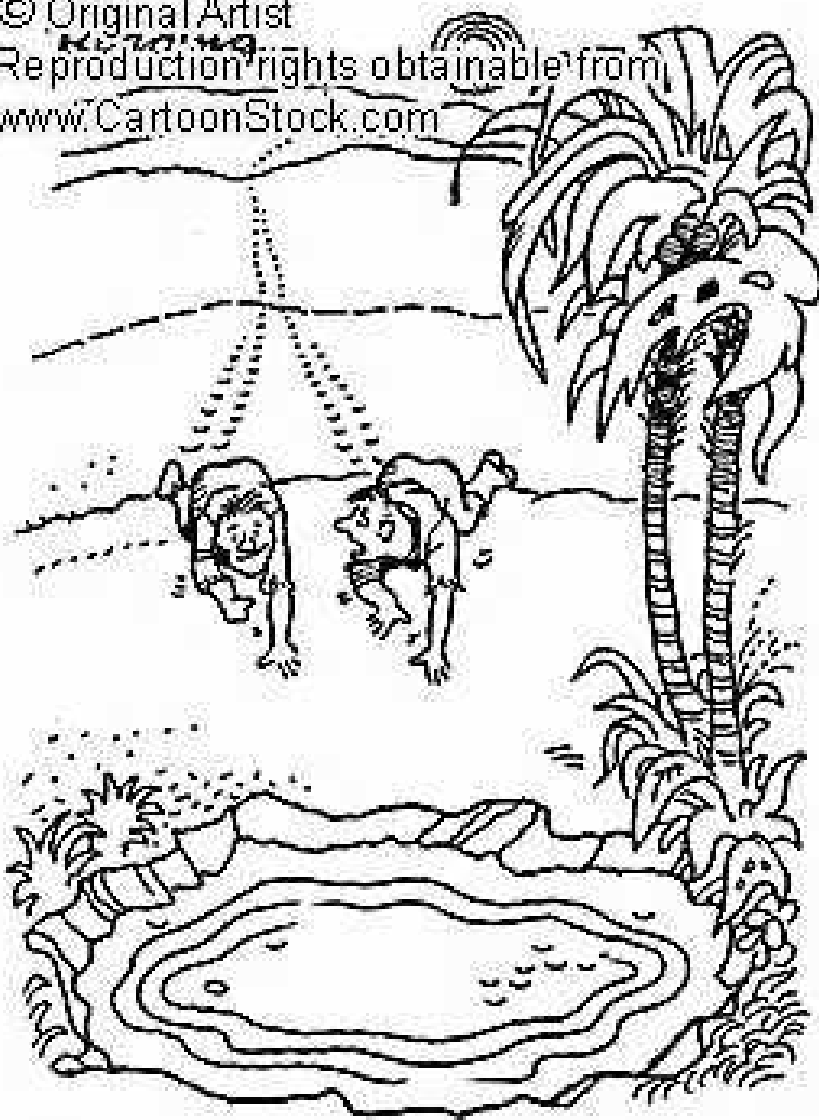


© Original Artist
Reproduction rights obtainable from
www.CartoonStock.com



*'CAREFUL CARRUTHERS, IT COULD BE A
COMPUTER SIMULATION'*

Never before has so much technology and information been available to mankind. Never before has mankind been so utterly confused.

www.kpmg.com

KPMG
It's time for clarity.

building**SMART**alliance™

Carnegie Mellon

***ZEN** and the Art of Building Information Modeling*

***BIM**@CMU*

禪

Khee Poh Lam PhD, RIBA
Professor of Architecture
Center for Building Performance & Diagnostics
School of Architecture
Carnegie Mellon University



National Institute of
Building Sciences

Carnegie Mellon

International Alliance
for Interoperability



- **Zen** (禪 or 禅) is a school of Mahāyāna Buddhism notable for its emphasis on *practice and experiential wisdom* — particularly as realized in the form of *meditation known as zazen*—in the attainment of *awakening*. As such, it de-emphasizes both *theoretical knowledge* and the study of *religious texts* in favor of direct individual experience of one's own *true nature*.

Maluan Bay, Xiamen, China (Yang, 2007)

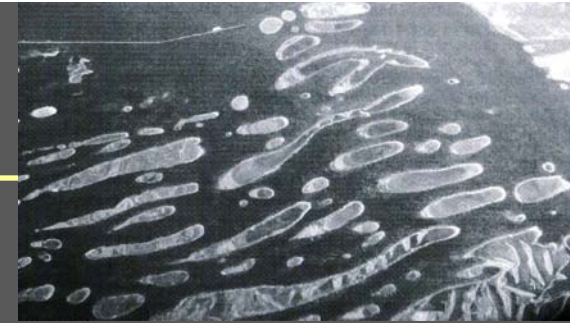
Ecological Design – City Scale



Ecology: the scientific study of systems of living organisms and the interactions among organisms and between the organisms and their environment.

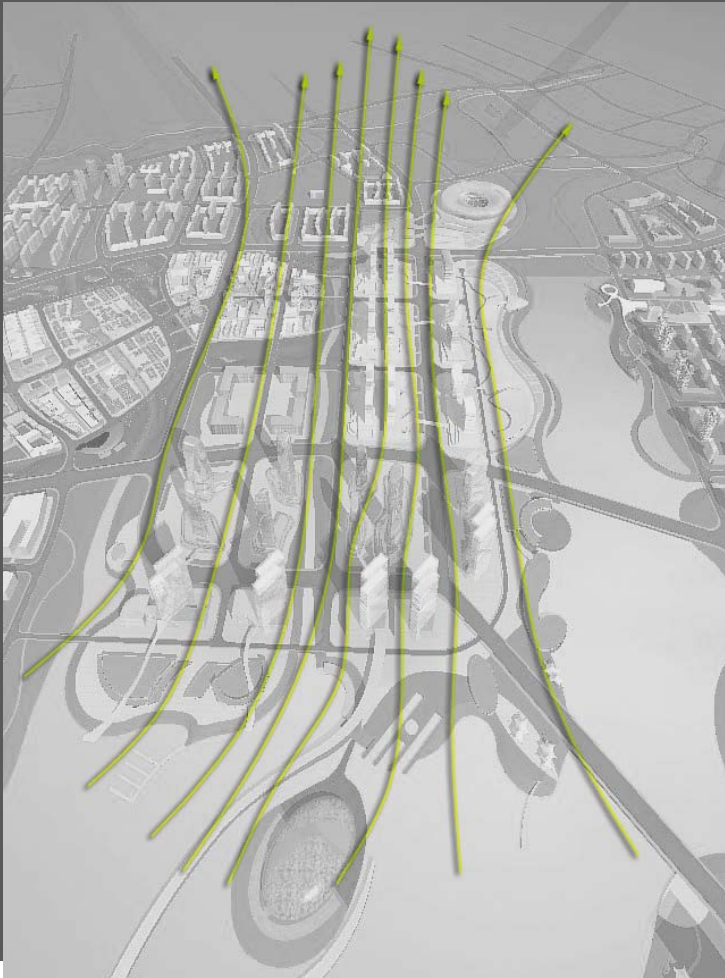
Eco-flows and Patterns

Maluan Bay, Xiamen, China (Yang, 2007)



Patch elongation driven by natural forces, (Forman, 1995)

