

20.302

Advanced Topics in Performative Design: Daylight and Electric Lighting

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Course Instructor

Daniel J. Whittaker

Course Description

This seminar course teaches natural and electric lighting in an architectural context. Students will learn the scientific basis of light and visual perception in order to apply them to the design of two course projects: the design and construction of an electric light fixture (luminaire) and the comprehensive lighting design of a large communal gathering space with integrated electric and daylight systems. Individual activities and lectures focus on lighting measures and metrics, calibrated high dynamic range photography, daylight simulations, material properties, visual comfort / perception, electric lighting design, lighting energy consumption, scale model building and human behavior.

Learning Objectives

By the end of this course, you will be able to:

- Discuss and explain the physics of the behaviour of light
- Describe the relationship between lighting design, building energy performance, human comfort, and perception
- Measure lighting quantities using accurate techniques
- Produce physically-based lighting simulations with a high degree of quality
- Apply physical knowledge about lighting and information from lighting simulations to the design of building elements and spaces
- Communicate and document a design process using lighting information via verbal, written and visual means

Measurable Outcomes

- Conduct a series of lighting design techniques utilizing rules of thumb, physically-based simulations, scale model construction, and measurements
- Identify, examine and classify elements which result in high quality lighting in an analysis of a case-study design
- Produce two projects using lighting measurements and lighting simulations: the design of a large gathering space and the design of an electric light fixture

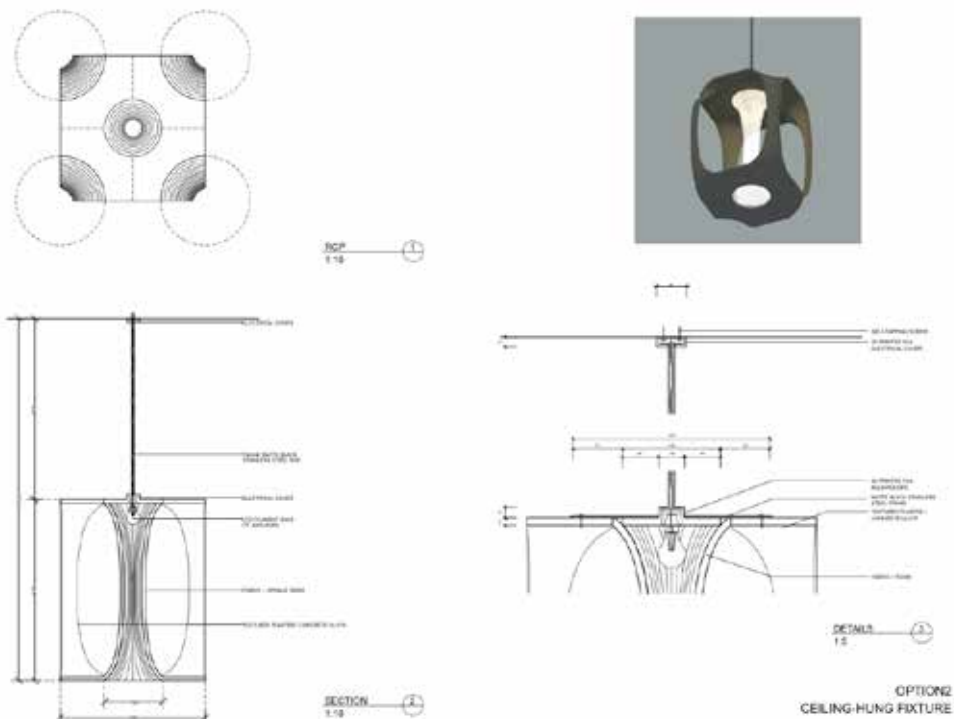


Figure 1: Thet Now and Song Tingxuan

Technique

Plan, Elevation, Section and detail drawings, complete with material annotation, dimensions and connection points, illustrate to the craftsman and electrician, how to fabricate, assemble and finish the luminaire. An additional Revit perspectival image illustrates a condition where opaque and translucent polylactic acid filament could be combined to form a dynamic tonal luminaire

Figure 1: Thet Now and Song Tingxuan

Technique

A dynamic ordinarily symmetrical form, polylactic acid filament supplied the base material for a 3D printed form. A center translucent column houses a columnar LED unit providing uniform radial illumination. Intended as a pendant luminaire, the final form created was a desk-top lamp providing functional reading illumination.



