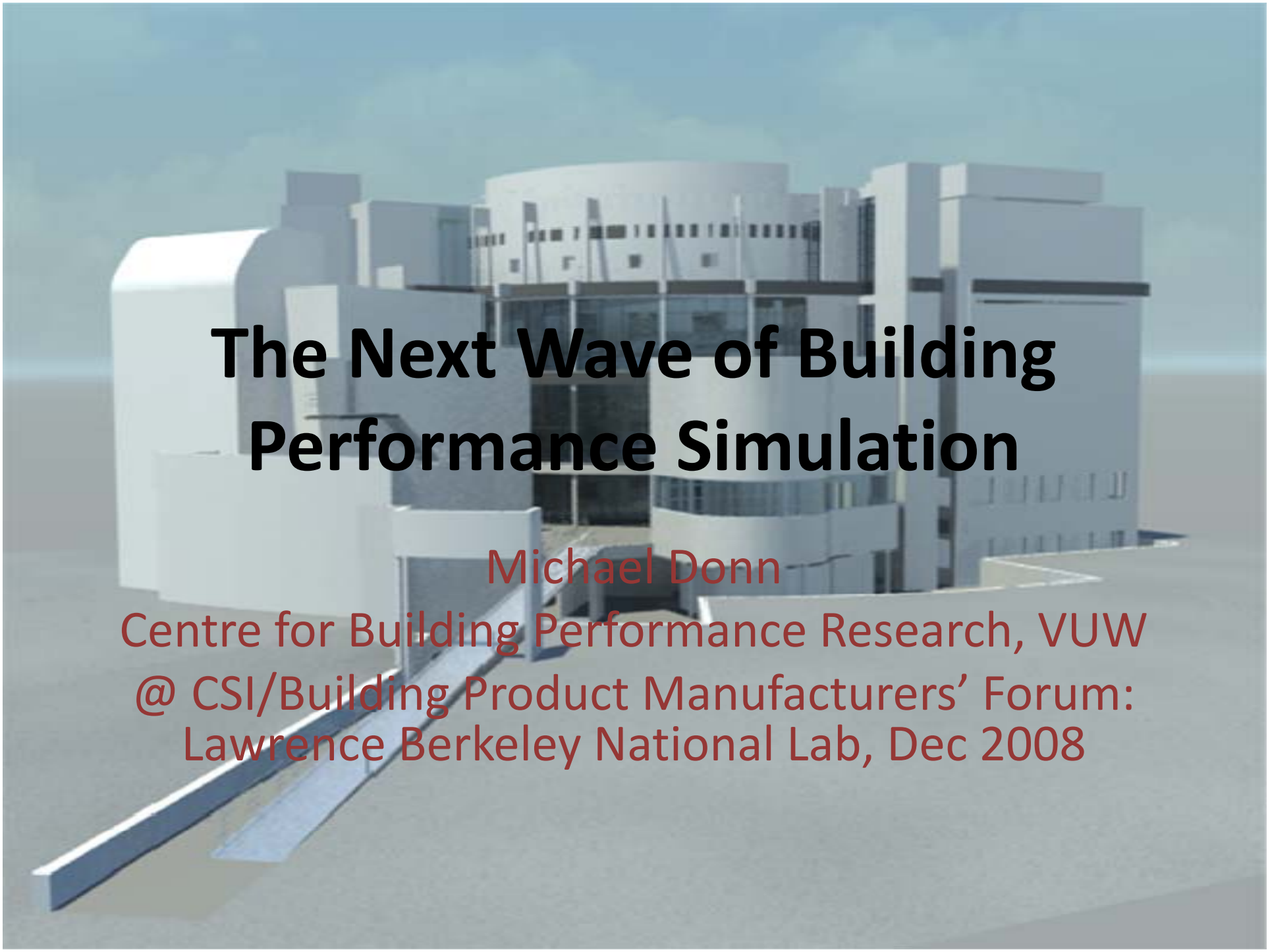


The Next Wave of Building Performance Simulation

Michael Donn
Centre for Building Performance Research, VUW

@ CSI/Building Product Manufacturers' Forum: Lawrence Berkeley National Lab, Dec 2008

The Next Wave:
Positioning yourself for the BIM future?

- a personal view of what the drivers are likely to be

- Challenge 4 U: what is Michael missing out?

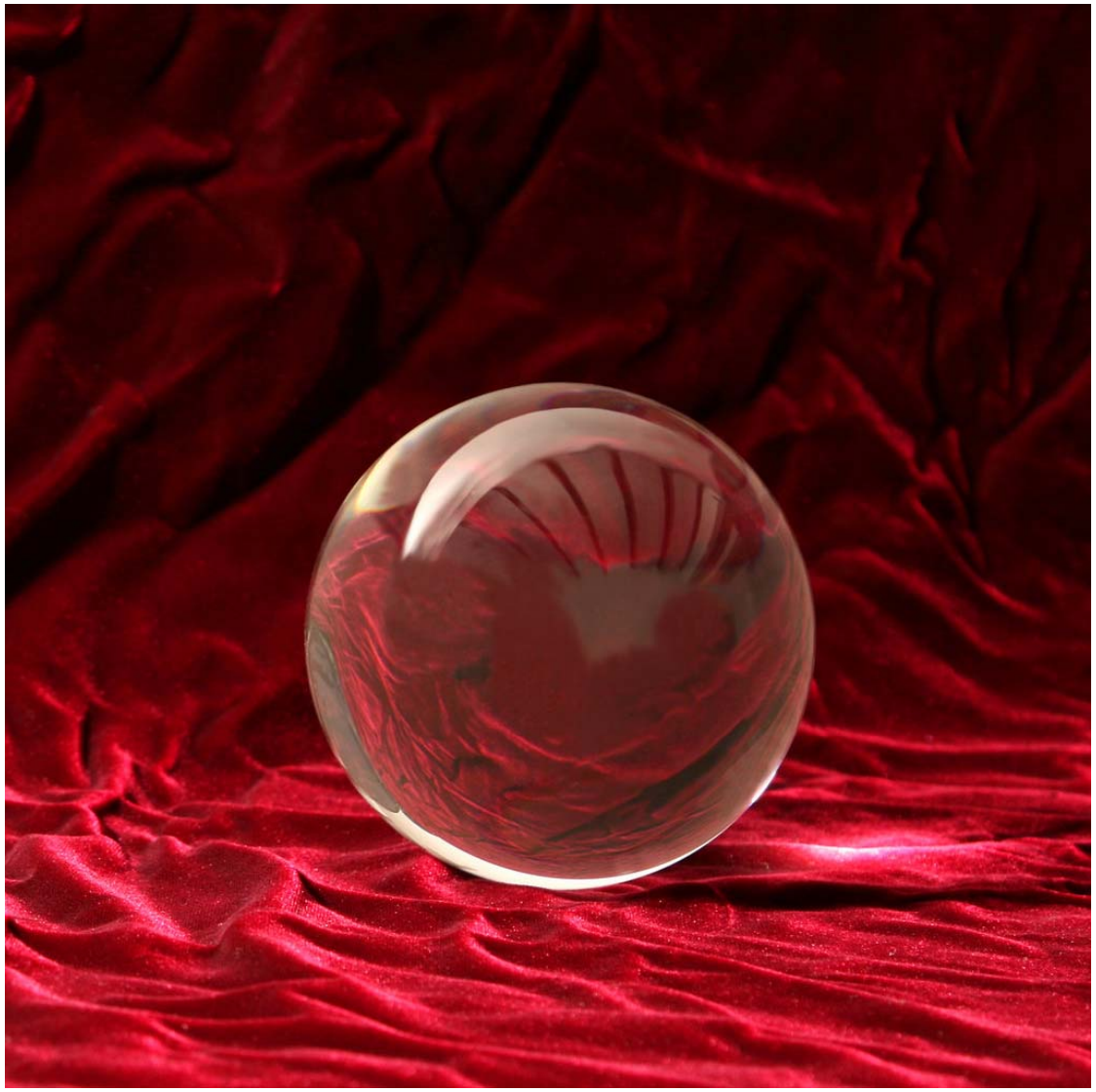
- Challenge 4 U: can I help design *as if people mattered*