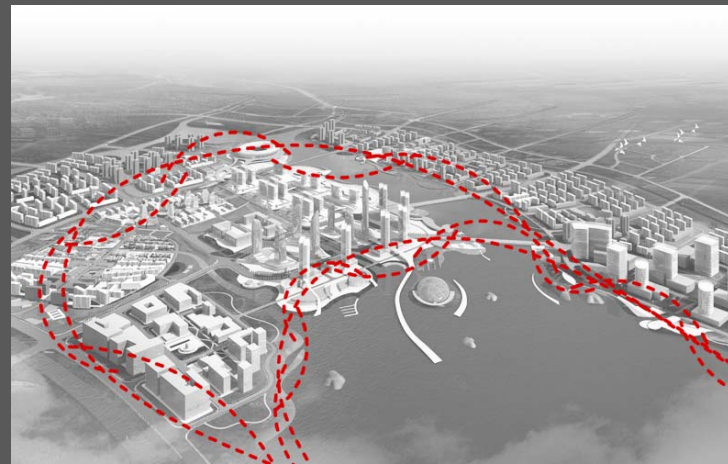
Air Flows



Water flows

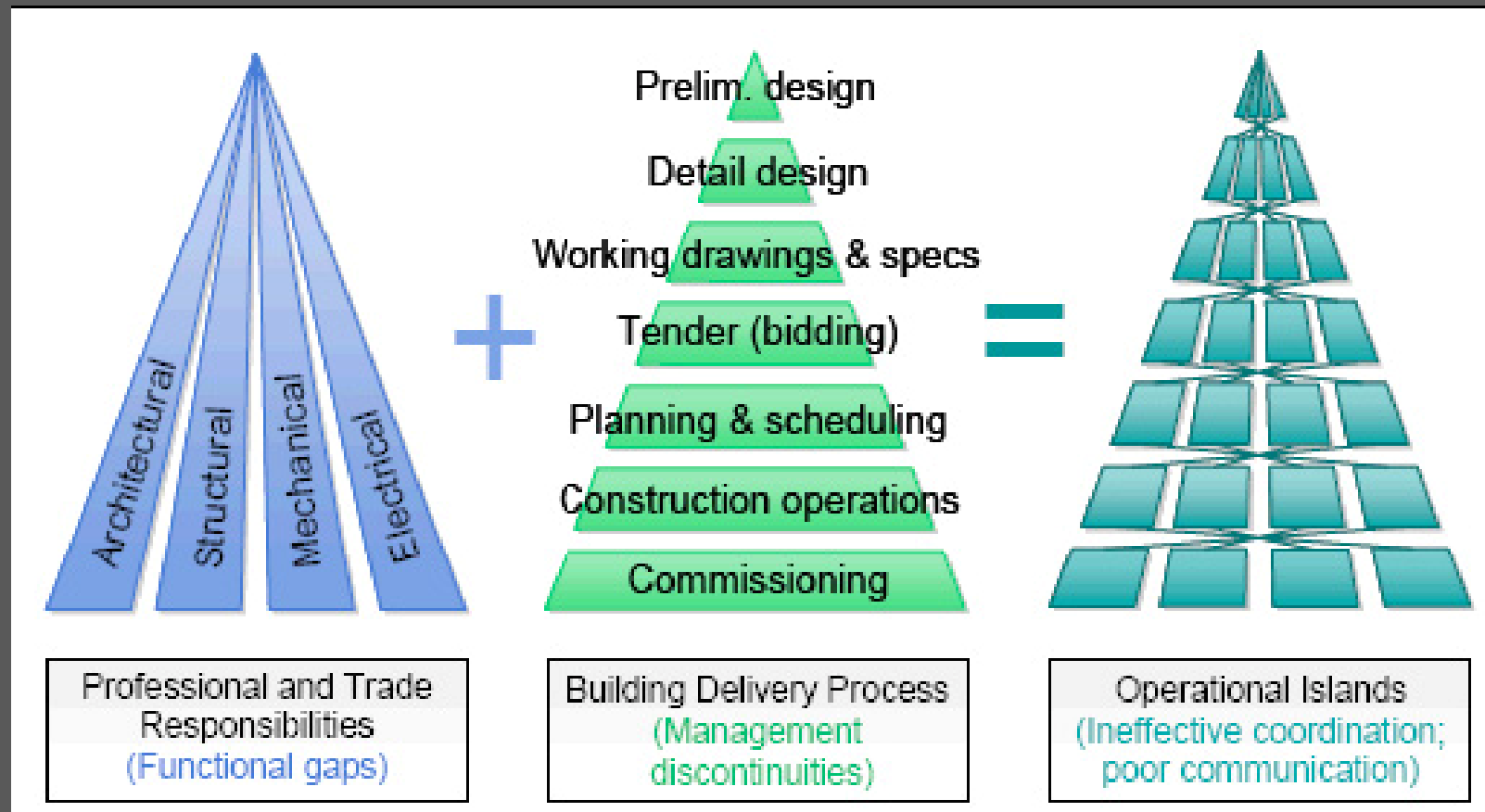


Solar Availability



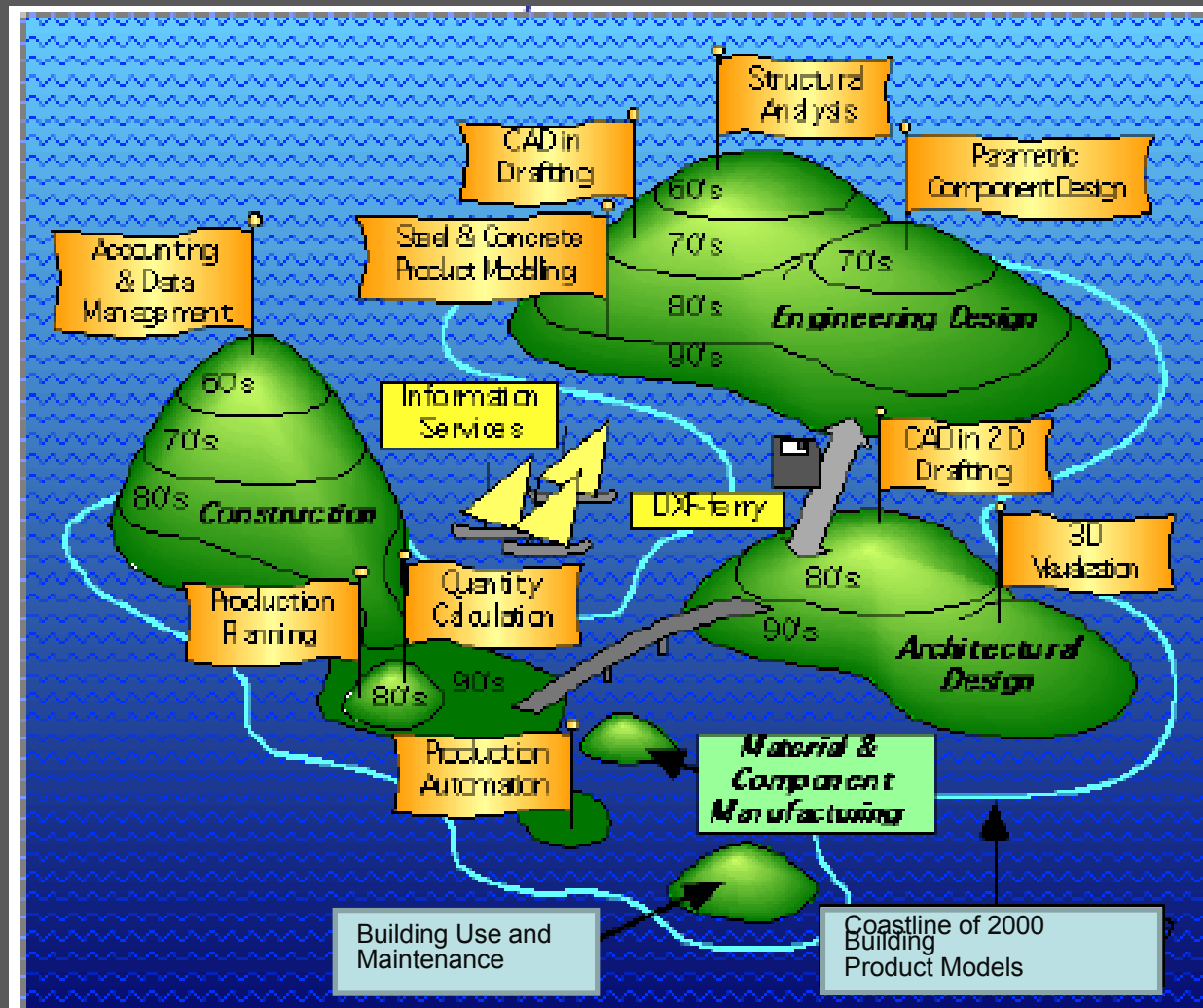
Wildlife Flows

Building Industry Infrastructure



Mattar S.G. "Buildability and Building Envelope Design". Proceedings, Second Canadian Conference on Building Science and Technology, Waterloo, Nov. 1983.

Knowledge Islands

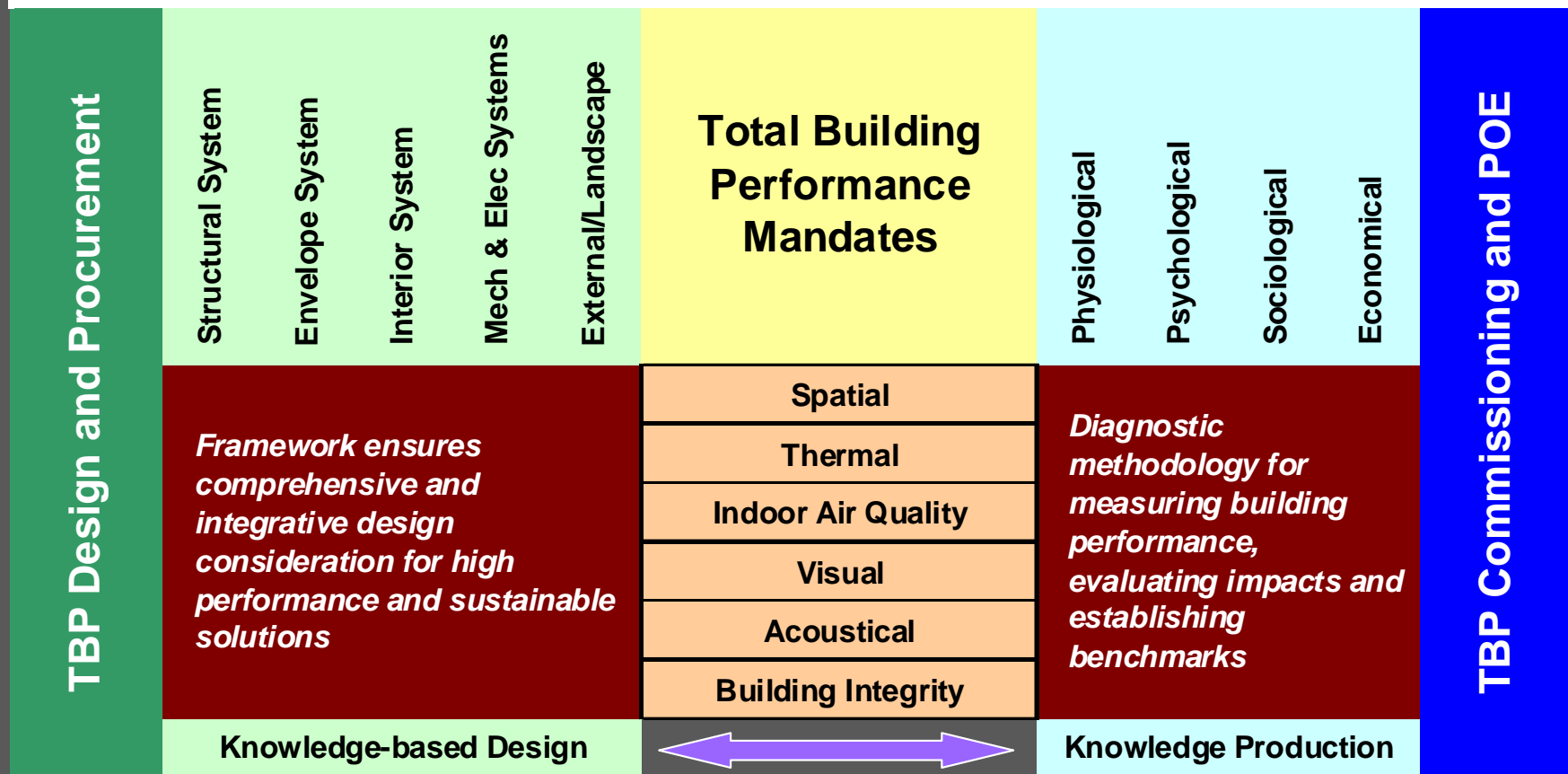


Four-function model

Climate modifier
Container of activities
Cultural Symbol
Object of Investment

Total Building Performance & Diagnostics

BUILDING DELIVERY PROCESS



Building Investment Decision Support (BIDS and e-BIDS)

Current Unit System: US/Imperial System

BIDS Tool EVA [®] Matrix [™]	First Cost	O & M, Energy	Organizational Churn	Technological Churn	Individual Productivity	Organizational Productivity	Health	Attraction / Retention	Taxes, Litigation Codes, Insurance	Salvage and Waste	Case Study Selection
Air	< > 16/38				✓						Fitzner 1985 / EPA 1989 Improved indoor air quality
Temperature Control	< > 2/17				✓						West Bend / Kroner et al 1992 Plenum floor v.s. conv. clg.
Lighting Control	< > 17/34	✓									Vattenfall Bid/Hedenström 01 Upgraded Lighting System
Network Access	< > 1/5	✓		✓							York 1993 Raised floor v.s. poke through
Privacy and Interaction	< > 8/22				✓						Banbury and Berry 1998a Acoustic Privacy / Quiet
Ergonomics	< > 7/20				✓		✓				OSHA 1999c (14) / Silverstein et al 2000 Ergo chairs + keyboards
Access to Nat'l Environment	< > 3/36				✓						Heschong et al 2002b / Schools 1 Daylighting in Schools - A
Whole Building	< > 1/57	✓			✓						VeriFone Inc. / Pape 98 Whole Building

Daylighting = Individual Productivity

Heschong et al 2002b / Schools 1 - Daylighting in Schools - A
In a 2002 multiple building study, Heschong et al identify 7% to 26% higher test scores for school children in highly daylight classrooms than for children in classrooms with no to very little daylighting. The average 15% improvement in test scores represents a significant measure of individual productivity, more information ...

Edit Case Parameters
New Scenario Quit

<http://cbpd.arc.cmu.edu/bidtrial>
<http://cbpd.arc.cmu.edu/bids>

Cost-Benefit Tools to Promote High Performance Components; Flexible Infrastructures and Systems Integration for Sustainable Buildings and Productive Organizations

home Email about

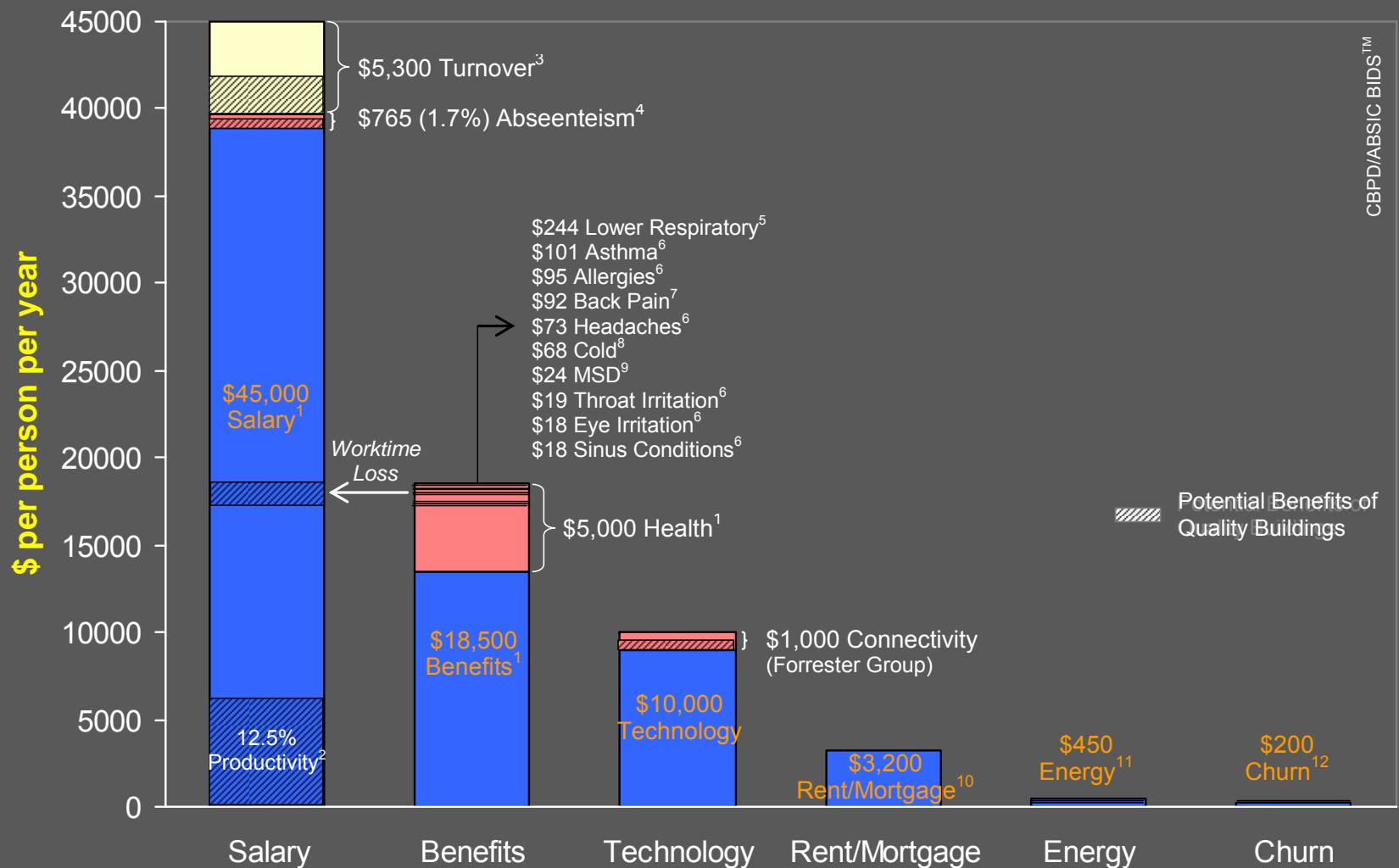
e-BIDS[™]
Investments in energy efficiency yield productivity, health, facility management and environmental gains.
Energy Building Investment Decision Support

Site Enclosure HVAC Lighting Connectivity Interior

Select structural system components and materials considering their service lives and material cycles.

