problem has led lighting designers to create electrically lighted artificial skies for testing proposed daylighting schemes. These artificial skies must be able to simulate a standard uniform overcast sky condition where the zenith is about three times brighter than the horizon with gradual darkening from zenith to horizon. To achieve this goal two basic types of electrically lighted skies have been used—mirror box and hemispheric skies. Both use considerable lighting energy. For example, the UI Integrated Design Lab (IDL) in Boise has an electrically lighted mirror box artificial sky that uses twenty-two 59-watt fluorescent lamps (1,298 watts total). Skies in Cardiff and London draw 12.8 and 5.4 kilowatts, respectively. Other skies exist at research universities and energy labs around the world.

Research Question: Can a low-energy artificial sky be developed to meet the teaching, research, and consulting demands of the existing high-energy artificial skies? Our unique project has explored the feasibility of creating an artificial sky that uses the natural sky as the light source. Last semester 20 students in a lighting research seminar,

using scale model skies, explored the design options for creating a passive low-energy artificial sky that uses the natural sky as the light source. They discovered two viable options, one that offers improvement in light distribution and quality, as well as energy use, over electrically lighted artificial skies. Our preliminary work has been unfunded with the exception of department support for purchase of the digital camera and circular fish-eye lens (~$1,700). With seed grant support we intend to build and instrument (for model testing) a full-scale prototype (~10′ x 10′) for temporary installation at AAN and eventual re-installation at our new interdisciplinary design laboratory on campus in Moscow—a hands-on research project for a group of architecture and interior design students. The prototype sky will become a lasting instrument for succeeding cohorts of faculty and students to use in their design studio work, research, and (potentially) consulting.

The seed grant will fund the prototype's instrumentation for model testing in the prototype sky (well-defined) and building materials for the artificial sky enclosure (we're currently refining the design and making construction documents) as well as part-time support for a graduate student who will serve as design, construction, and testing team leader. The team of student researchers will construct (summer 2012), instrument, test, and analyze the results of the prototype during summer, fall, and spring terms 2012-13 in non-thesis research classes led by the PI. In addition to being work new to the PI (although related to his expertise), it is unique to the field—no one else has created a passive artificial sky, and will offer a reliable, low-cost, energy-conserving alternative to the current electrically lighted artificial skies. Moreover, it will replace the need for our students to expend energy and carbon for transportation to and from the most proximate existing artificial sky in Spokane as well as the energy required to illuminate the sky. Having an artificial sky on campus will also serve to involve more students in daylight model testing and research.

Results: Research findings and plans for the daylighted artificial sky will be disseminated widely via conference paper presentations and journal articles accessible to the academic and professional design communities in the United States and internationally. We presented the preliminary work on the project to the Professional Lighting Designers' Convention (PLDC 2011) in Madrid, Spain, in October 2011. We have been invited to present the results of the Lighting Research Seminar to the World Renewable Energy Forum in Denver, CO, in May 2012. Hopefully, results from the working prototype will be presented to the Passive and Low-Energy (PLEA) Conference in Lima, Peru in November, 2012. Upon completion of the work a journal article is likely.

As a platform for student-centered research and practice experience, the prototype will be a research, education, and consulting resource at UI for years to come, benefitting our students, faculty, and regional design professionals who are striving to create a low-energy, low-carbon future.

Bibliography

1. University of Cardiff School of Architecture
   http://www.cardiff.ac.uk/archi/skydome.php
2. The Bartlett School of Architecture
   http://www.bartlett.ucl.ac.uk/research/consult/sky/sim01.htm
3. Integrated Design Lab Boise http://www.idlboise.com/node/105
4. Architecture 2030 http://architecture2030.org
5. *Advanced Buildings Daylighting Pattern Guide*
   http://patternguide.advancedbuildings.net/patterns/pattern-11-toplighting-classroom
6. Haglund, Bruce, "Feasibility and Design of a Daylighted Artificial Sky ," *PLDC 2011 Convention Proceedings*, Joachim Ritter, ed., Oct 2011