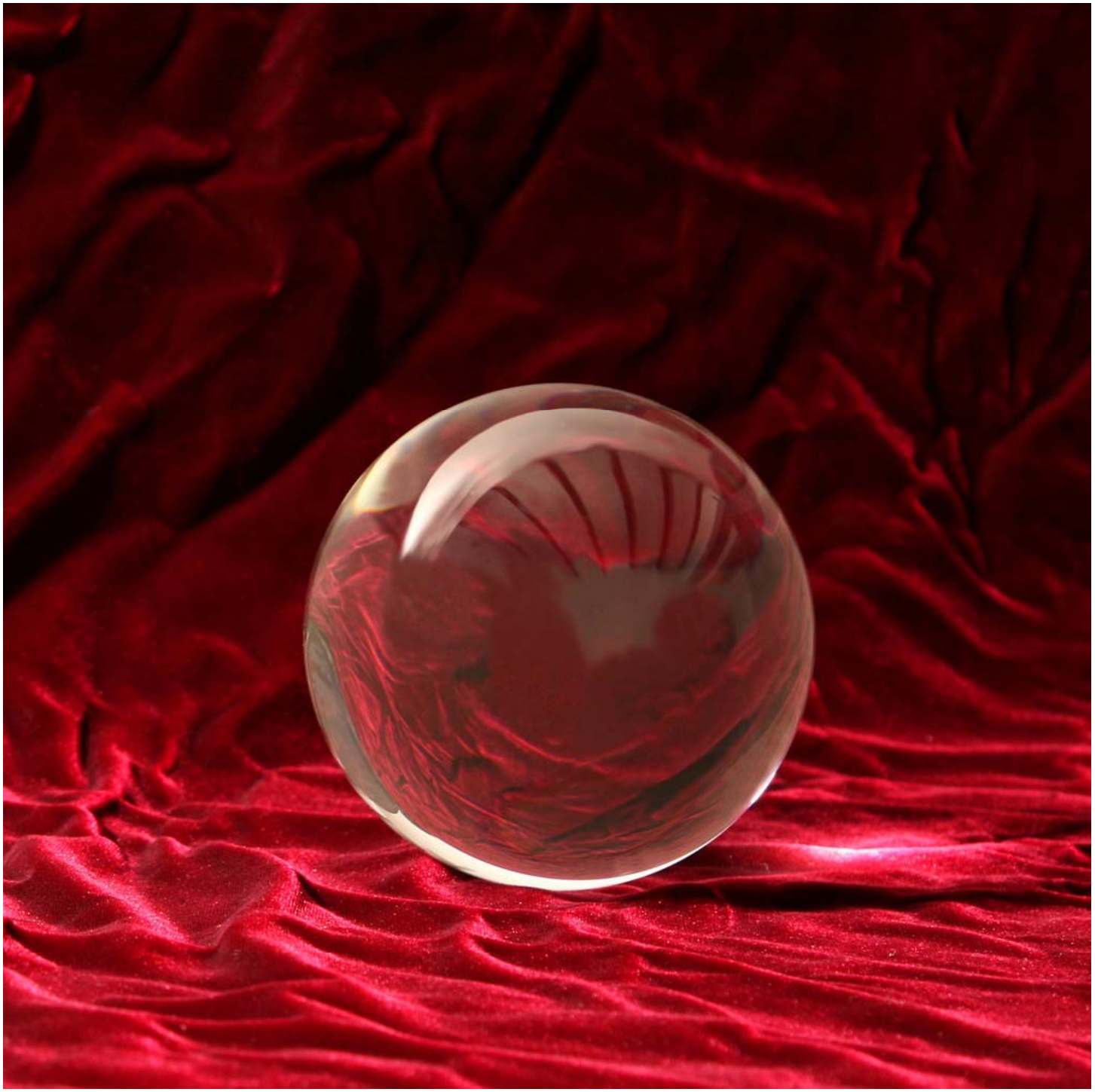
Who am I?

- Victoria University School of Architecture, Wellington, NZ.
- Currently working with the LBNL team on COMFEN design tool and writing a book on *Rendering Daylight*.
- Active in building energy use and building performance simulation research (energy use, lighting and building aerodynamics) since 1979.
- Research FETISH is quality assurance in simulation – *about which more later*.
- Member of the scientific organising committee of the Int'l Building Performance Simulation Association bi-annual conference scientific executive committee since 1999 – next Strathclyde 2009.
- Sub-task leader for the International Energy Agency *Net Zero Energy Buildings* international research project: 40+ researchers, ~15 countries focusing on design integration.
- Presented 2 classes at Autodesk AU last week.

‘The next wave’

