Understanding How Virtual Prototypes and Workspaces Support Interdisciplinary Learning in Architectural, Engineering and Construction Education

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High Performance Buildings require Collaboration
Complexity => interdisciplinary learning

Methodology

Language

More than one discipline

(Schaffer et al. 2008, Orr, 2006)

Interdisciplinary Studio
(Lab) Design Courses

(McCuen & Fithian 2010
Dossick & Pena 2010
Holland et al. 2010
Dib & Koch 2010
Gardzelewski et al. 2010
Salazar et al. 2010)
“design as a social process”  
(Bucciarelli 1994)

develop shared mental models collaboratively  
(Orr 2006)

A move away from Cooperative Approaches  
- division of work into independent parts (Smith et al. 2005)

to Collaborative Interdisciplinary Learning

• unstructured processes
• negotiate goals,
• define problems,
• develop procedures, and
• produce socially constructed knowledge

(Goldsmith & Johnson 1990, Dorsey et al. 1999)
COLLABORATION WORKSPACES AND VIRTUAL PROTOTYPING

“Problem solving aligns with display interaction”
(Leicht et al. 2007)

“Integrate spaces, teams, information, and processes”
(Fernando 2003)

“Computer simulation of a physical product”
(Wang 2002)
RESEARCH QUESTION

What models and technical infrastructure are required for collaborative, team-based, interdisciplinary engineering education?
The Sites: Integrated Design-Build Studios

Sustainability
BIM
Collaboration

“Comm” Students
Collaboration

**UW - Teams of 8**
Dual Degree, Architecture, Construction Management, Engineering

North Building
Current Production: 97.7022

West Building
Current Production: 97.7022

Combined Production: 97.7022

34° array tilt
Collaboration

PSU - Teams of 6
Architect, Landscape Architect, Structural Engr, HVAC Engr, Lighting Designer, Construction Engr

4-D Modeling

Day 113 Week 17

Day 121 Week 18

Day 204 Week 30

Day 268 Week 39

Student Work

Student Work
University of Washington’s Studio

**Team A**
Collaborative Workspace

“their use of the space was more conducive to collaboration “

**Team C**
Cooperative Workspace

“the group-centered technology was not used as much “
University of Washington’s Studio

Construction Phasing

Phase 1 Foundation:  Phase 1 Structural Framing:  Phase 1 Enclosure:

Phase 2 Foundation:  Phase 2 Structural Framing:  Phase 2 Enclosure:

Phase 3 Foundation:  Phase 3 Structural Framing:  Phase 3 Enclosure:

Team A
Collaborative 4D Model

Team B
Cooperative 4D Model
Penn State’s Studio

**PSU - Team B**
**Separated Workspace**

“The two sub-groups used one member as a runner to communicate between the two groups separated across the room to different clusters”

**PSU - Team C**
**Low-Tech Workspace**

“They would leave the computing lab during their studio time to work together using drawings and sketches, treating the modeling tasks as assignments between team meetings”
Communication Influence

[Diagram showing communication influence factors]

- Feedback Immediacy:
  - Textual Information
  - Graphic Images
  - Video
  - Verbal tone & hand gestures
  - Math models

- Rehearsability
- Reprocessability
- Symbol Variety
- Parallelism
Findings: Spaces reinforce Norms

Teams differed significantly

Collaboration norms established early

Co-ownership in design

Strong relationship between space usage and interaction

“It is not only a matter of appropriate hardware and software, but also one of appropriate digital studio layout to facilitate collaborative team work.”

- Bob Holland
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