Interdisciplinarity as a Sustainable Pedagogical Tool

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"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

-the United Nations World Commission on Environment and Development
Sustainability: possibility?
Buildings consume a significant proportion of energy used in the U.S.
Overall US energy consumption

- Buildings: 48%
- Transportation: 27%
- Industry: 35%
- Residential: 21%
- Commercial: 17%

Source: architecture2030.org
Overall US electricity consumption

- Buildings: 76%
- Industry: 23%
- Transportation: 1%

source: architecture2030.org
Buildings consume a significant proportion of energy used in the U.S. Reducing building energy use, then, is an important strategy towards a sustainable society.
Five principles of an environmental architecture

- (Thomas A. Fisher, AIA, November, 1992)

* Healthful Interior Environment.
  – Safe
  – Accomodating

* Energy Efficiency.
  – Small energy footprint
  – Wise use of energy

* Ecologically Benign Materials.
  – Sustainable resource use
  – Low site impact
  – Low environmental impact

* Environmental Form.
  - Passive strategies

* Good Design.
Sustainable decision-making

* Healthful Interior Environment.
  – Safe
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* Environmental Form.
  - Passive strategies
* Good Design.

• Sourcing
• Location
• Transportation
• Harvesting impact
• Processing impact
• Use/Impact of use
• Disposal
Sustainable decision-making

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  - Passive strategies
  - Design.
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How do we prepare students for sustainable decision-making?
“thick” decision-making

- cross-disciplinary considerations
- avoids “universality” of one discipline’s viewpoint
- objective, impartial, generalizable assessment to foster correct results to complex problems
interdisciplinarity

- *Initiatives that cross disciplines*
- *Provides broad inquiry into complex problems*
- *Solution set validated by multiple groups*
Project Solar House
Kansas State University
University of Kansas
Project decision map

Primary stakeholders: architecture (KSU) & architectural engineering (KU)

- Faculty Team
  - advisory board
  - core student team
    - design
    - construction
    - documentation
    - fundraising
- student volunteers
  - building systems
  - solar systems
  - HVAC/water
  - budget/scheduling
  - web design
  - marketing
Core student team – curricular units
architecture students in studios
engineering students in labs & other classes

Faculty Team
- advisory board
- design
- construction
- documentation
- fundraising

Core student team
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- solar systems
- HVAC/water
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- web design
- marketing

Student volunteers
Curricular units

**Architecture**
- Spring '06  Design Development
- Fall '06  Construction Documents
- Spring '07  Construction
- Fall '07  Competition

**Interior Architecture**
- Fall '07  Design and Construction of Interior Furnishings

**Landscape Architecture**
- Fall '06-Spring '07  Sustainable Landscape Systems

**Electrical Engineering**
- Fall '06  Solar System Design

**Mechanical Engineering**
- Fall '06  HVAC Design
- Spring '07  Construction & Installation of HVAC

**Architectural Engineering (KU)**
- Spring & Fall '06  Preliminary & Final Energy Analysis
Project Solar House – Design Process

Energy efficiency
Renewable energy strategy
Design of HVAC system
Energy Efficiency
architecture (KSU)
architectural engineering (KU)
Energy Efficiency

architecture (KSU)
architectural engineering (KU)

goals: reduce energy use through building envelope design
redirect expectations in regard to energy use
maximize usable ambient energy
minimize detrimental external loads
Energy Efficiency

Compact size
Environmental Form
Compact size
Energy efficiency

Turning one’s back to the sun
Energy Efficiency

Turning one’s back to the sun
Energy Efficiency

SIPs
Energy Efficiency
SIPs
Energy Efficiency
Metal roof
Energy Efficiency

Metal roof
Energy Efficiency

daylighting – indirect light
Energy Efficiency
daylighting
Energy Efficiency

daylighting – vertical glazing
Energy Efficiency

daylighting – vertical glazing
Energy Efficiency

daylighting - skylights
Energy efficiency
Energy Simulation

Electric Consumption (kWh)

Base case – 10,130 kWh-hrs

EEM case – 7,003 kWh-hrs
Renewable Energy

electrical engineering (KSU)
architecture (KSU)

goals: provide all power needed
allow PV system to have presence in design & occupant experience
PV system as educational tool
On-site Renewable Energy Production

Building integrated photovoltaics

photovoltaic array

The system uses BP solar modules of type BP 275F which have a nominal voltage of 12V and a peak power of 75W.
Renewable Energy
Building integrated photovoltaics
Renewable Energy

64 degree angle “sun wall”
Renewable Energy
Building integrated photovoltaics
HVAC System

architecture (KSU)
mechanical engineering (KSU)

goals: provide optimal thermal conditions
       minimize energy use
       maximize control
HVAC System
Decision matrix

goals: provide optimal thermal conditions
minimize energy use
maximize control
HVAC System
Decision matrix

goals: provide optimal thermal conditions
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Outcomes & Recommendations

student responses

- broadened understanding & sensitivity to decision-making
- team-building & interpersonal skills
- heightened concern for sustainability

interdisciplinarity at K-State

- good job at intra-college collaboration & at foundational level
- NRES secondary major, Honors system

incorporate interdisciplinarity in curricula

- identify common educational goals
- identify skills that will advance sustainable approaches
- make collaboration a priority
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