Crystal ball gazing



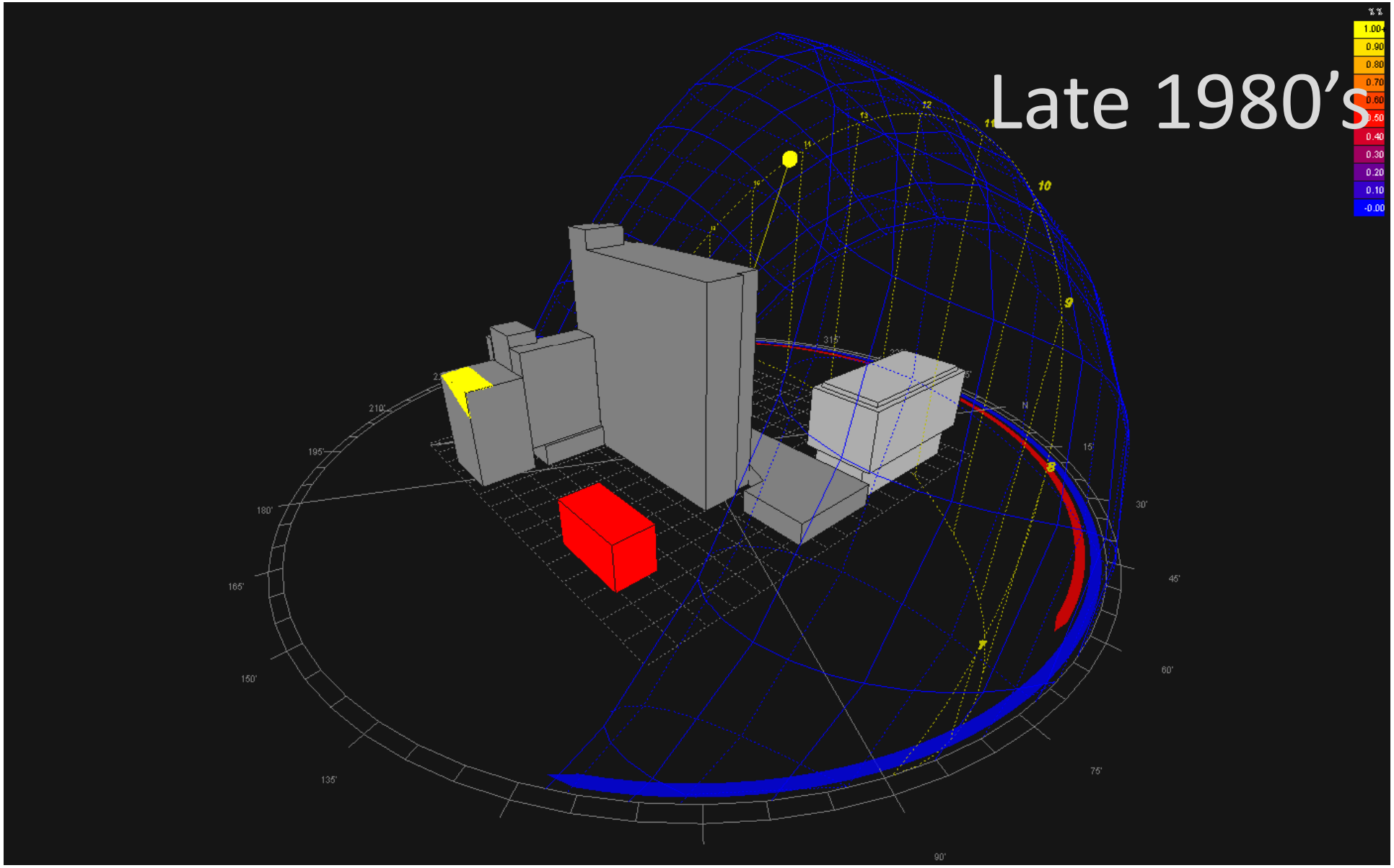


Software used by VUW SoA

www.vuw.ac.nz/architecture

www.arch.school.nz

Ecotect – building eds performance



3d studio – animation/rendering

Early 1990's

Click and drag to interact with model.

<Alt>X – section

F11 Full screen

Model made in AutoCAD – rendered 3d studio 1992

Lightscape – lighting design

1995

Revit – CAD modelling

~2000

Click and drag to interact with model.

<Alt>X – section

F11 Full screen

Model made in Revit – 1 module from LBNL window test facility

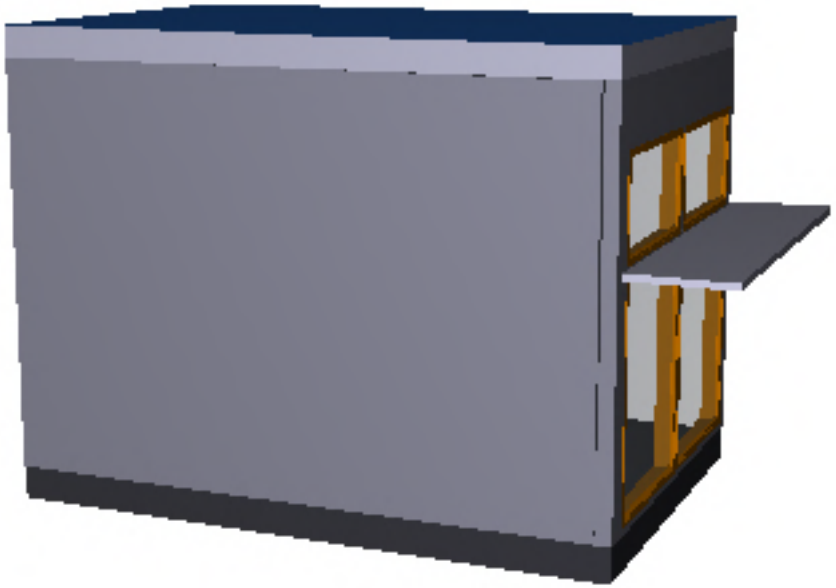


Image Modeller – 3D from photos

2002/3

Image Modeller – 3D from photos

2002/3

Generative Components – CAD?

2005

That history translates to:

3D Studio/Gary Yost

Lightscape/Charles Friedman

Revit/

Generative Components/Robert Aish

Ecotect/Andrew Marsh

Image Modeller/Dominique Pouliquen

Autodesk

Green Building Studio?

