POP modeling of a green dorm

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Virtual Design and Construction (VDC)

Use of multi-disciplinary performance *models* of design-construction projects, including

- *Product* (i.e., facilities)
- *Organization* of the design-construction-operation team
- *Work Processes*
- *Economic Impact* (i.e., model of both cost and value of capital investments)

...to support (explicit, public) business *objectives*. 
Class Deliverables

• For the Stanford Sustainable Dorm, submit
  – *POP model*
    • Level-1: the 10 product, organization and process elements that “cost” most
  – *Product, organization & process models* associated with the POP model
    • Level-1 CAD, organization, process models
  – *Description* of POP model content
  – *Description* of POP relationships (Design Narrative)
  – *Final presentation*
# Example “Level-1” POP (BIM, VBE) Model

**Product**
- **Functional requirements**
  - Construction cost
- **Designed program-level Generic physical forms [10 for level-0]**
  - Roof
  - Exhibit space
  - Lab space
  - Collection/public storage
  - Office space
  - Exterior skin
  - Podium
  - Service spaces
  - Preserve and upgrade existing buildings: exhibits
- **Systems**
  - Roof structure
  - Life support for exhibit, lab, collection
  - Interior (FFE)
  - Podium structure
  - HVAC
  - Exterior skin
- **Measurable objectives**
  - Schedule: 95% conformance
  - Cost: >= 95% conformance
- **Predicted (product) behaviors**

**Organization**
- **Organization functional requirements**
  - Completion date
- **Measurable Organization objectives**
  - **Designed Organization actors**
    - Architect
    - Exhibit design consultants
    - MEP consultant
    - Owner
    - Pre-construction consultant
    - Structural consultant
  - **Controllable objectives**
    - Coordination requests
    - Coordination support
    - Risk element list
    - Recorded decisions made
  - **Activities schedule duration of 1-3 weeks:**
    - Track program and budget compliance
- **Predicted actor behaviors**
  - Actor with greatest predicted backlog
  - Greatest predicted actor backlog

**Process**
- **Process functional requirements**
  - Completion date
  - Safety
- **Measurable Process objectives**
  - Response latency
  - Decision latency
  - Budget estimate consistency
  - Meeting agenda appropriateness
  - Drawing coordination consistency
- **Designed process activities**
  - Known Architecture Tasks
  - Identify Hi cost Risk Elements
  - Identify Hi Cost-Risk C Elements
  - 3D Detail Hi Risk Elements
  - Estimate Hi Risk Elements
- **Predicted (process) behaviors**
  - Task with greatest schedule risk
  - Greatest task schedule risk (days)

- **POP = product, organization, process**
- **BIM = building integration model**
- **VBE = virtual building environment**
POP model content

- Columns
  - Product
  - Organization
  - Process (design + construction)

- Rows:
  - Functions
    - Program Function, Schedule, Cost, Sustainability, ... 
  - Forms (design choices)
    - L1: x10
  - Behaviors (predictions)
Example “Level-0” POP Model

<table>
<thead>
<tr>
<th></th>
<th>Product</th>
<th>Organization</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional</td>
<td>Required generic physical spaces, components and systems</td>
<td>Required generic Organization groups</td>
<td>Required major milestones and types of process activities</td>
</tr>
<tr>
<td>requirements and</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measurable objectives</td>
<td>House 60 students</td>
<td>Design</td>
<td>Design</td>
</tr>
<tr>
<td></td>
<td>Sustainability &gt; 2002 comparables by 25%</td>
<td>Build</td>
<td>Build</td>
</tr>
<tr>
<td>Designed forms [~10</td>
<td>Generic space, systems and physical elements</td>
<td>Organization actors</td>
<td>Process Milestones and Tasks</td>
</tr>
<tr>
<td>each for Level-1]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Building Elements: Dorm</td>
<td>Design-build team</td>
<td>Design-build plan</td>
</tr>
<tr>
<td>Predicted behaviors</td>
<td>Capacity</td>
<td>RFIs</td>
<td>Duration</td>
</tr>
<tr>
<td></td>
<td>Annual Energy use (BTUs)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Design narrative for L-0 POP model

Diagram showing the relationship between Designer, Simple calc, Energy calc, Number of Dorm Beds, Number of BTUs/year, Plan Design, PM, VDT, Design-Construct Organization, Design-Construct Project Duration, Human, Project RFIs, Reasoning, Representation, and Information flow.
Example Narrative

- Current energy indicators
- What is the status of energy in the world
- Fossil Fuel
- Solar Power
- Time

- What does the building look like?
- Building section

- Building Energy Use
- How much energy will the building use?

- Building Energy Use
- Environmental sensitivity
- How Environmentally Sensitive?

- Energy
- How effective are we?

- Energy
- Day lighting summary
- How well does daylight enter the building?

- Energy
- Day lighting analysis
- How does daylight enter the building?

- Environmental sensitivity
- Architecture
- Aesthetic
- Functional
- Economic
- Operational

- Building Energy Use
- Environmental sensitivity
- Integration with Surroundings
- Access to Fresh Air
- Access to Light

- Energy
- Renewable Resources
- Construction

- Embedded Energy in Materials

- Dependency
- Representation

Legend
CIFE Breakthrough Objectives

- **Safety**: 0 lost hours
- **Schedule**:
  - *Design* within “1 year” (SD, DD, CD)
  - *Construct* within “6 months”
- **Cost**: within “2% of budget” (98% reliability)
- **Sustainability**: “20% better” than previous recent jobs
- **Delivered Scope**: 100% satisfaction by POE assessment (all jobs)
- **Globalization**: >= “50%” of supply chain from global suppliers + “50%” of sales in global markets
Friday, Oct 15

- For the Stanford Sustainable Dorm, develop draft-1
  - **POP model**
    - Level-1: the 10 product, organization and process elements that “cost” most
  - *Product, organization & process models* associated with the POP model
    - Level-1 CAD (ADT, other?)
    - Organization (SV)
    - process models (SV, MSP, P3)
  - *Description* of POP model content
  - *Description* of POP relationships (Design Narrative)
Decisions today

• Homework, if any
  – Dorm functional objectives
  – Dorm architectural design

• Assignments: who does what on Friday
  – Product modelers
    • Architectural function; sustainability concerns
  – Organization modelers
    • Design, construction
  – Process modelers
  – POP modelers
  – Owner, user stakeholder representatives

• Times on Friday

• Observations to make on Friday
What do you have? ... What do you want?

2005?, ... 2015?

2005?, ... 2015?