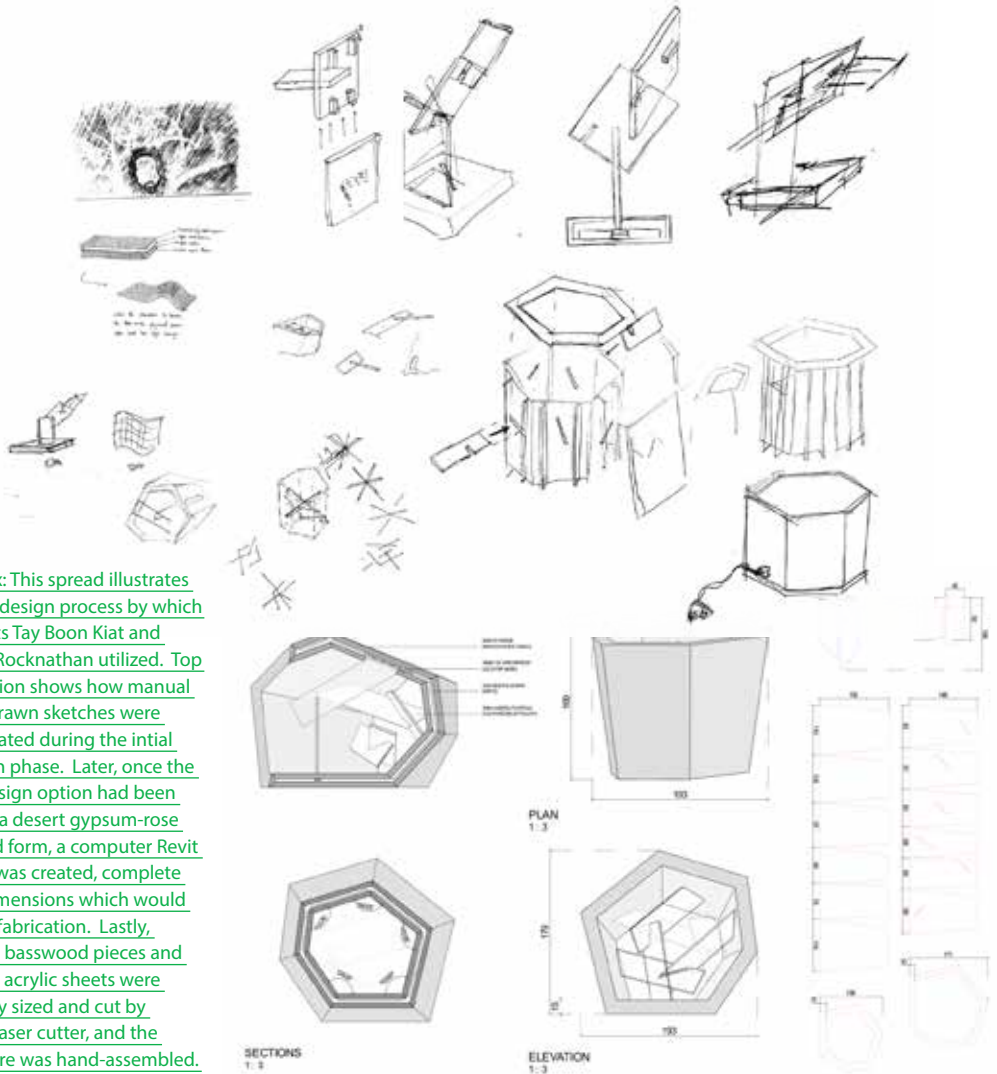
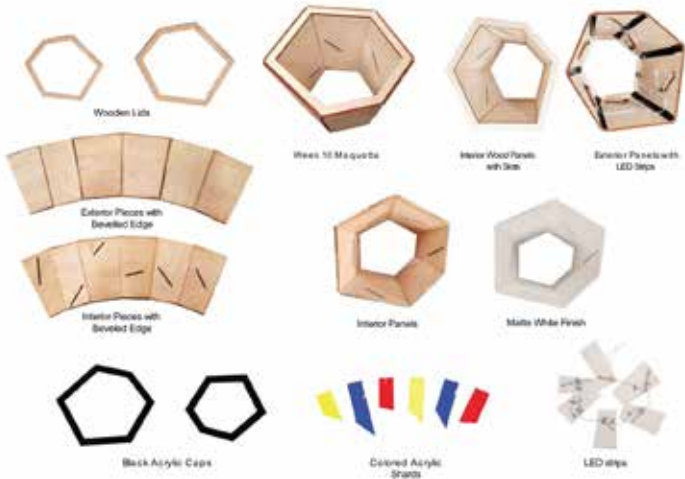