3D Studio/Gary Yost

Lightscape/Charles Friedman

Revit/

Generative Components/Robert Aish

Ecotect/Andrew Marsh

Image Modeller/Dominique Pouliquen

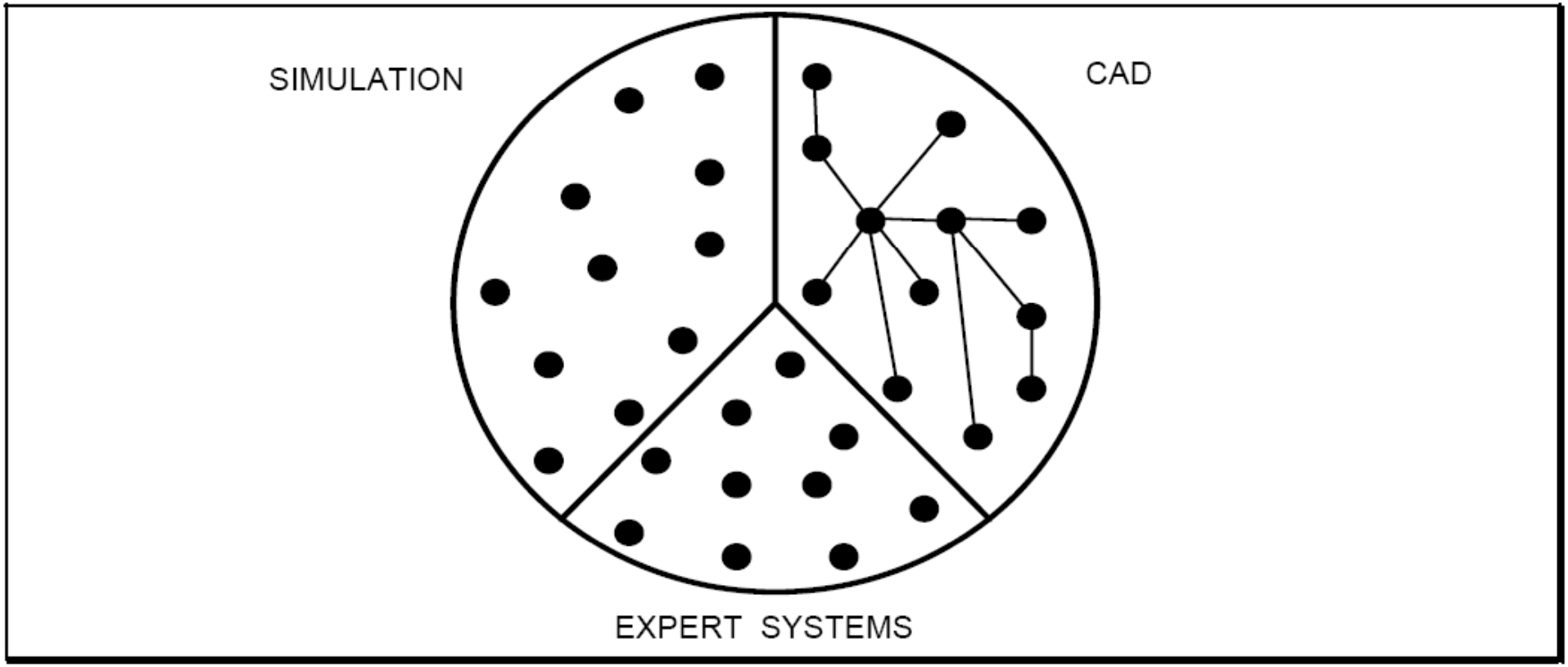
CATT Acoustic

Light Studio

Energy+

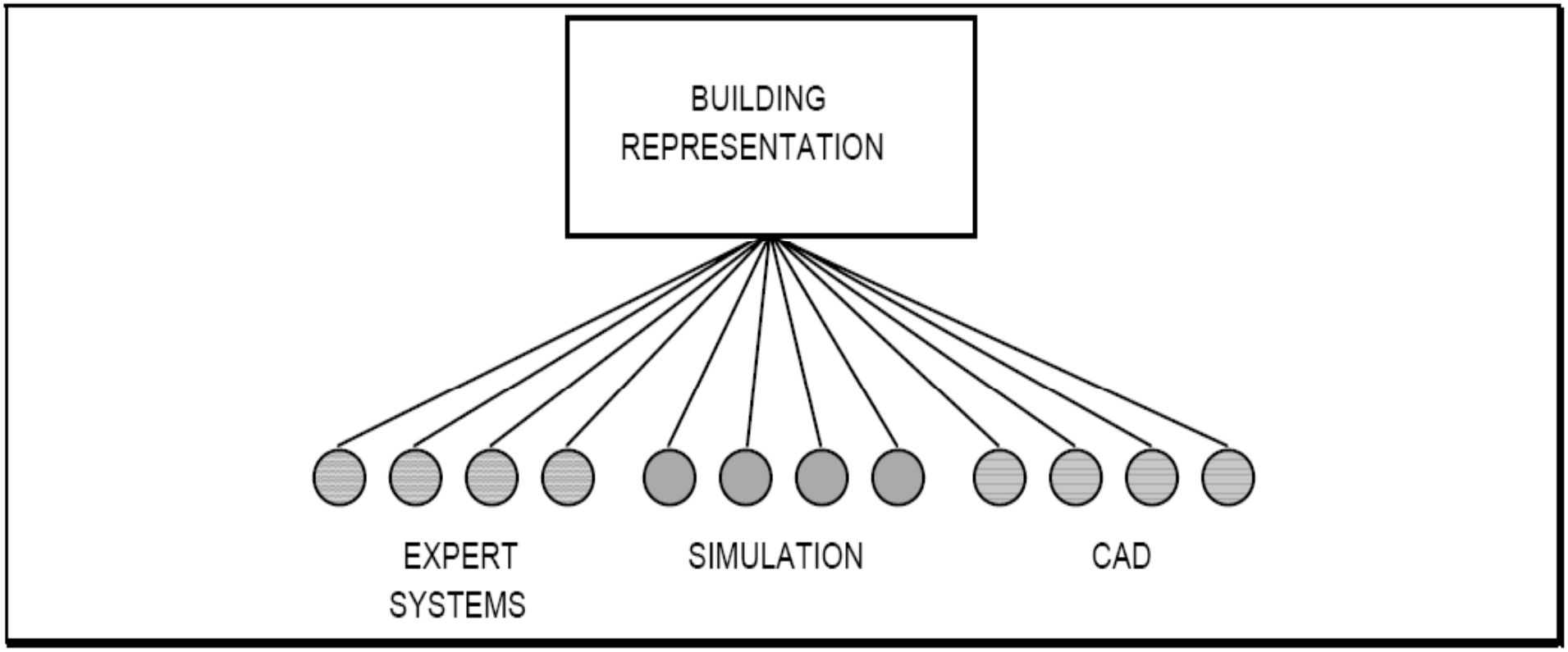
A personal *BIM* history - ICATECT

- 1990: Robert Amor *Integrating Design Tools for Building Design*



A personal *BIM* history - ICATECT

- 1990: Robert Amor *Integrating Design Tools for Building Design*



A personal BIM history – SF - 1995

International Alliance for Interoperability

A personal BIM history – SF - 1995

International Alliance for Interoperability

NOT *COMBINE*

(*Computer Models for the Building Industry in Europe*)

A personal BIM history – SF - 1995

COMBINE 1990-95

(*Computer Models for the Building Industry in Europe*)

"COMBINE is an international project with at present 11 partners from seven countries. The project is funded in the JOULE rational use of energy program in the framework of European Union R&D funding. Its objective is the development of future intelligent integrated building design systems (IIBDS) through which the energy, services and other performance characteristics of a planned building can be analyzed. This will be accomplished through the use of standardized IT solutions for data integration emerging from the ISO-STEP standardisation effort." G Augenbroe.
ftp://erg.ucd.ie/public/pdfiles/combine_papers/paper1.pdf

