# **Construction Technology – Global Trends**



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Additional Roles:

- Senior Fellow, Precourt Institute for Energy
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- Visiting Professor, School of the Built Environment, University of Salford, UK

# How much do you want to earn per hour?

# More than 11.9 cents?

# 1 computing hour in the cloud costs 12 cents.

# What can you do with 3.5 Million data points per day for a building? (Y2E2 Building Stanford)

# Or 500 Million data points per day for a campus? (Microsoft Puget Sound)





http://www.grida.no/graphicslib/detail/historical-trendsin-carbon-dioxide-concentrations-and-temperature-ona-geological-and-recent-time-scale\_a210#

# Reversing our climate change trajectory

HUMBLE ENCO

### EACH DAY HUMBLE SUPPLIES ENOUGH ENERGY TO MELT 7 MILLION TONS OF GLACIER!

This giant glacier has remained samelted for centuries. Yet, the petroleum energy Humble supplies—it converted into heat—could melt it at the rate of 80 tons each second. To meet the nation's growing needs for energy, Humble has applied science to nature's resources to become America's Londing Energy Company. Working worders with eil through research, Humble provides energy in many forms—to help beat our hones.



### Huge changes are required to lower carbon footprint: Predicted impact of global warming



Source: Sustainable Energy — without the hot air: MacKay, 2008, based on Baer and Mastrandrea (2006)

# Global Trends that will affect Construction dramatically

- Computing is (almost) free
- Computing is mobile
- Data are abundant
- "What you see is what you get" is today's good practice
- Projects must be economically, environmentally, and socially sustainable
- All this is normal for today's high school students

# A good design ...

- is buildable
- can be operated efficiently
- makes the users of the facility productive
- enhances its environmental and social context

 and contributes to learning how to do it even better next time.

# Is this the best we can do?

# 1,000s of construction activities don't get done as scheduled (practice on well-managed projects)



# **CIFE** Development and Background

- 100% funded by industry
  - Building owners
  - Design and construction companies
  - Software and hardware vendors
  - Seed projects and implementation
  - Leveraged with government and other funding
- 1988-2000
  - Building Information Modeling (BIM)
- 2000-2010
  - Virtual Design and Construction (VDC)
- 2010+
  - Integrated Facility Engineering
  - Breakthrough performance



The CIFE community (industry, academia) invents the next practice together



# Virtual Design and Construction (VDC)









# Combining data and visualization

Social Interface with Stakeholders

Visualization

Conceptual project planning & design	Design	Procurement	Construction	Start-up	Operations

Data

Interface with Engineering and Project Control and Management Systems

# Past $\rightarrow$ Present $\rightarrow$ Future

- Yesterday's practice: YCASWYG You can't always see what you get
- Today's practice: WYSIWYG What you see is what you get
- Next practice: WYMIWYG What you model is what you get performance







# Sutter Medical Center Castro Valley, CA, USA – \$320 Million

PRESENTATION FOR: BIM VISION, STRATEGY AND IMPLEMENTATION CONF., ABU DHABI DECEMBER 13-14, 2011





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# PUBLIC, TRANSPARENT PERFORMANCE METRICS



# Team organized to work together with BIM



# Very Detailed Process Mapping – Every 2 weeks



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# Everything above 1.0 cm was modeled in 3D



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# **Prefabricated Bathrooms**



**BIM LESSONS LEARNED DISCUSSION WITH ARUP | MARCH 21, 2011** 



# **Actual Fabricated Panel Installation**



BIM LESSONS LEARNED DISCUSSION WITH ARUP | MARCH 21, 2011







Just imagine a task list. You can also look at it as...





...a floorplan.

Reporting a new task is very easy, just tap the location and a pin appears.

	-	
Back	12:20 AM Task Details	22%
0	[A1-B] - Safety The rebars are not covere ASAP (	ed. Fix 🔘
	@yvesfrinault : The r covered. Fix ASAP I @yvesfrinault : Brian have one of your guy	ebars are not a do you still rs in site ?
		Send
	6	



Then, just type a little text and send it. It's immediately shared around the entire site.





It's too long to explain it in a few words? What about you snap a picture or draw a little sketch over the floor plan.





### SCOPE

(1)Façade (2)MEP System

### **OBJECTIVES**

(1) Minimize total cost of ownership
(2) Minimize carbon footprint
(3) Minimize energy consumption

### VARIABLES

- (1) Building Orientation
- (2)Glazing type
- (3)Glazing percentage by façade
- (4)Shading elements by facade

### **DESIGN SPACE**

Possible design configurations: **TBD** 





# Opt 2+4: LCC vs. Energy Cost



# Opt 1: Parallel Coordinates Plot





## **Industry Case Studies** (with Benjamin Welle)



Case Study #1: GSA Office Building



Case Study #2: GSA Border Station



CIFE **Center for Integrated Facility Engineering** 



Next Steps....



total building daylighting performance C







# Is this the best we can do?



Flager, F. and J. Haymaker (2007). "Comparison of Multidisciplinary Design, Analysis and Optimization Processes in the Building Construction and Aerospace Industries." 24th International Conference on Information Technology in Construction. I. Smith. Maribor, Slovenia: p. 625-630

### Team-Information Interaction Sequence (TIIS) for 1 year



**Core Disciplines** exchanged much information

Many disciplines exchanged little information with each other



preliminary results from 403,607 digital interactions during the design of a California hospital using Bentley Projectwise (October2010 to November 2011)

# **Opaque Workflows Inhibit** Learning from Past Projects

### Repeating workflow mistakes costs companies money, time, and reputation.

On my last two projects, this mechanical contractor never looked at the column layout!

**Project Manager** 



\*Khanzode and Fischer (2000), "Potential Savings from Standardized Electronic Information Exchange: A Case Study for the Steel Structure of a Medical Office Building," Stanford University, CIFE TR 121.

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15s

30s

60s



### **Integration of Design** and Simulation

Comparison of the simulation runs shows that the evacuation might become critical in the case of the 2 staircases option

# 2 staircases

### 3 staircases



# I have made all my generals out of mud. Napoleon