Copyright © NSF/ IUCRC Center for Building Performance and Diagnostics,
Carnegie Mellon University Advanced Building Systems Integration Consortium
<http://cbpd.arc.cmu.edu/ebids>

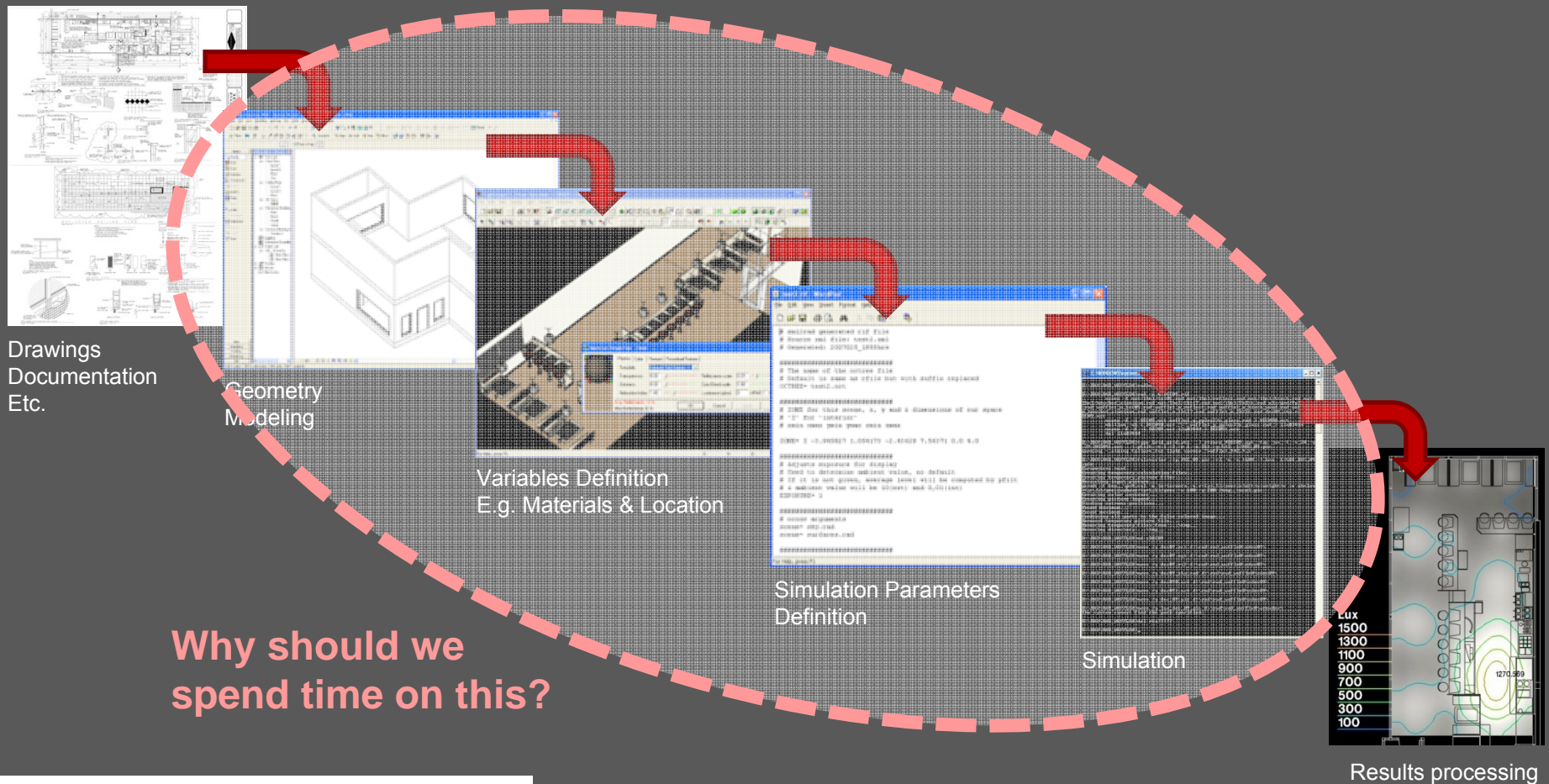
Financial Cost/Benefits Indices/ International Baselines



Design Performance Modeling

Reduce resources required to conduct performance simulation

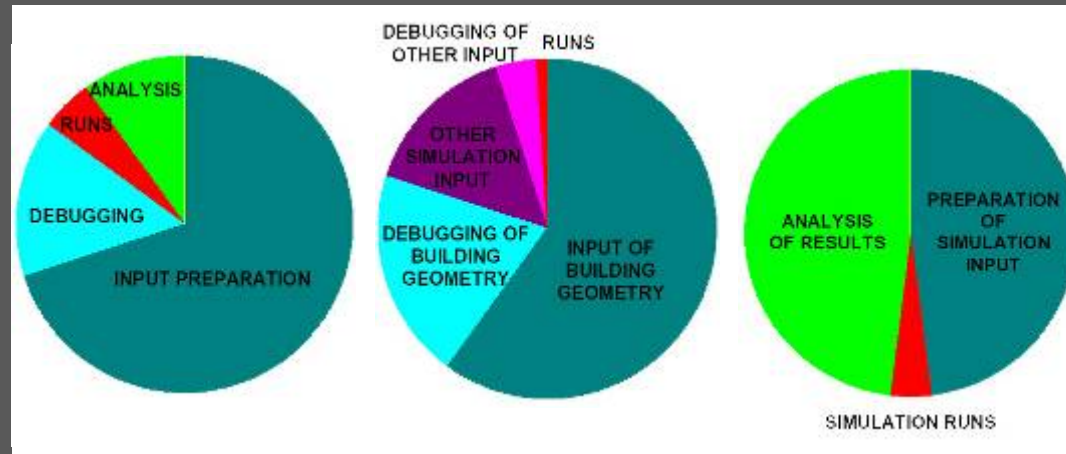
Reducing time and effort required to prepare for simulations (applicable to all domains)



Why should we
spend time on this?

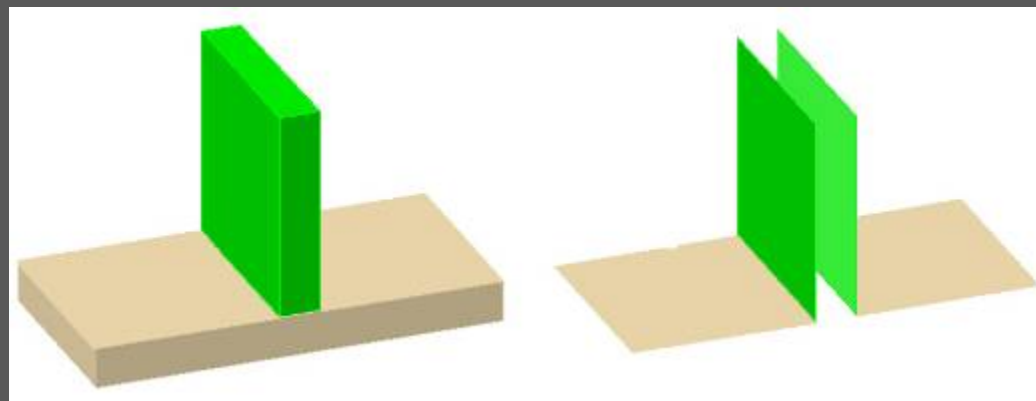
Information Needs During Design Process

Significant time required to set up geometry – redundant tasks



Bazjanac 2001

Significant effort required to deal with semantics – expert knowledge



Examples of BIM Schemas and Languages

Industry Foundation Class (IFC)

A schema with definitions, relationships and rules.

Define a standard way of describing, representing, and interfacing with A/E/C objects. Data representation in EXPRESS, data exchange in STEP 21 format.



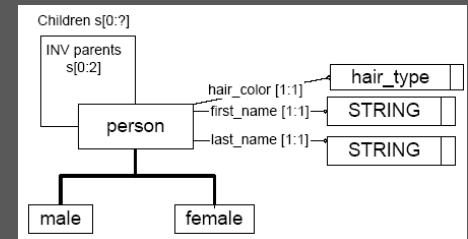
EXPRESS

Language developed within ISO-STEP community for representing application interpreted models.

```
#3=IFCPROJECTAPPPREGISTRY({});
#10=IFCNOTATIONFACET('NotationString', $);
#11=IFCClassificationNotation({#10});
#12=IFCClassification('WallMaterial', $, #11, 'Brick', $);
#13=IFCClassificationList({#12}, 1);
#25=IFCDimensionalExponents(1, 0, 0, 0, 0, 0, 0);
#4=IFCSUNIT(*.LENGTHUNIT., MILLI., METRE.);
#14=IFCMATERIAL('DefaultWallMaterial', #13);
#15=IFCProjectMaterialRegistry({#14, #45});
```

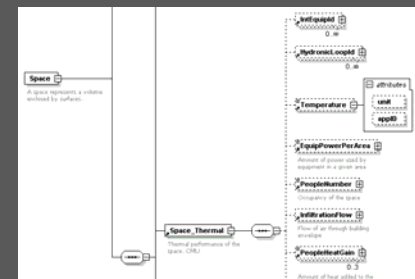
EXPRESS-G

Graphical means of depicting EXPRESS



GbXML

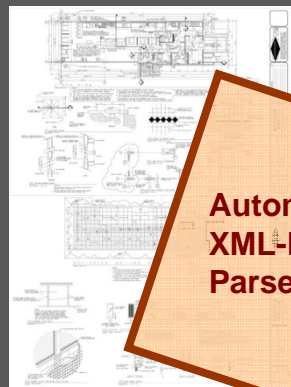
An XML-based schema representing the building information (geometry, material properties..) for energy simulation purpose, and being extended to other simulations.



Design Performance Modeling

Reduce resources required to conduct performance simulation

Reducing time and effort required to prepare for simulations (applicable to all domains)



Drawings
Documentation
Etc.