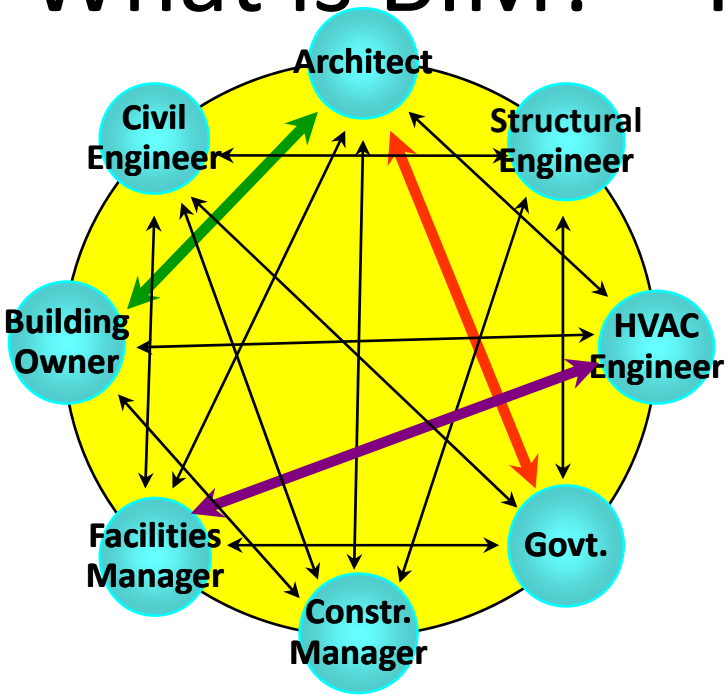
A personal BIM history – post 1995

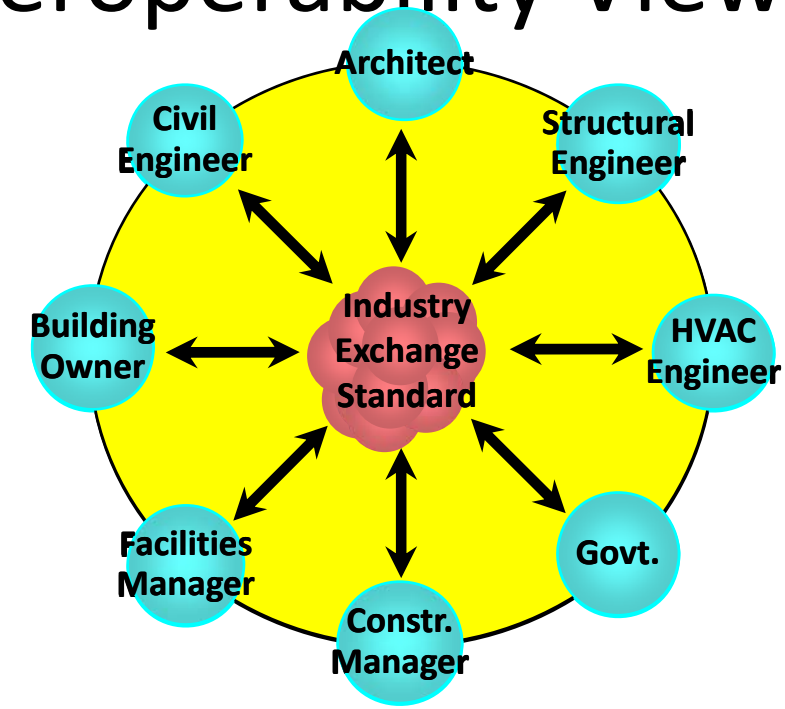
Industry Alliance for Interoperability

A personal BIM history – post 2007

BUILDINGSMART ALLIANCE

What is BIM? – Interoperability View



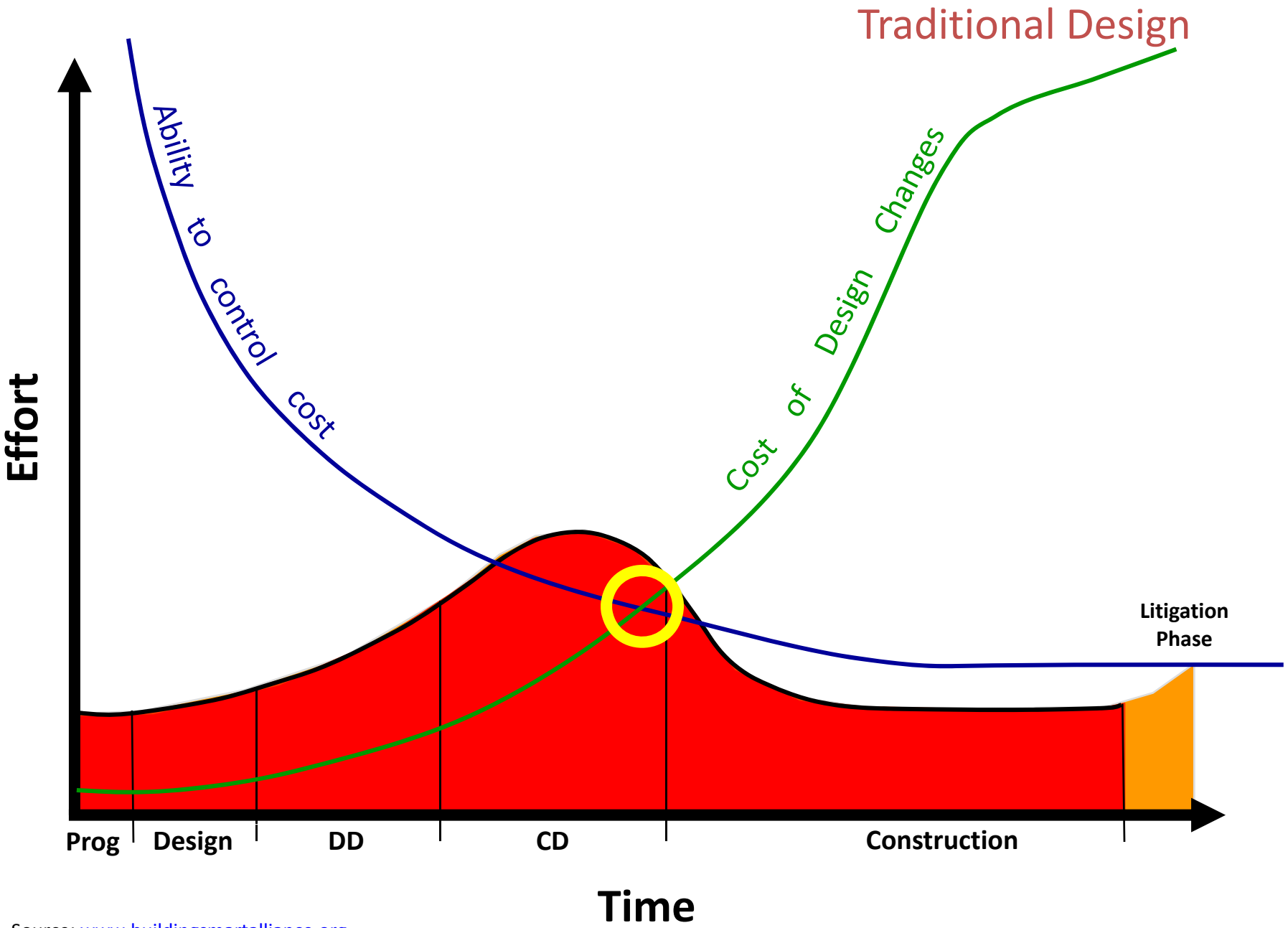


Number of Components to Integrate	Formula/Calculation (See Last Slide for Calculation Details)	Cost of Integration (FTE's)	Labor Cost ($50,000/FTE)
20	N(N-1) 20(19)=380	38	$1,900,000
20	N=2.0 20(2.0)=40	4	$ 200,000
NET SAVINGS	**340 CONNECTIONS**	**34 FTE's**	**$1,700,000**

Study performed by the Open Application Group (OAGi)