Figure x: This spread illustrates the full design process by which students Tay Boon Kiat and Simon Rocknathan utilized. Top illustration shows how manual hand-drawn sketches were first created during the initial ideation phase. Later, once the best design option had been vetted, a desert gypsum-rose inspired form, a computer Revit model was created, complete with dimensions which would aid in fabrication. Lastly, full-size basswood pieces and colored acrylic sheets were carefully sized and cut by a CNA-laser cutter, and the luminaire was hand-assembled.



Term 7

Figure x: Ee Yan Eion Goh / Sean Lee Jun Wei point out the background elements which influenced the shape, configuration and inspiration of the design of their luminaire which utilized flexible electroluminescent fibre.

Figure x: Chin Kee Ting and Goh Min Rui explain the background of their design process and how it influenced their luminaire design to the abassador.

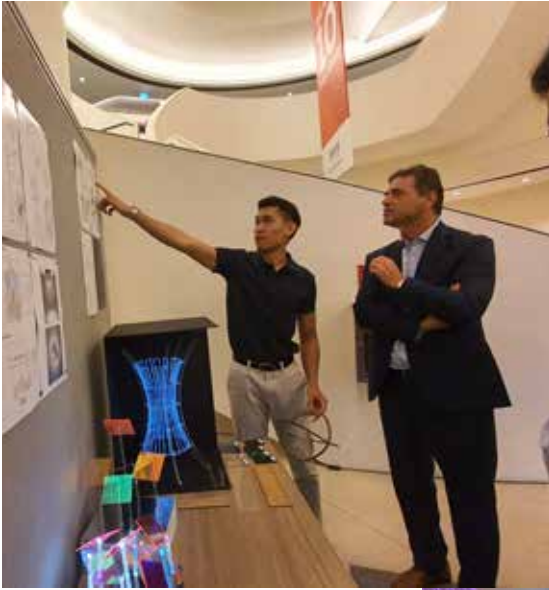


Figure x: Pleased with the results of the preliminary review in the Campus Centre, a portion of the daylight and electric lighting course celebrates with an impromptu group photo.





Figure 1: Teo Shao Tian and Benjamin Chong

“Hachimitsu”

Wrapped thin-gauge aluminum forms conceal the source of their illumination. Thin-mesh translucent nylon fabric is supported within by a hidden armature of laser-cut acrylic panels. A thorough exploration of geometric forms is demonstrated through the diverse array of hand-drawn sketches. The students worked in tandem to create complimentary designs in order to conclude the best solution for a desk-top luminaire. Numerous maquettes ensured all possible assembly forms and geometries were experimented with during the intense design development phase.



Figure 1: Teo Shao Tian and Benjamin Chong

“Hachimitsu”

Final design poster, exhibited for the special Hungarian-embassy sponsored presentation concerning hidden histories of the Bauhaus. Students received additional reviews and critical eyes from ambassadorial staff. Review of the Bauhaus design process linked the pedagogy of the course to early modern design didactic precedents.