**Automatic
XML-Based
Parser**

**Automatic
Default
Values**

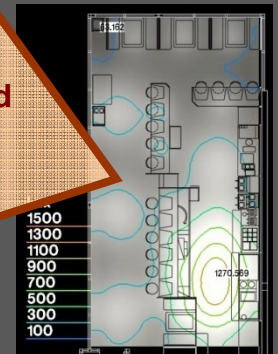
**Automatic
Engine
Selection**

**Automatic
Simulation
Files Creation**

**Improved
Analysis
Features**

**User-editable
Input**

**Automated
Processing**

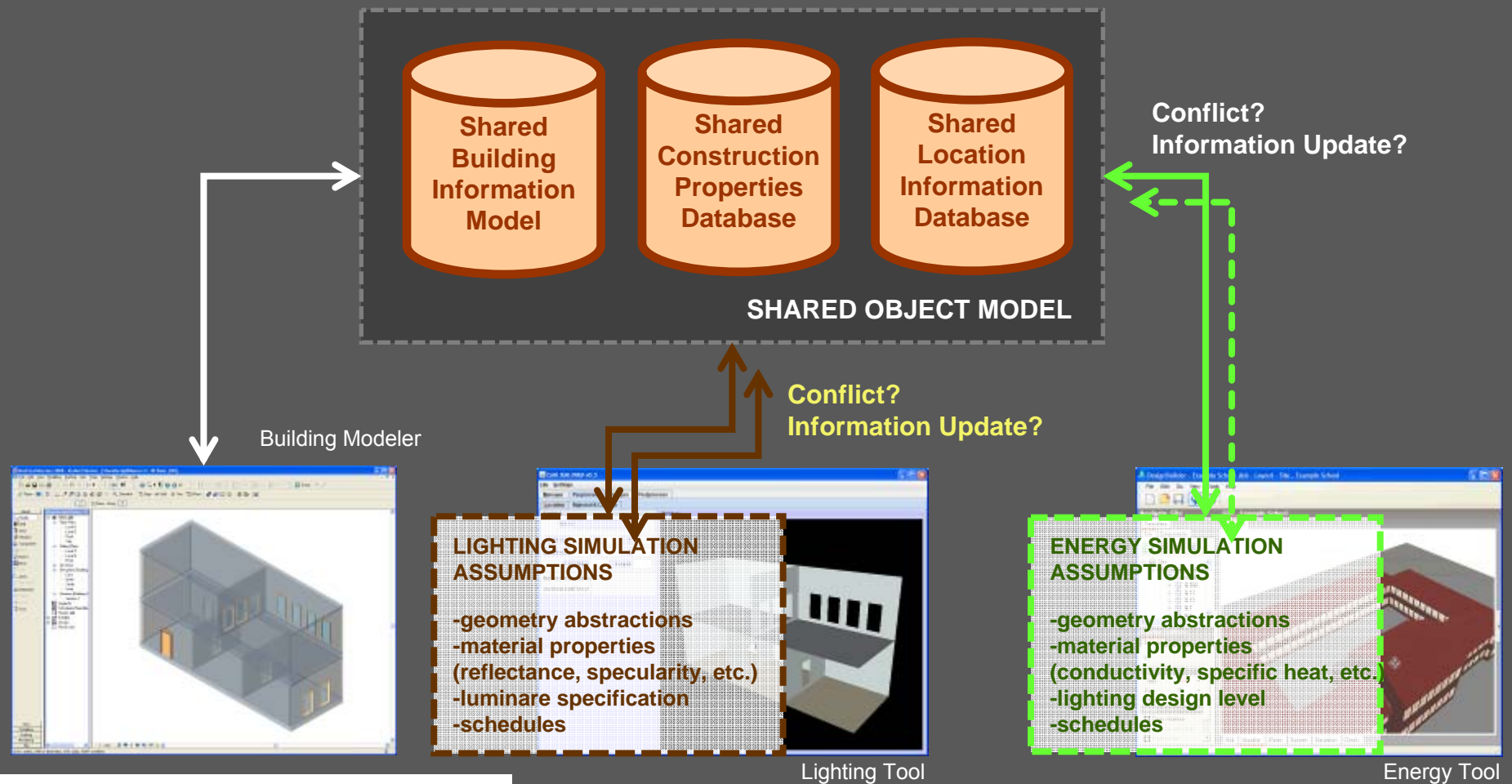


Results processing

Design Performance Modeling

Efficiency and consistency in defining BIM and assumptions

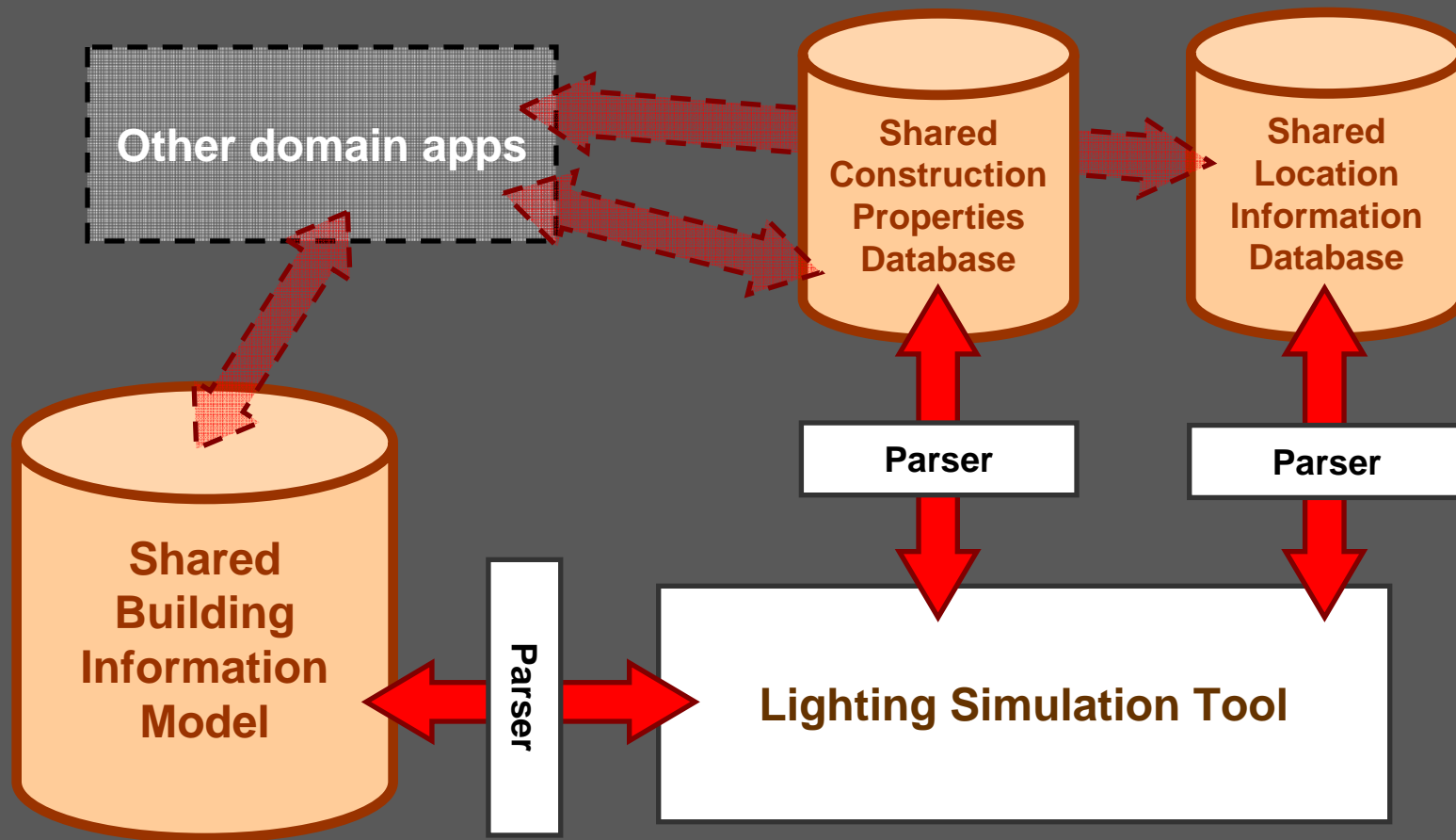
Externalizing project shared information



Design Performance Modeling

Efficiency and consistency in defining BIM and assumptions

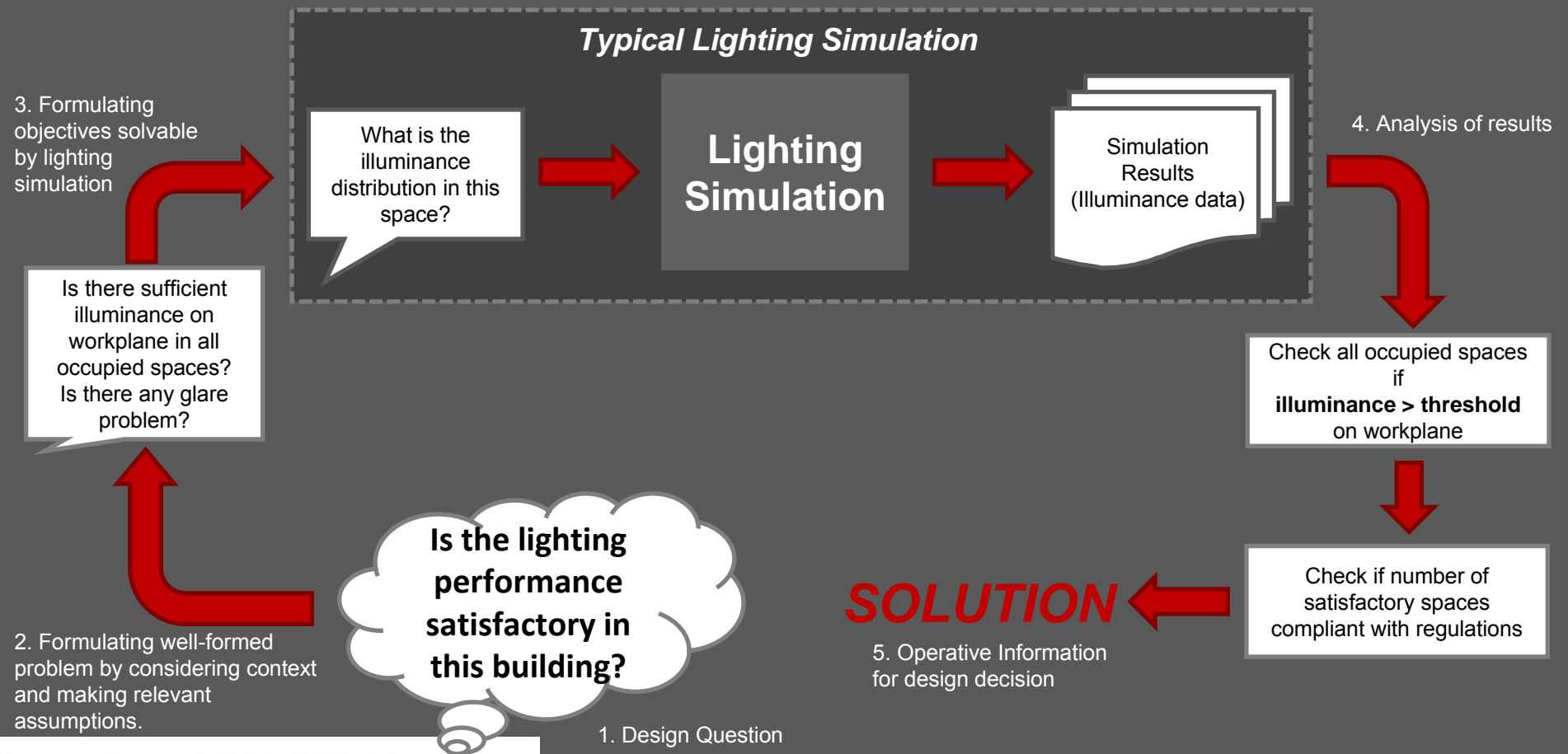
Externalizing project shared information



Design Performance Modeling

Obtaining Operative Information for Design Decisions

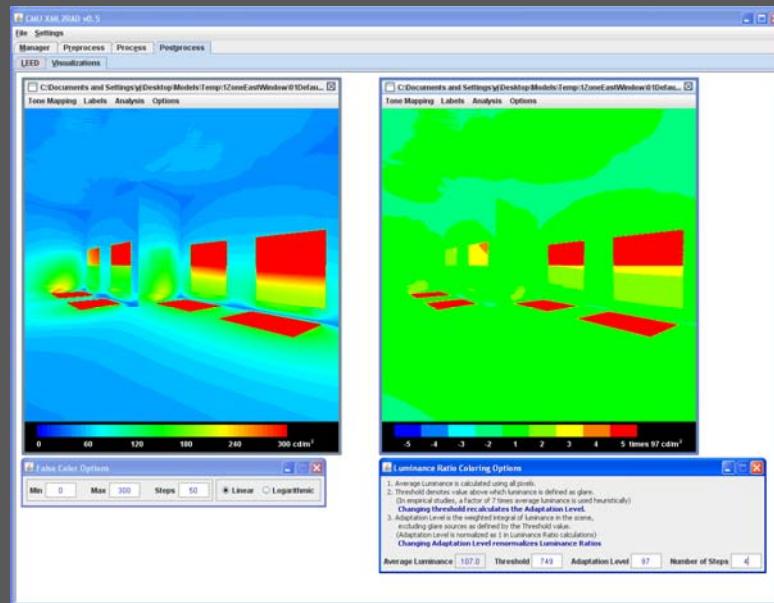
Lighting simulations address low-level objectives, not higher-level questions typical of primary design inquiries.