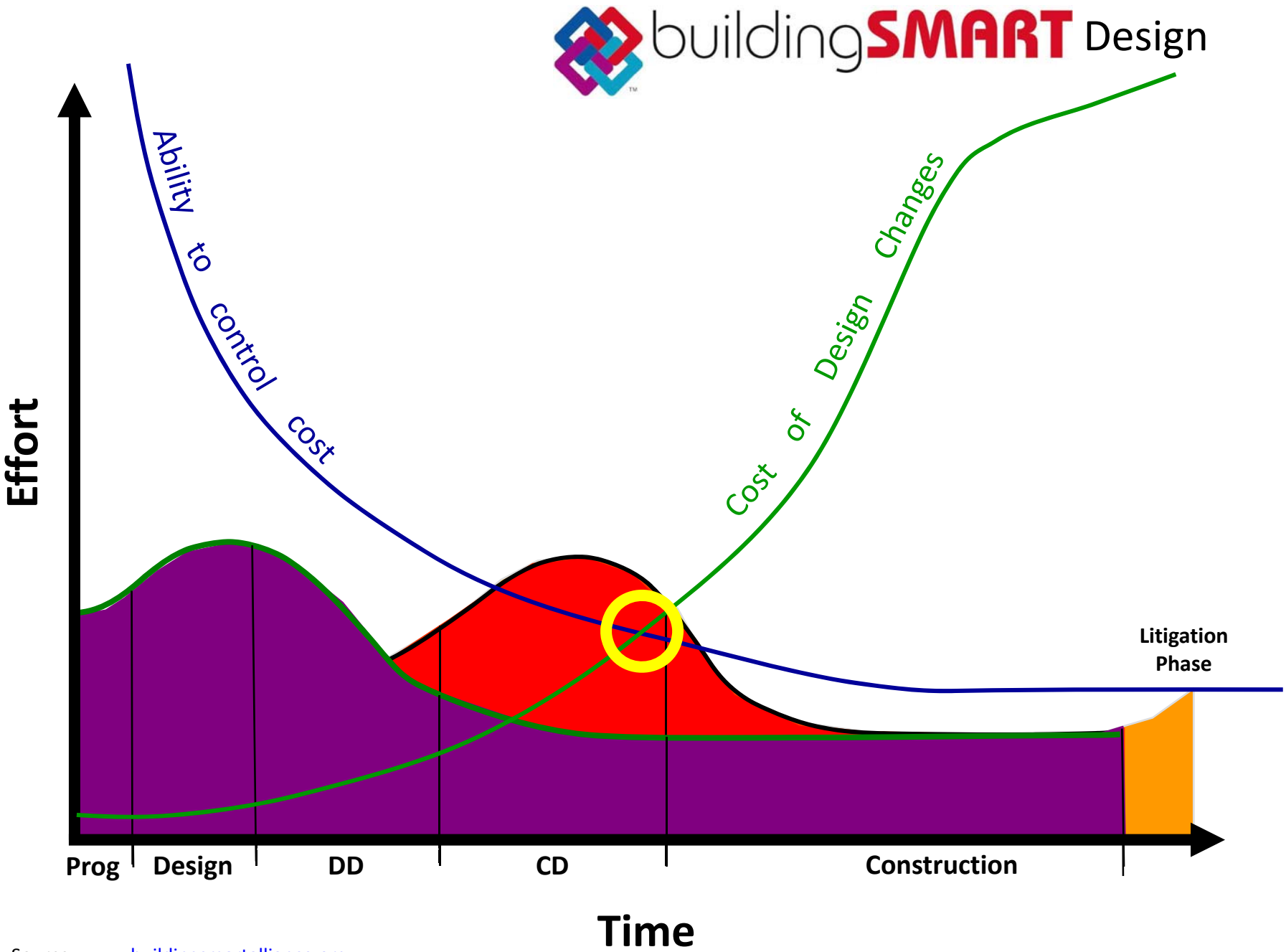
©2007 OSCRE, Americas, Inc.