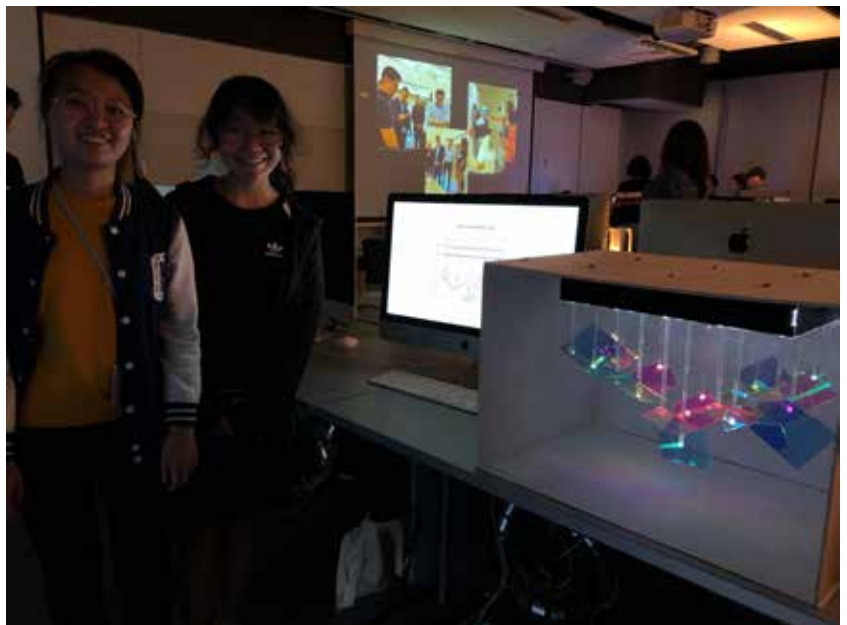


[Figure x: Final review classroom](#)

[Figure x: Yeo Kai Lin and May Thinzar Lin](#)

"Mirage"

Numerous high-intensity LEDs illuminate multiple acrylic rods, transmitting light terminating on dichroic-coated acrylic sheets. Positioned at multiple rakish angles, this maquette illustrates how a final luminaire could be fabricated at large-scale.





[Figure x: Arisa Terivapirom and Mary Agnes Angel](#)

Technique

Inspired by traditional Japanese oragamic techniques, this luminaire harnesses thick folded mylar sheets, layered with thin-sliced veneers of basswood. A hybrid luminaire is illuminated by a singular internal LED, casting a desirable warm glow upon the room.

[Figure x: Chen Ran](#)

Technique

Additive printing techniques were harnessed to create angled leaves which comprise each shade 'petal'. Traditional polylactic acid filament yields a warm translucent glow, and aids in directing the task light downward upon a work surface.





[Figure x: Chin Kee Ting and Goh Min Rui](#)

Technique

An exquisite luminaire, this fixture combines the best of both precise hand-crafted crochet (knitting and weaving) techniques with laser-cut solid wood panels. A fine filigree of light falls through the deft weave onto the supporting table surface. A pin-point led light source ensures a crisp moiré of shadows are cast upon the supporting table.

[Figure x: Lau Ruiqi Rachel and Natalie Tsang Yan Ting](#)

Technique

Thin, narrow strips of treated basswood, water-soaked and heated conforms to a radius set in permanent compression. Rotate-able on washers, narrow slivers of light can be configured to precisely emit the desired degree of illumination. Anchored on a cast-concrete pedestal base, set in formwork created through additive printing, this torchiere was created ready for both serial production and to solve numerous architectural illumination challenges.





[Figure x: Chan Jia Qi Audrey and Clarissa Maharani Hartanto](#)

Technique

A hybrid potted plant hangar and LED plant light is showcased in this innovative luminaire. Flexible LED strips provide ample illumination for plant growth along both an X and Y radiused axis. A polylactic acid filament 3-D printed spherical planter pot cradles the plant in the center axis of the implied sphere.

[Figure x: Kelly Yeo Jing Er and Nidi Hegde](#)

Technique

Concentric rings, stacked and anchored to a sloping veneer wood back, incorporate annular rings of LED lamps, gently illuminating thin sliced walnut wood veneer. The power driver is deftly incorporated into the luminaire's base, also providing anchoring ballast for the otherwise lightweight fixture.





Figure x: Goh Ee Yan Eion and Sean Lee Jun Wei

Technique

Flexible electroluminescent fiber, emitting light from a 360-degree radius along its length, is woven into a laser-cut acrylic armature. Sections of a hyperbola provided the dynamic curvature of the armature; precisely positioned mirrors provide the illusion of form continuing *ad infinitum*.

Figure x: Singapore architects guest critics

Final Review

Khai Toh, AIA, LEED AP, Singapore architect accompanies Senior Lecturer, Daniel Joseph Whittaker, Ph.D., and Singapore architect Nicholas Tan reviewed the students' final projects: completed maquettes, computer-rendered perspectival images and construction document drawings. Critical feedback from outside professionals provide an essential component of the final review, enriching student design understanding.