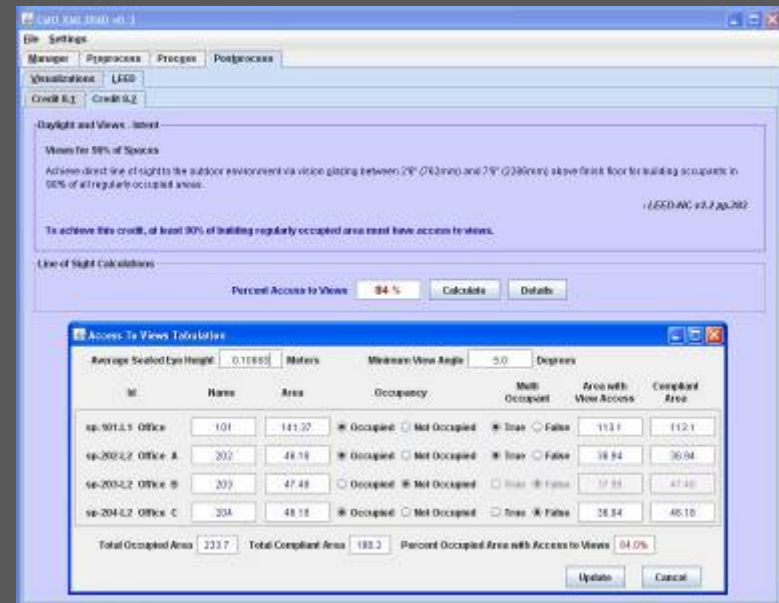
Design Performance Modeling

Obtaining Operative Information for Design Decisions

Providing post-processing analysis toolkit

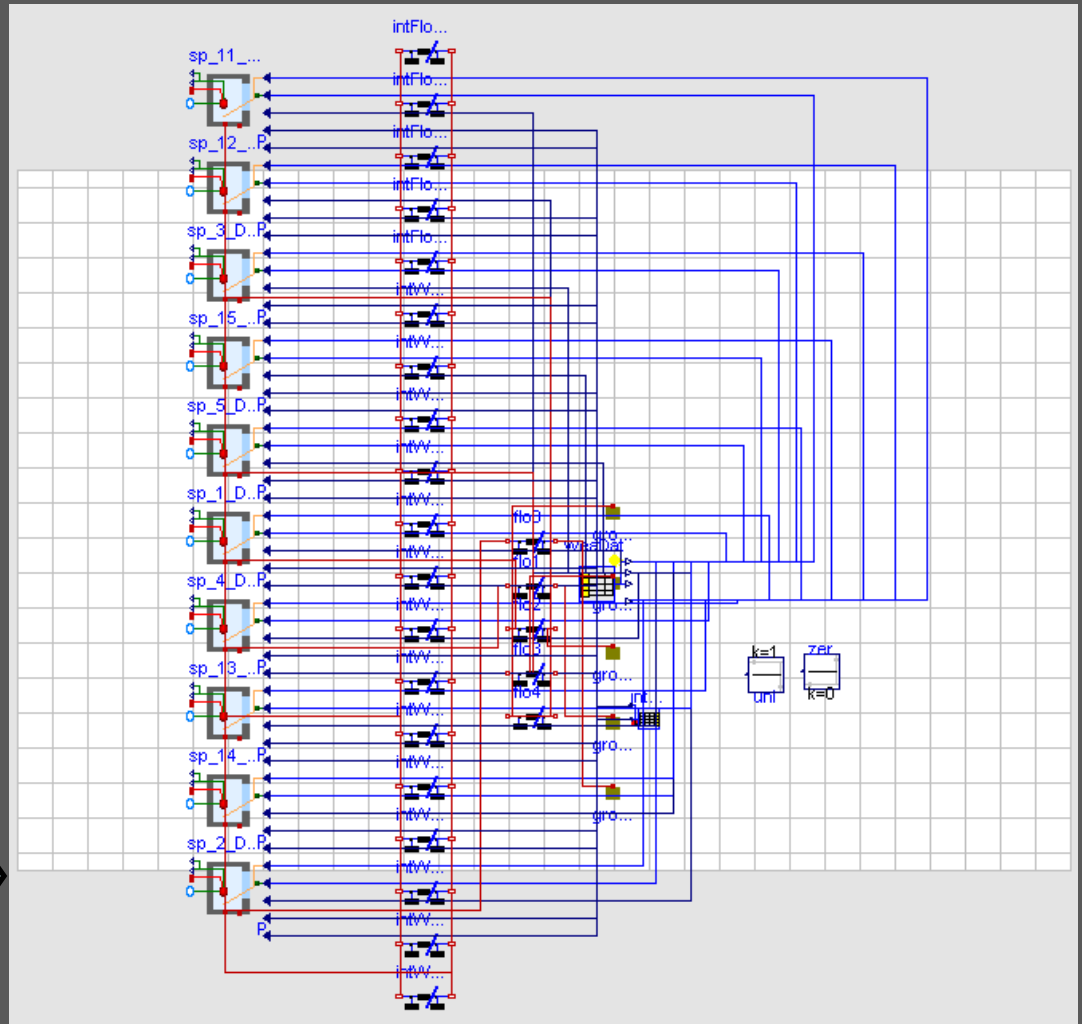
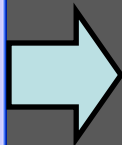
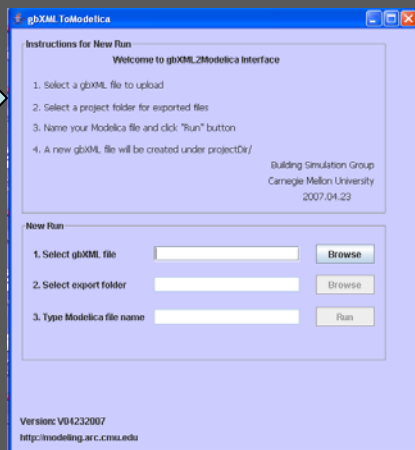
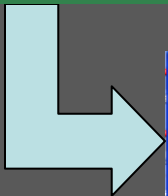


Tone-mappers
Luminance data inspection and false-color analyses
Luminance ratios calculator
Data comparisons



LEED rating system Credit 8.1 & 8.2 calculators
Tabulation of results

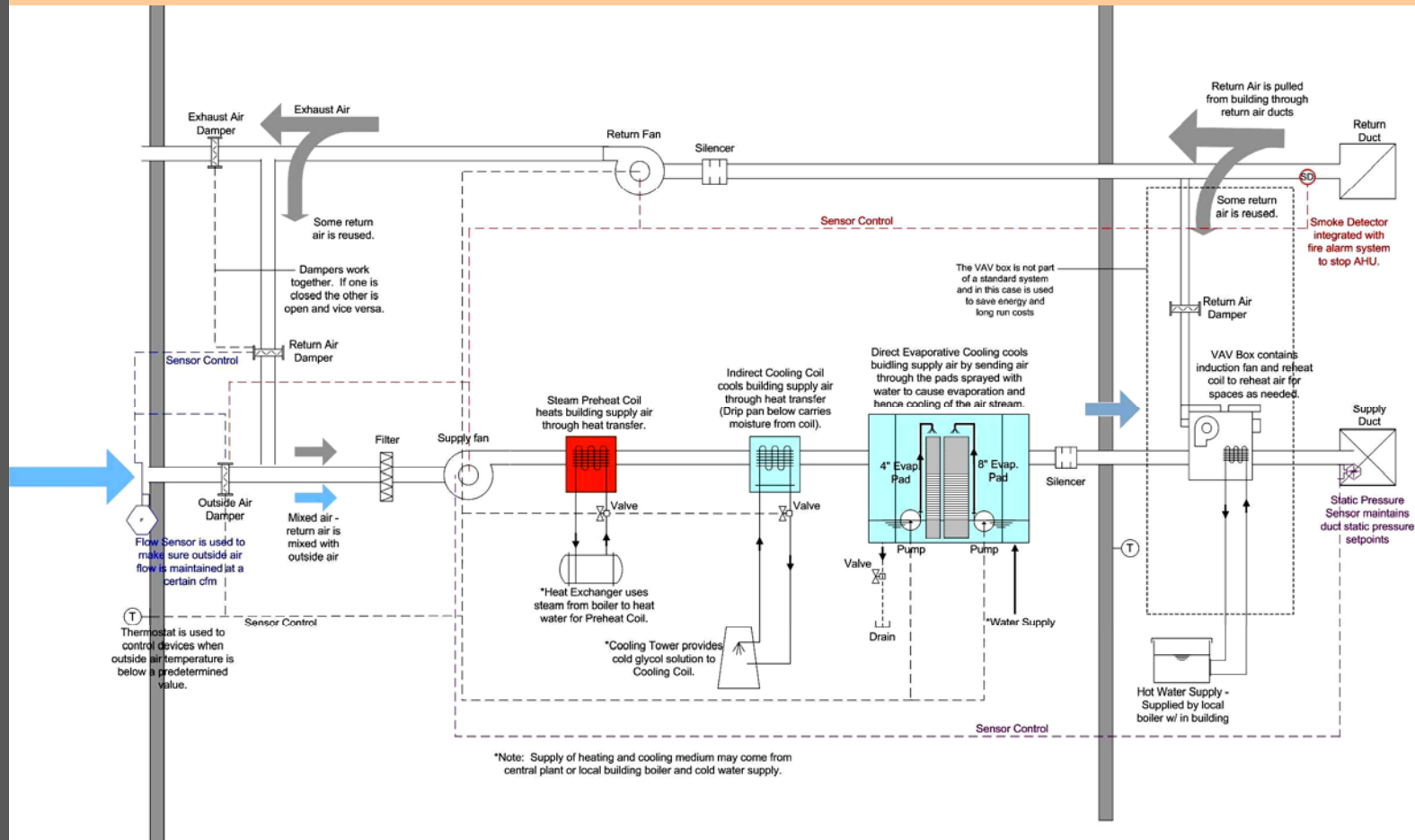
N-Dimensional Mapping – BAPP Dymola Model



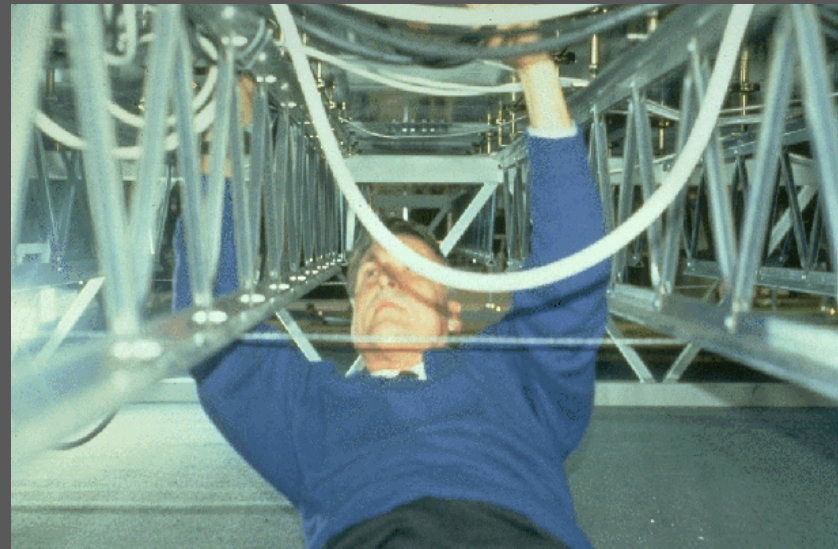
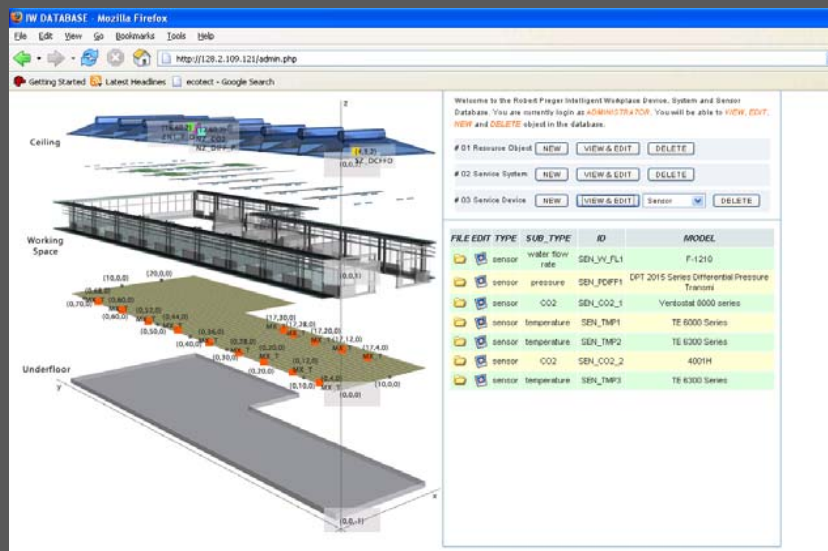
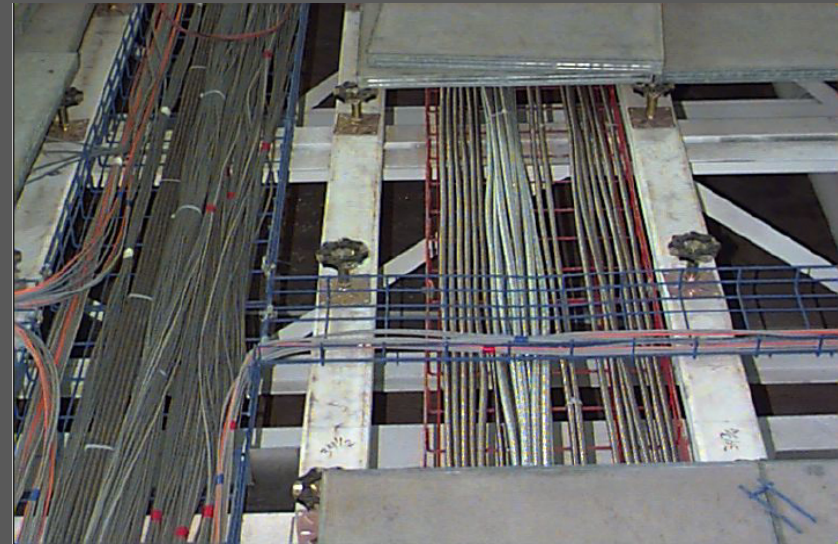
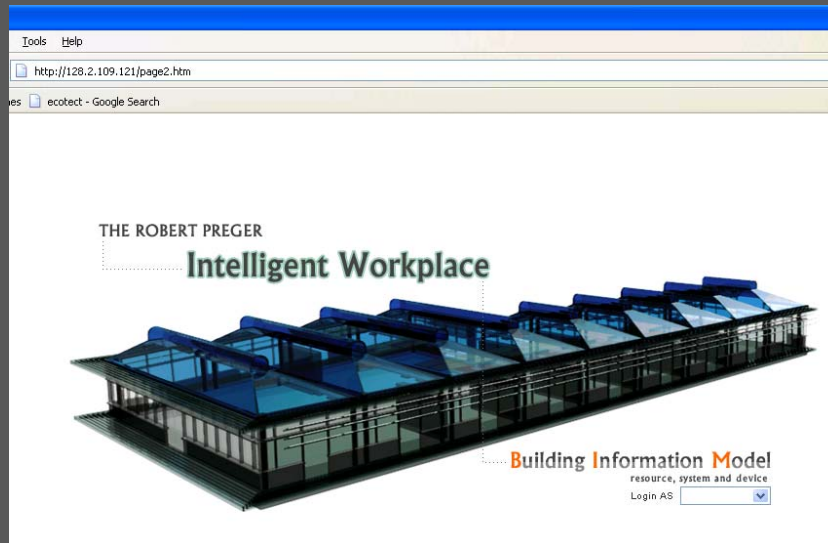
BIM Application in Continuous Commissioning

A product model for commissioning

Based on standards, products, designers, and commissioning authority



Future Challenge: Integrative Information Management



BIM Tools Development-Information Visualization

IW DATABASE - Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://128.2.109.121/admin.php

Getting Started Latest Headlines ecotect - Google Search

Welcome to the Robert Preger Intelligent Workplace Device, System and Sensor Database. You are currently login as **ADMINISTRATOR**. You will be able to **VIEW, EDIT, NEW** and **DELETE** object in the database.