Source: www.buildingsmartalliance.org



Source: www.buildingsmartalliance.org

Courtesy of Patrick MacLeamy, HOK

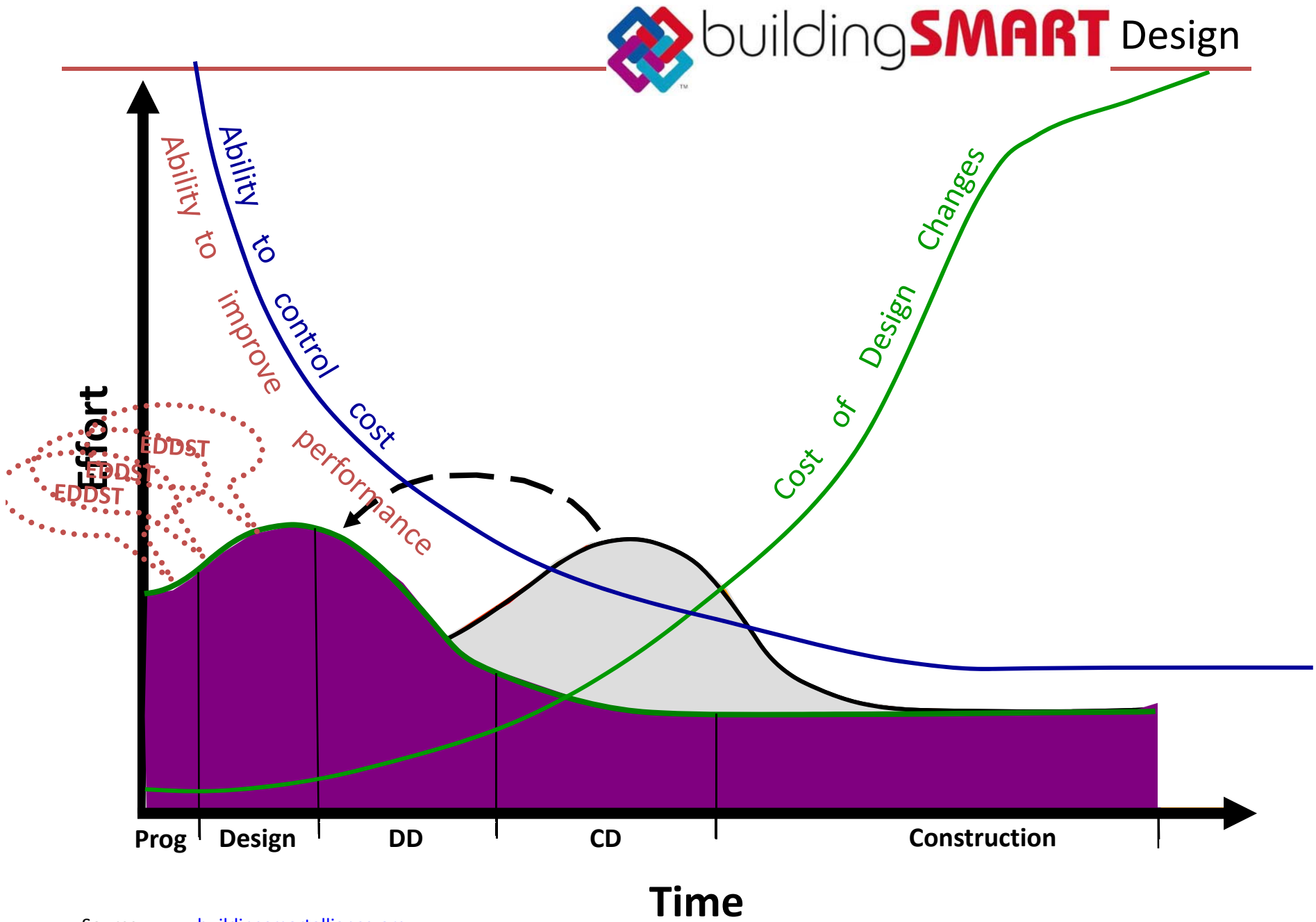


Source: www.buildingsmartalliance.org

Courtesy of Patrick MacLeamy, HOK

environmental design decision support tools

eddst



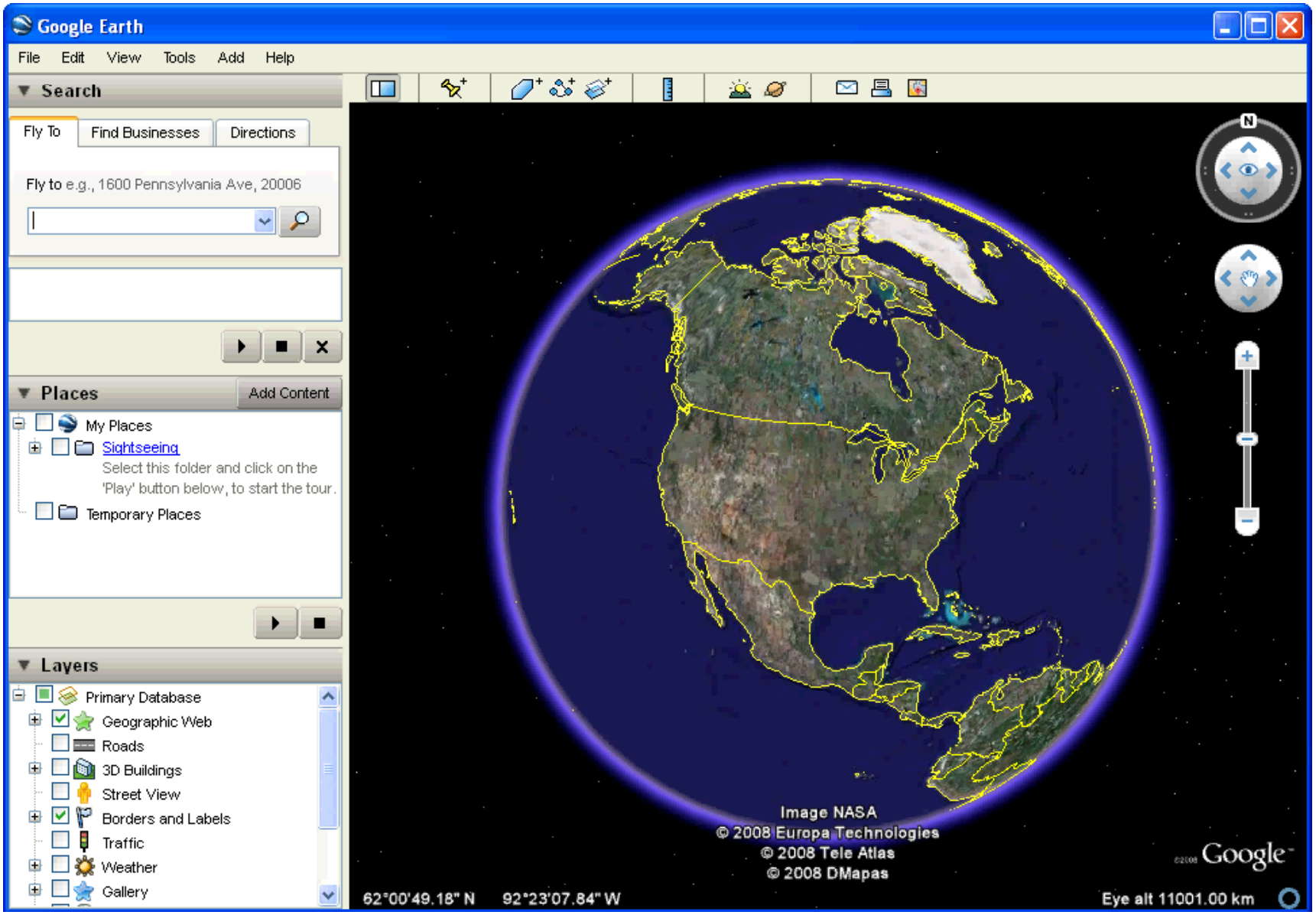
Source: www.buildingsmartalliance.org

Courtesy of Patrick MacLeamy, HOK

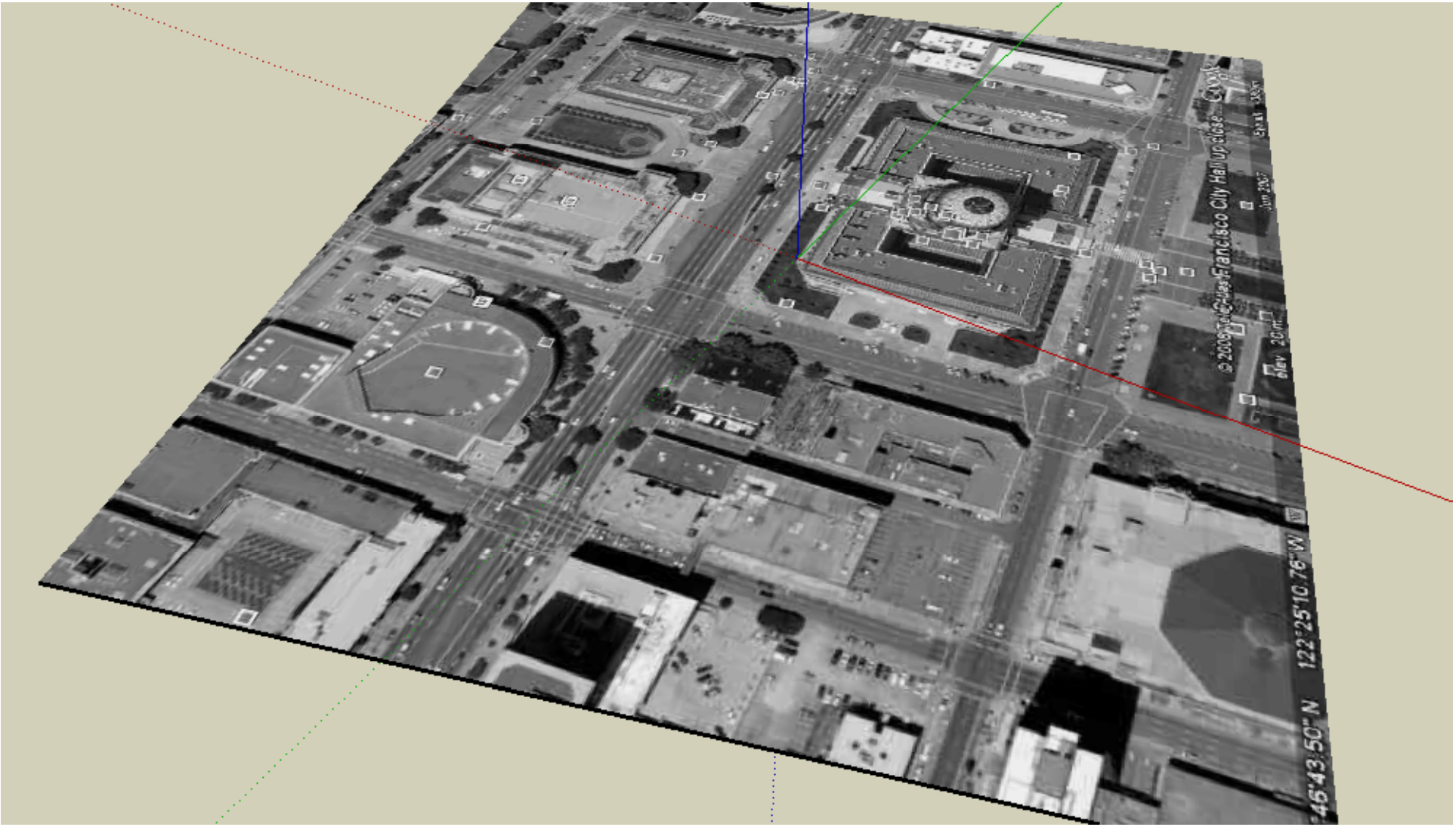
‘The Next Wave?’

