The Effects of Comparative 4D Models on Schedule Development and Controls

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PMICOS Conference – Research Track

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Presentation Outline

- 4D Modeling Overview
- Terminology
- Users and Project Types
- Benefits
- Process
- Comparative 4D Modeling Overview
- Pre-construction
- Construction
- Post-construction
- Conclusions and Future Research Needs
2D drawings can be used to represent the construction schedule, but not a project’s spatial features.
4D Modeling Overview

...add cost, resources, etc. to create 5D, 6D or nD Models
Terminology

- 3D
- 4D, 5D, nD
- Computer Aided Drafting (“CAD”)
- Building Information Modeling (“BIM”)
- Virtual Building
Users

- Architects
- Construction Litigators
- Construction Managers
- Design/Build Firms
- Developers
- Engineers
- Facility Owners and Managers
- General Contractors
- Subcontractors
- Urban Planners
Project Types

- Chemical
- Excavation/shoring
- Financial Facility Asset Modeling
- Heavy Civil
- Hospitals (New and Retrofit)
- Land Development
- Manufacturing
- Off-shore platforms
- Office/Retail complexes
- Pharmaceutical
- Plant turnarounds
- Power plants
- Transportation
- Tunneling
Benefits – Case Studies

- 20% fewer design changes
- 40% reduction in change order rates
- 8% cost growth avoidance
- 80% reduction in time required to explain schedule to project stakeholders
- Reduced construction phase (4-month savings to critical path)
Cost and Influence Curves for 4D Models

The diagram illustrates the relationship between cost and influence level over the stages of a project: Conceptual Design, Detailed Design, Construction, and Closeout & Claims. The y-axis represents the cost level, ranging from 0% to 100%, while the x-axis represents the different stages of the project. The red line indicates the influence level, starting high in Conceptual Design and decreasing as the project progresses. The blue line represents the cost, starting low in Conceptual Design and increasing as the project moves towards Closeout & Claims. The predicted outcome and known outcome are highlighted in the middle of the diagram.
Process – Information Flow
4D Model Screen Key

- Steel
- Concrete
- Glass
- Stairs
- Floor Slabs
- Frame Walls
- Foundation
- COST to date 518,125

100% "Walls, Internal - 2nd Floor" 09/26/2005 10/04/2005 10000.00
100% "Girders, Small - Roof, Glass" 10/04/2005 10/04/2005 5000.00
12% "Girders, Large - Roof, Glass" 10/04/2005 10/11/2005 625.00
25% Slab - Roof 10/04/2005 10/07/2005 12500.00
4D Model Demo

Video File
Comparative 4D Modeling Overview

1 3D Model/2 Schedules
Comparative 4D Modeling Overview (cont’d)

2 3D Models/2 Schedules
Comparative 4D Modeling Overview (cont’d)

2 3D Models/1 Schedule
Pre-Construction – Comparative 4D Modeling Uses

- Marketing presentations
- Schedule assessment and validation
- Site logistics and sequencing
- Communication of project scope
- Resource planning
Pre-Construction – “What-if” Schedule Assessment

Pre-cast Concrete Structural System

Steel Structural System

Video File

10/12/2005
Pre-Construction – “What-if” Schedule Assessment (cont’d)
Construction – Comparative 4D Modeling Uses

- Site coordination and overview
- Workflow coordination and site logistics
- Zone/move management
- Monthly schedule updates
- Change orders and contract modifications
Construction – Progress Schedule Updates

Baseline

Progress Update
Construction – Typical Time Impact Analysis Steps

1. Define the impact, delay, or new scope of work
2. Develop fragnet(s)
3. Insert new fragnet(s) into the applicable progress schedule update in chronological order
4. Modify existing activity duration(s) and/or logical relationship(s)
5. Recalculate impacted schedule and quantify the resulting impact to the project’s critical path
Construction – Time Impact Analysis Demo

Condenser #1
Condenser #2
Condenser #3

Baseline Schedule
Construction – Time Impact Analysis Demo (cont’d)

Update Schedule

Update Schedule - Impacted
Construction – Time Impact Analysis Demo (cont’d)
Post-Construction – Comparative 4D Modeling Uses

- As-built documentation
- Operations and maintenance
- Alternative dispute resolution and litigation
Post-Construction – Alternative Dispute Resolution and Litigation
Post-Construction – As-Planned versus As-Built Delay Analysis

As-Planned Activities
As-Built Activities
As-Built Critical Path
Post-Construction – As-Planned versus As-Built Delay Analysis (cont’d)

As-Planned

As-Built

05/01/2001

100% Project Start

Video File
### Post-Construction – As-Planned versus As-Built Delay Analysis (cont’d)

<table>
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<tr>
<th>Activity ID</th>
<th>Activity Description</th>
<th>Org Start</th>
<th>Perm Brr</th>
<th>% Complete</th>
<th>Plan Start</th>
<th>Plan Finish</th>
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**Graphical Representation:**
- As-Planned Activities
- As-Built Activities
- As-Built Critical Path
Observations and Conclusions

- Current use of comparative 4D models is limited.
- Comparative 4D models offer opportunities for increasing and/or improving:
  - Scheduling efficiency and reliability
  - Constructability
  - Resource utilization
  - Project communication/coordination
  - Schedule update process
  - Effectiveness of delay analyses
Research and Improvements Needed

- Further develop comparative functionality in existing software
- Streamline and automate certain processes for increased user efficiency
- Increase interoperability between parties and project life-cycle segments
Questions?

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4D Modeling and Design Conflict Analysis CD