01 Resource Object

02 Service System

03 Service Device Sensor

MySQL Query Browser - root@localhost:3306 / bingco2

File Edit View Query Script Tools Window Help

SELECT * FROM itest_co2_manu 1

Go back Next Refresh

Execute Stop

Resultset 1

device_name MySQL Query Browser - root@localhost:3306 / bingco2

File Edit View Query Script Tools Window Help

SELECT * FROM oper_infor0510 o

Go back Next Refresh

Execute Stop

Resultset 1

type	device...	curr...	time_hour	time_date	sample...	sensor_location...	sensor_location...	sensor_location...	install_date	recal_date	gasDetected
co2Sensor	F	399	17:30:09	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay9_F	429	17:40:13	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay7_N	428	17:40:13	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay10_Y	421	17:40:13	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay6_V	494	17:40:13	2007-05-10	60	200	500	1200	04212007	NA	CO2
co2Sensor	Bay6_R	439	17:40:13	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay5_S	381	17:40:13	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay9_F	383	17:42:13	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay7_N	427	17:42:13	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay10_Y	400	17:42:13	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay6_V	479	17:42:13	2007-05-10	60	200	500	1200	04212007	NA	CO2
co2Sensor	Bay6_R	437	17:42:13	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay5_S	382	17:42:13	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay9_F	382	17:44:14	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay7_N	425	17:44:14	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay10_Y	390	17:44:14	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay6_V	493	17:44:14	2007-05-10	60	200	500	1200	04212007	NA	CO2
co2Sensor	Bay6_R	442	17:44:14	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay5_S	405	17:44:14	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay9_F	386	17:46:14	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay7_N	430	17:46:14	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay10_Y	401	17:46:14	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay6_V	514	17:46:14	2007-05-10	60	200	500	1200	04212007	NA	CO2
co2Sensor	Bay6_R	443	17:46:14	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay5_S	405	17:46:14	2007-05-10	60	200	500	1200	05012007	NA	CO2
co2Sensor	Bay9_F	385	17:48:15	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay7_N	437	17:48:15	2007-05-10	60	2500	2500	1200	04212007	NA	CO2
co2Sensor	Bay10_Y	392	17:48:15	2007-05-10	60	2500	2500	1200	04212007	NA	CO2

3 rows fetched in 0.00...

1: 1

MySQL Query Browser - root@localhost:3306 / bingco2

File Edit View Query Script Tools Window Help

SELECT * FROM itest_co2_manu 1

Go back Next Refresh

Execute Stop

Resultset 1

device_name MySQL Query Browser - root@localhost:3306 / bingco2

File Edit View Query Script Tools Window Help

SELECT * FROM oper_infor0510 o

Go back Next Refresh

Execute Stop

Resultset 1

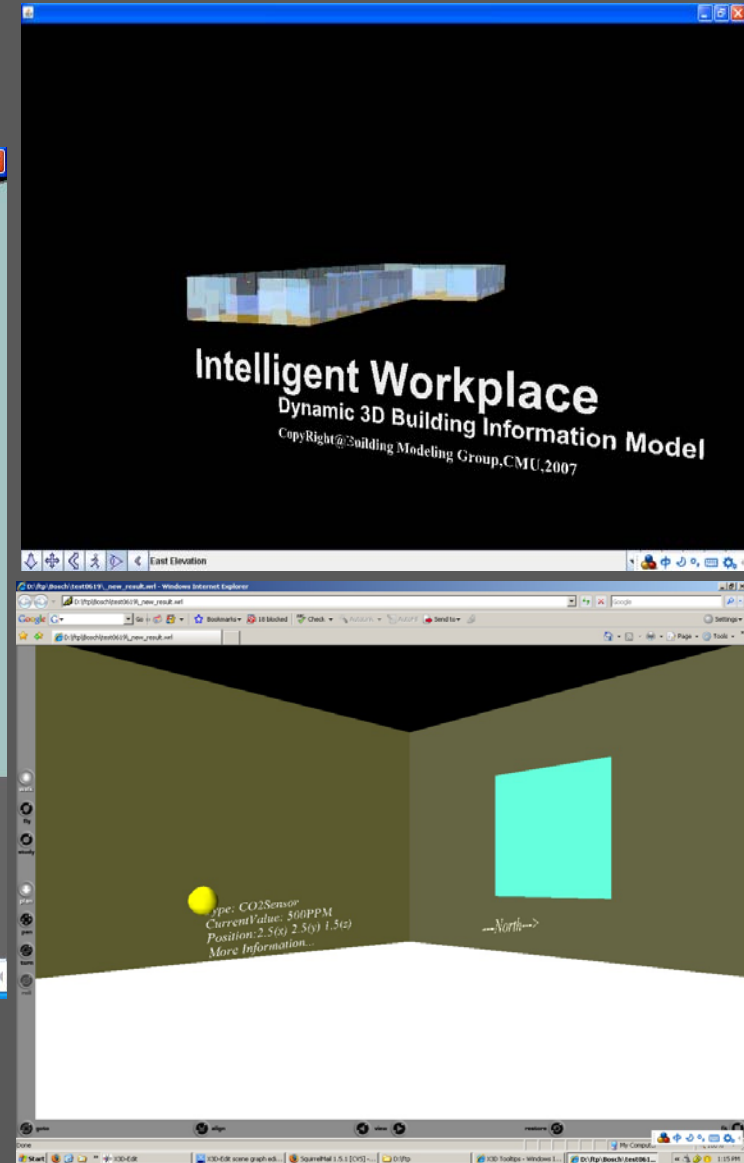
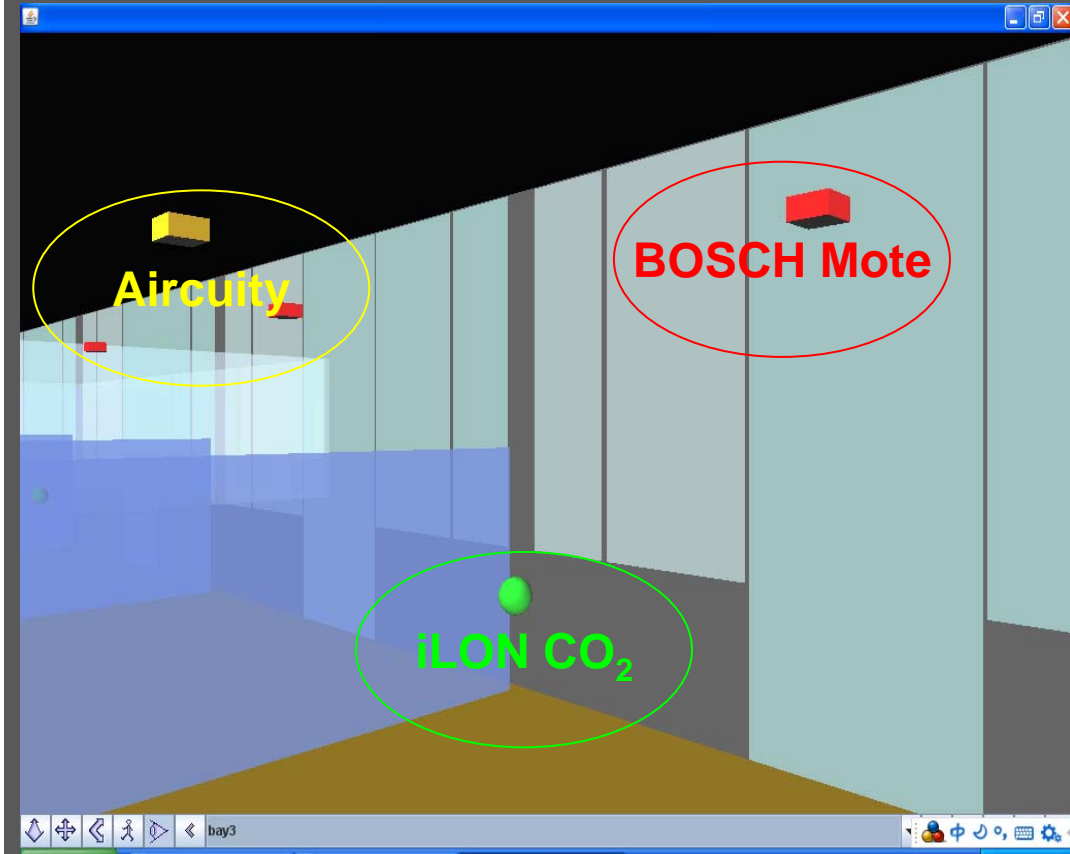
3883 rows fetched in 0.3115s (0.0069s)

1: 1

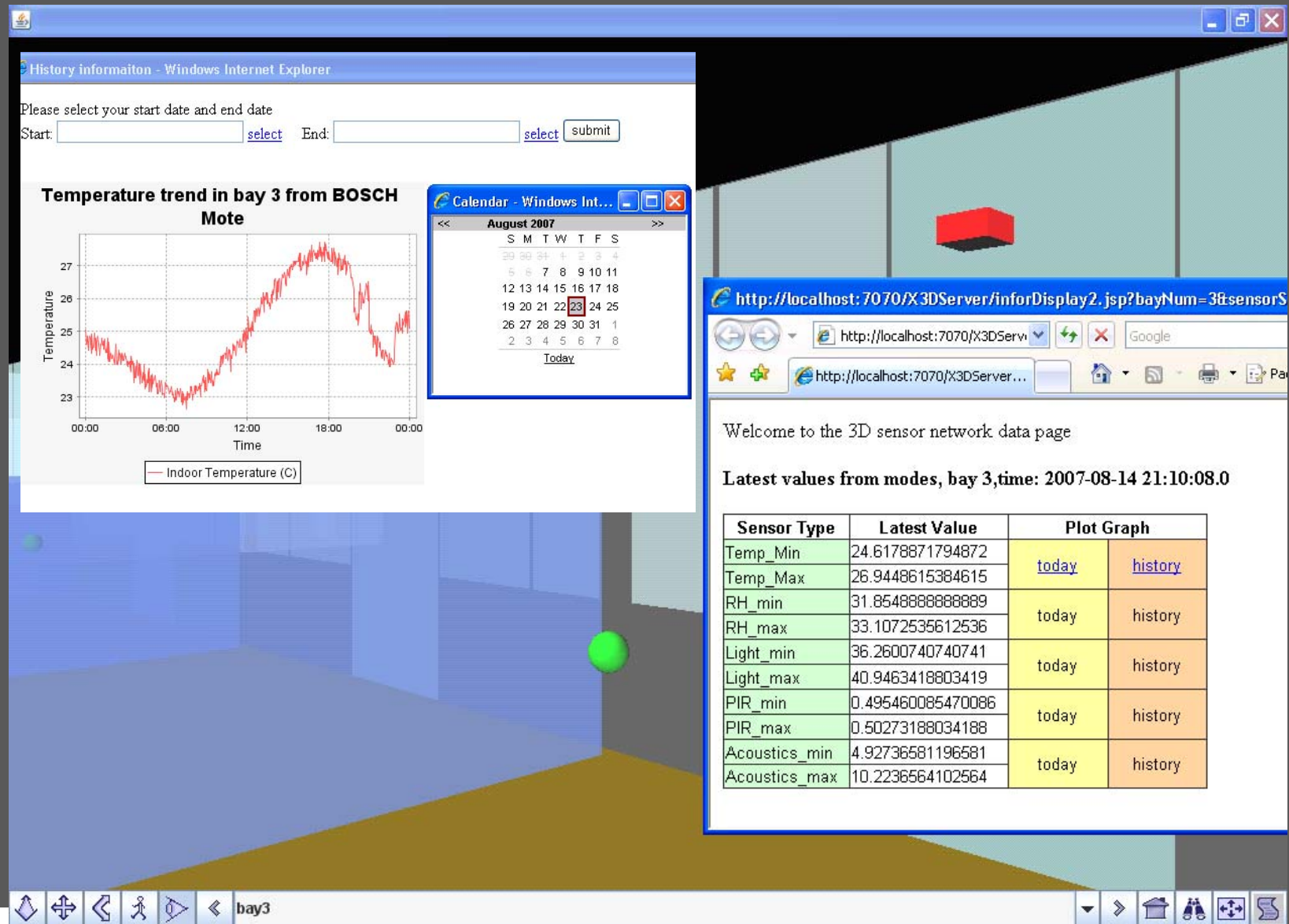
buildingSMARTalliance™

Carnegie Mellon

BIM Tools Development - Information Visualization

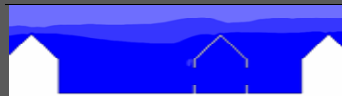


BIM Tools Development - Information Visualization



Sustainable Building Information Model

Virtual  Real



Wind speed: 3.28 fps (1 m/s)



