Future ICT Development for Construction and Facility Management

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About me

On the Faculty of the Construction Engineering and Management Program since 1991

Research at CIFE on 4D modeling since 1993, Director of CIFE since 2001

4D Consultant to Walt Disney Imagineering from 1998 to 2001

Co-Founder of Common Point Technologies, Inc.

http://www.commonpointinc.com
If they could only see it my way ...

- describe, explain, evaluate, predict (DEEP)

Can this project be built?
ICT should make the individual and the team more effective

- Simplify and integrate the description, explanation, prediction, and evaluation of building alternatives
  - Make the building and related processes sustainable
  - Give all involved parties a good experience
  - Reduce wasted planning efforts
  - Eliminate rework on site
  - Make the building occupants more productive
Agenda

• Virtual Design and Construction
  - Definition
  - CIFE’s role

• State of the Art
  - Design and schedule coordination with 3D and 4D models
  - 3D -> BOM, analyses, etc.
  - Real time building information

• Practical and Research Needs
  - 4D -> BOM, analyses
  - Models and comparisons at multiple levels of detail across life cycle and disciplines
  - Support of multi-stakeholder decision making
  - Process performance measurement
CIFE defines VDC as:

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

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

...to support (explicit, public) business objectives.
CIFE’s mission is ...

... to be the world’s premier academic research center for Virtual Design and Construction

- **Virtual Design and Construction**: develop and test new ways to model, visualize, analyze and evaluate the multi-disciplinary performance of design-construction projects to support explicit business objectives
- **Education**: increase awareness of the value and costs of strategic IT for practitioners and Stanford students
VDC big ideas

- Build project model early and often, before committing large money or time

What?
- Product, process, organization

How?
- Detailed: to “DEEP” the product, process, organization entities that are “expensive” in time, money
- Virtual: in the computer
- Visual: multi-discipline, multi-view, for multiple stakeholders
- Objective-based: set and track explicit public objectives
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Paradise Pier: gain strategic insight and improve site logistics planning

6/1/00

test & adjust ride (blue)

current lagoon work (red)

interior and exterior work on facility (light blue)
Exploration of different hoisting methods

4D Models help plan construction methods
4D models facilitate communication and make face-to-face meetings more productive.
PM4D approach on HUT-600 project

Product model exchange
Multi-stakeholder decision making

President of HUT: "The first row is too close to the speaker"
3D design and selection of mechanical systems linked to analysis software.
Energy and comfort simulations

Figures courtesy Granlund Oy
displacement cooling
mixed cooling
This is the Building Information system of the Lintulahdenkatu 5 facility. View reports by selecting building spaces on the left.
• Weather Data
• Indoor Conditions
• Environmental Impacts
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Research examples to address practical needs

• Parametric 4D modeling
  - Levels of detail
  - Intelligent product/process model

• CIFE iRoom
  - From single user, single device interfaces
  - To multi-user, multi-device interfaces
  - Use models in multi-stakeholder meetings

• Multi-perspective models
  - IFC + modular transformation mechanisms

• Process performance metrics
Barriers

- **Cultural**
  - Formal models in informal practice

- **Business**
  - Modeling cuts across today’s business models and boundaries

- **Technical**
  - Analysis knowledge for many types of analyses not yet formalized
  - Focus on data vs. focus on what to do with the data
Construction schedules do not show how to build projects

- Schedules are not detailed enough for process analysis and visualization
  - Work balancing
  - Resource allocation
  - Detection of conflicts
- Parameters used for planning are lost
- Difficult to consider what-if scenarios
There are many spatial organizations

- Region Hierarchy
  - Automatically organize elements by location and building element type
  - Define workflow direction
  - Manage activities at multiple levels of detail
  - Bound search space
Parameters used for zoning

- Baseline production rate
- Workflow direction
- Activity sequencing, buffering
- Factors affecting production rate
- Design related information

Excavate
Clay
Mesh
Place Concrete
3D work balancing

- Trade balancing
CIFE’s iRoom-to-go

Virtual Design and Construction Case Study

- Case Overview
- Baseline
- Delay
- Acceleration
- Summary and Analysis

How we spend time in meetings

- Predictive (10%)
  - Can we get access to the parking a week earlier?

- Explanative (20%)
  - What drives the turnover date for the theater?

- Descriptive (40%)
  - When do we have access to retail zone?
  - Where are you placing the crane?

- Evaluative (30%)
  - Which acceleration alternative is better?
CIFE’s iRoom-to-go

Comparison of project scenarios with two 4D models, MS Project schedule, and the CIFE Time Controller
Multi-stakeholder models

Customize views of 3D and 4D models beyond pre-defined attributes
(Multiple) predictable performance objectives

- **Safety**: 0 lost hours
- **Schedule**: 95% on-time performance
- **Cost**: >= 95% of budgeted items within 2% of budgeted cost
- **Delivered Scope**: 100% satisfaction
- **Decision latency (decision-making promptness)**: mean working days <= 1; 95% within 2 days
- **Response latency (decision-making no earlier than necessary)**: mean working days <= 1; 95% within 2 days
- **Field-generated Requests for Information**: 0 (for questions related to issues that could have been identified at the award of the construction contract)
- **Rework volume**: 0 (for field construction work); Goal = 10-20% for virtual work
- **Meeting effectiveness**: > 90% participation
- **Meeting efficiency**: > 70% prediction, evaluation
- **Coordination activity**: planned, explicit, public, informed > 90%
- **Facility managed scope**: 100% of items with > 2% of time or cost
- **Prediction basis**: > 80% of predictions founded in analyses of VDC model
- **Design versions**: 2 or more >= 80%
Participate in the VBE initiative

The Virtual Building Environment initiative:

• improves the way industry works
• educates industry about virtual buildings and IT
• advances software interoperability in the industry
• helps VDC projects
The good news: projects are moving targets
The bad news: projects are moving targets