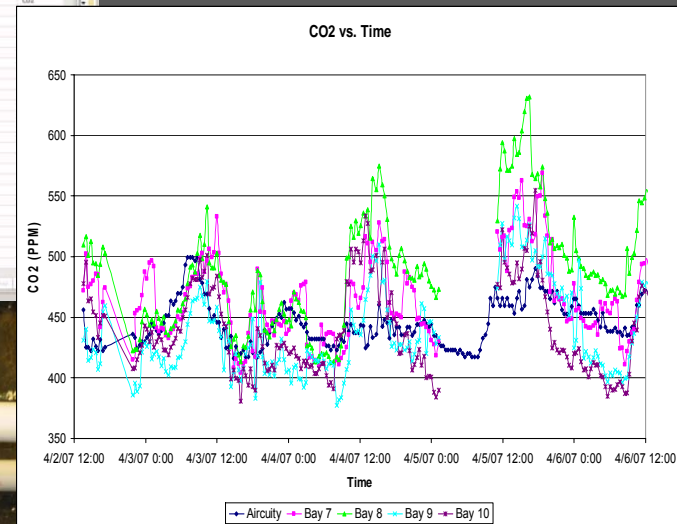
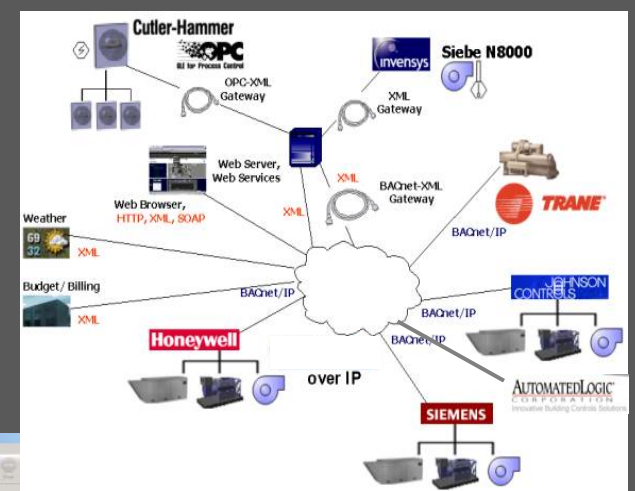
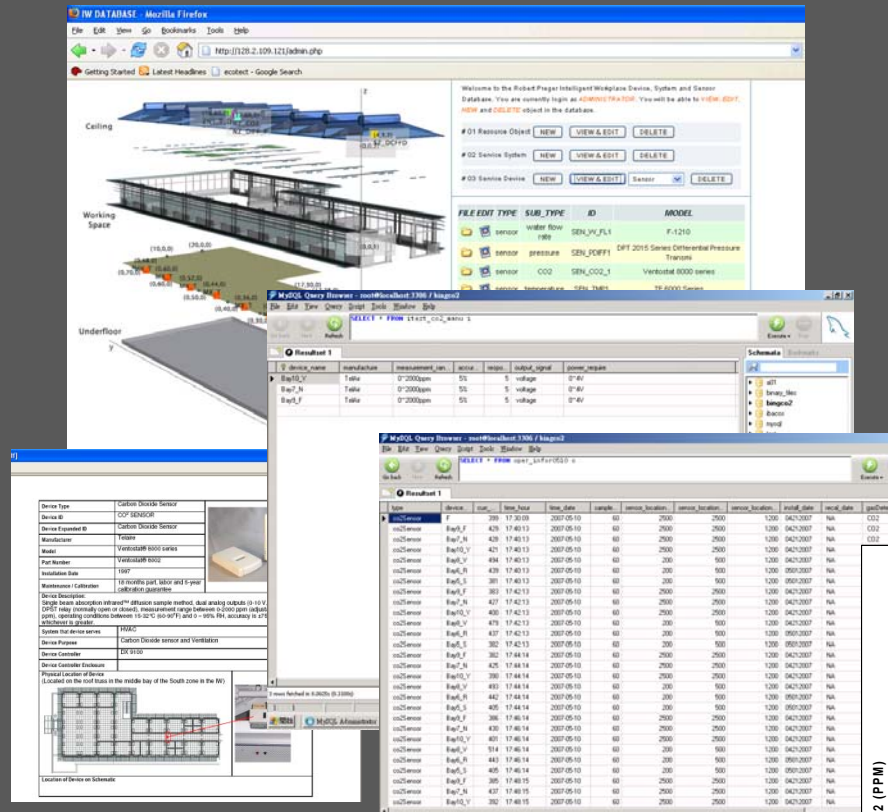
Wind speed: 9.84 fps (3 m/s)



Wind speed: 16.40 fps (5 m/s)



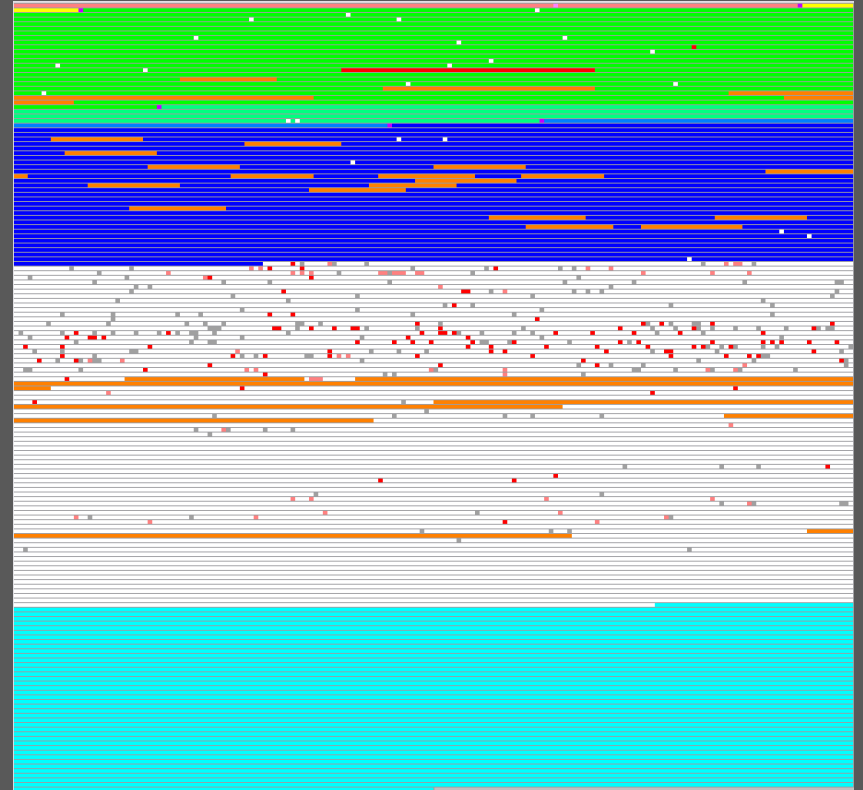
Wind speed: 32.8 fps (10 m/s)



What does your hard disk look like?



OR



Building Life Cycle Phases

Version control

Design Construction Commission Operation

Oculus 6 Pillars

Requirements

Definition and quantification of “what is good?”

Concept

Definition and management of design alternatives

Sequence

Framework for seamless integration with BIM tools

Results

Capturing and managing all building performance measurements including simulation artifacts

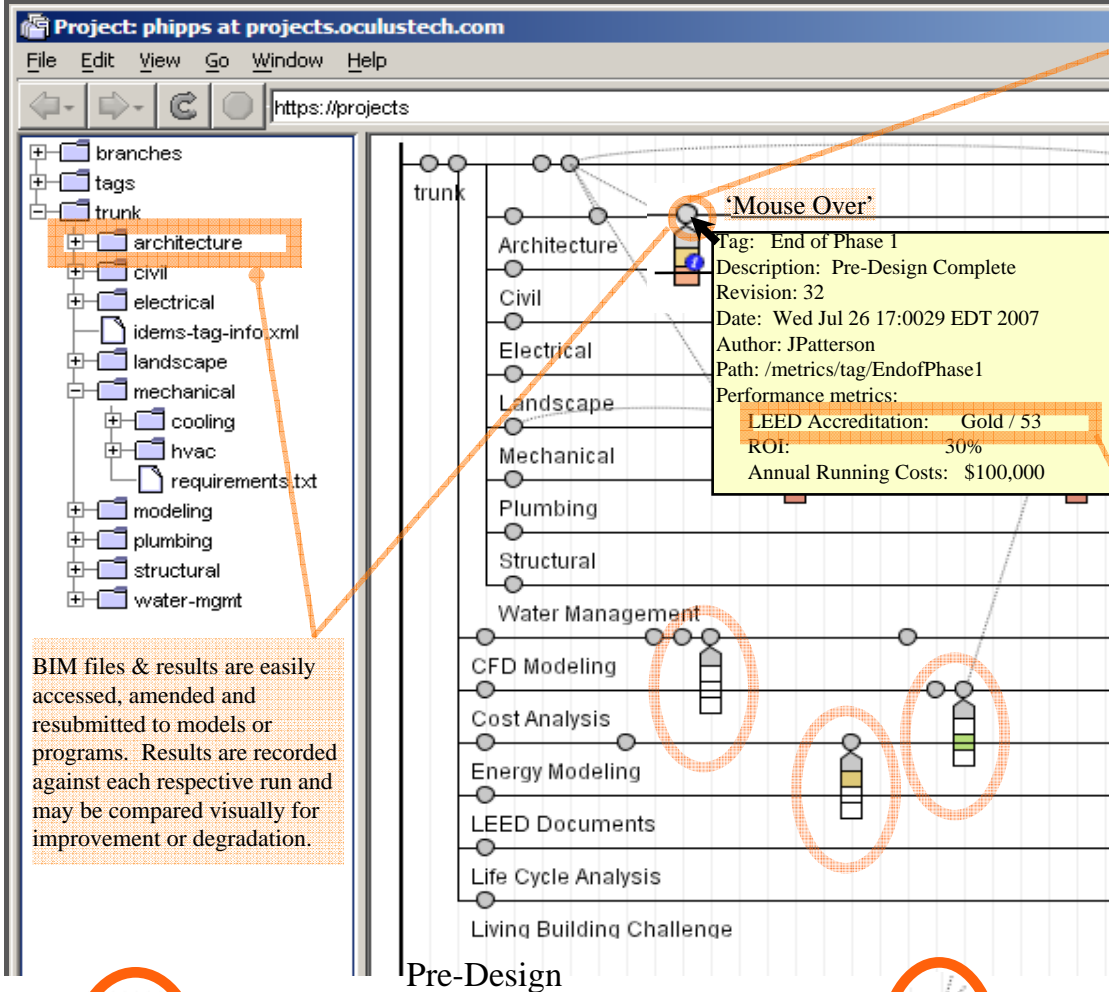
Performance

Real time tracking of results against requirements using performance metrics

Revision

Framework for collaborating with all project participants and the deposit/retrieval of all project life cycle documents

BIM Interoperability



BIM files & results are easily accessed, amended and resubmitted to models or programs. Results are recorded against each respective run and may be compared visually for improvement or degradation.

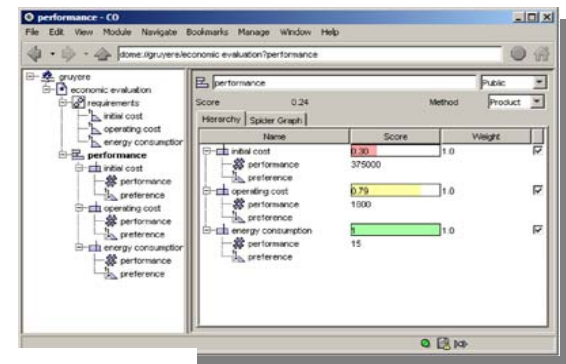
- branches 'swim lanes' enable concurrent exploration of design alternatives

- performance metrics are visible to all participants at all times
- effects on performance are displayed immediately

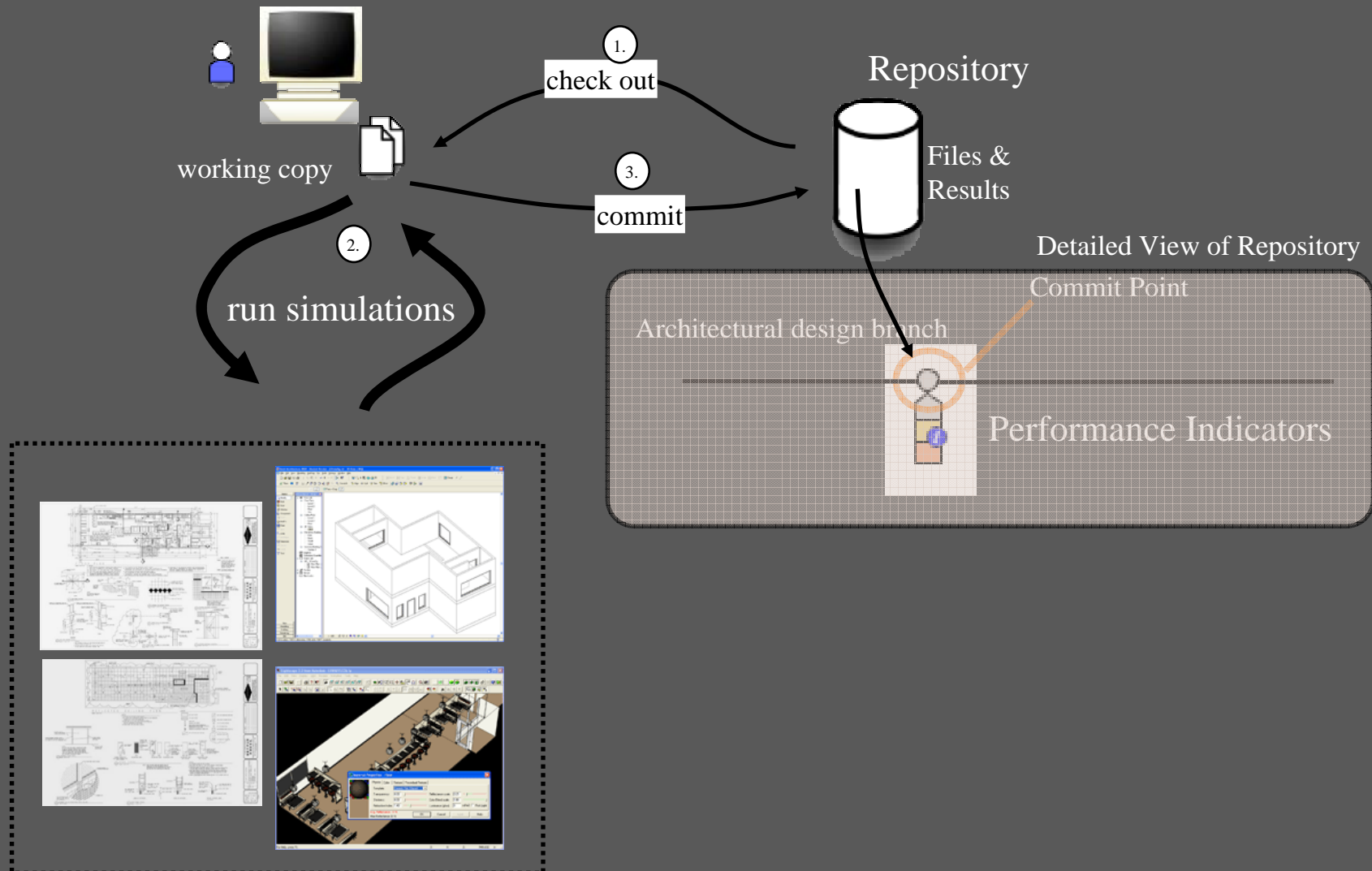
'Double-click Mouse' to display/access BIM files

Name	Size	Modified	Committed	Revision	Author
Air Circulation		Today 22:44	30 Jan 2007 18:02	778 mwall	
clirids	45 30 Jan 2007 18:02	30 Jan 2007 18:02	778 mwall		
Air Circulation	4721 30 Jan 2007 18:02	30 Jan 2007 18:02	778 mwall		
results.txt	0 Today 22:44				
Building Envelope		Today 22:44	30 Jan 2007 18:02	778 mwall	
clirids	45 30 Jan 2007 18:02	30 Jan 2007 18:02	778 mwall		
Building Envelope	3664 30 Jan 2007 18:02	30 Jan 2007 18:02	778 mwall		
requirements.doc	0 Today 22:44				
results.txt	0 Today 22:44				
foobar	13 Jun 2007 00:30	06 May 2007 22:...		1654 mwall	
one	13 Jun 2007 00:30	06 May 2007 22:...		1654 mwall	
idems-tag-info.xml	273 23 May 2007 11:04	23 May 2007 11:...		1679 mwall	
testing.txt	24 08 Jun 2007 14:37	08 Jun 2007 14:37		1709 asucott	

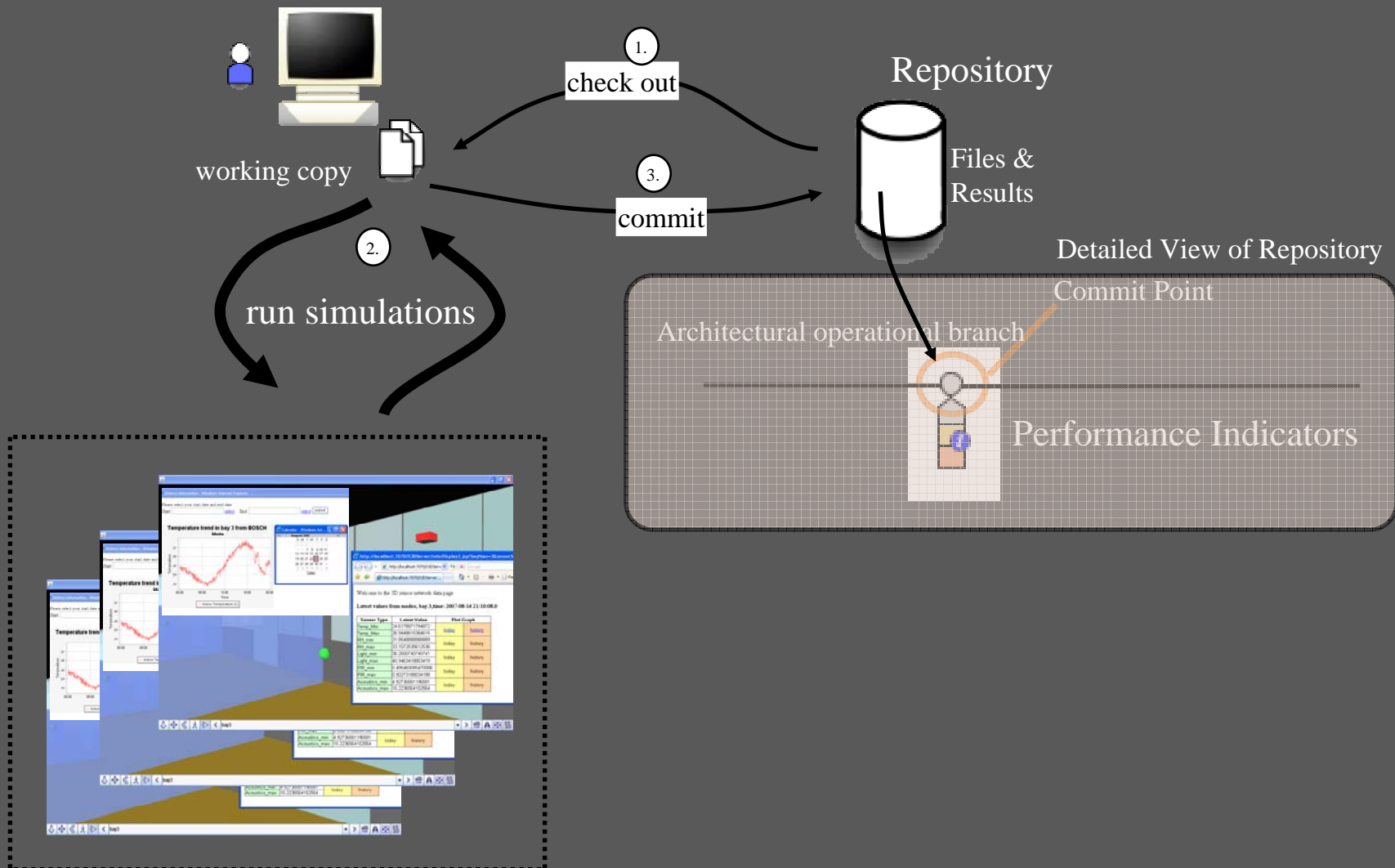
The LEED Accreditation metric is an aggregate of all LEED credits (which may be viewed separately) and is displayed as a color and number of credits secured.



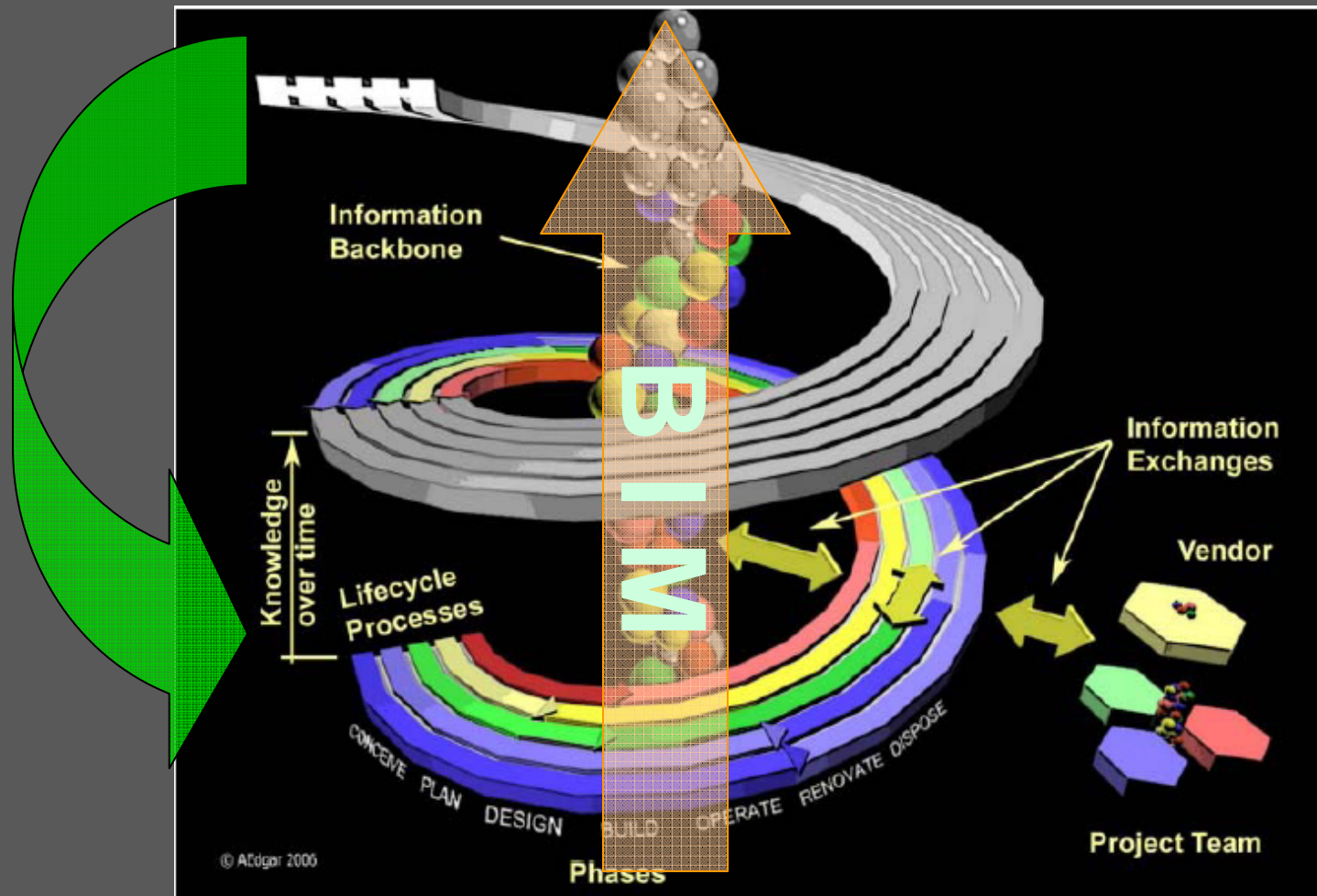
BIM - Design Phase



BIM - Building Operational Phase



Information Needs Through Building Life Cycle (NBIMS 2007)





Gone out...here is a computer simulation of your dinner

Thank you
谢谢



National Institute of
Building Sciences

Carnegie Mellon

International Alliance
for Interoperability