The work flow currently

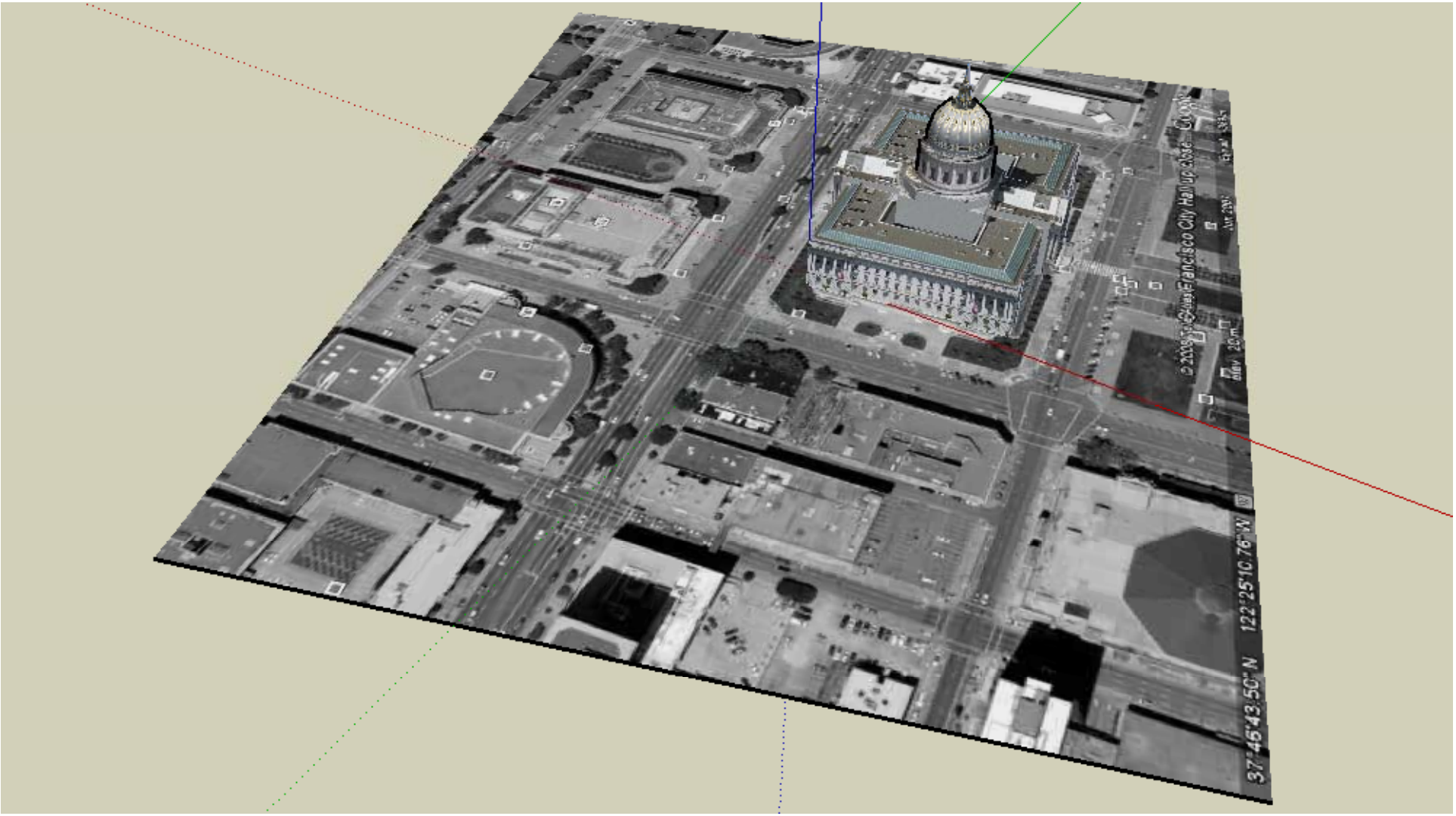
Find location …



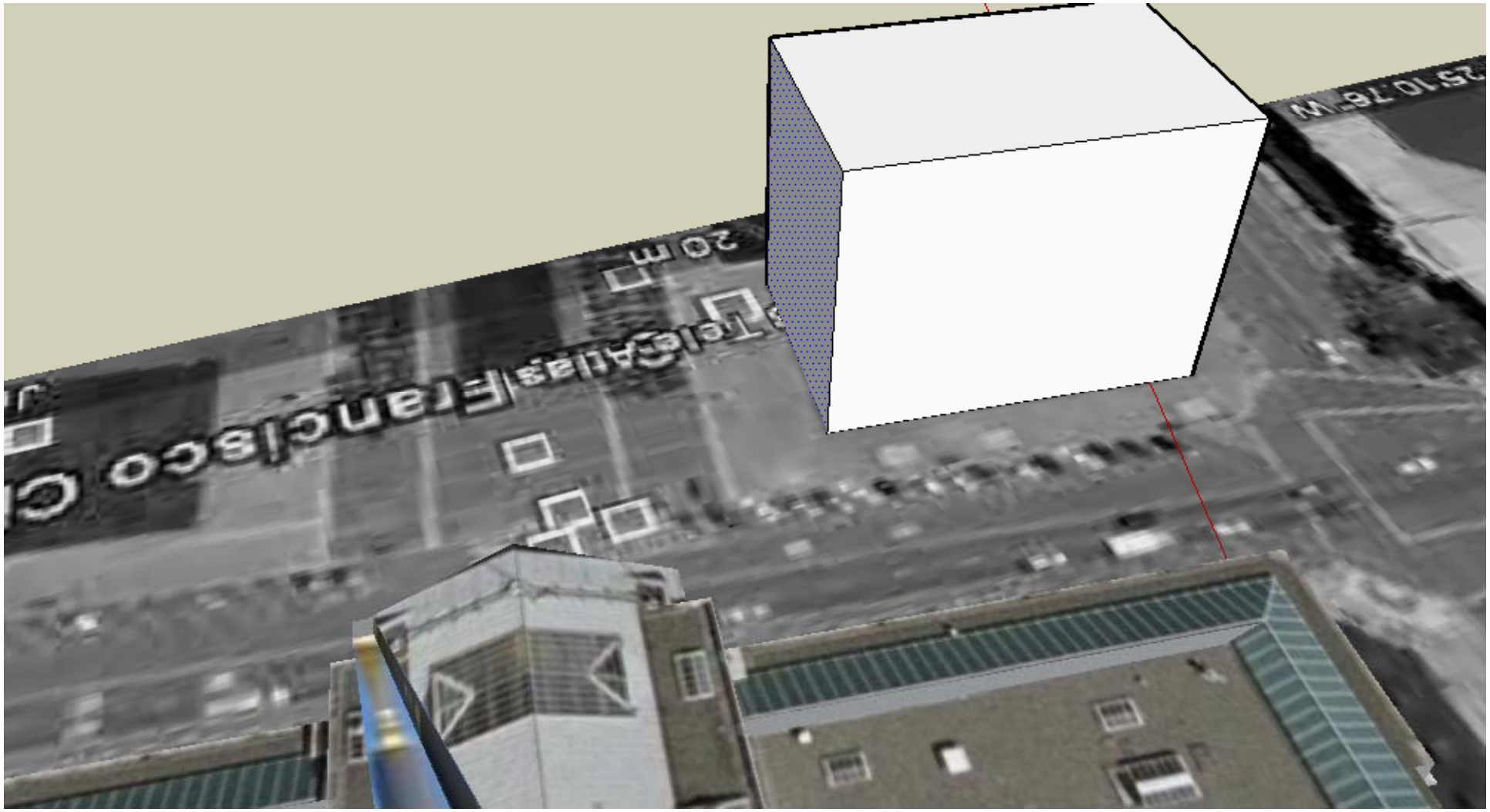
Google Earth imported into SketchUp



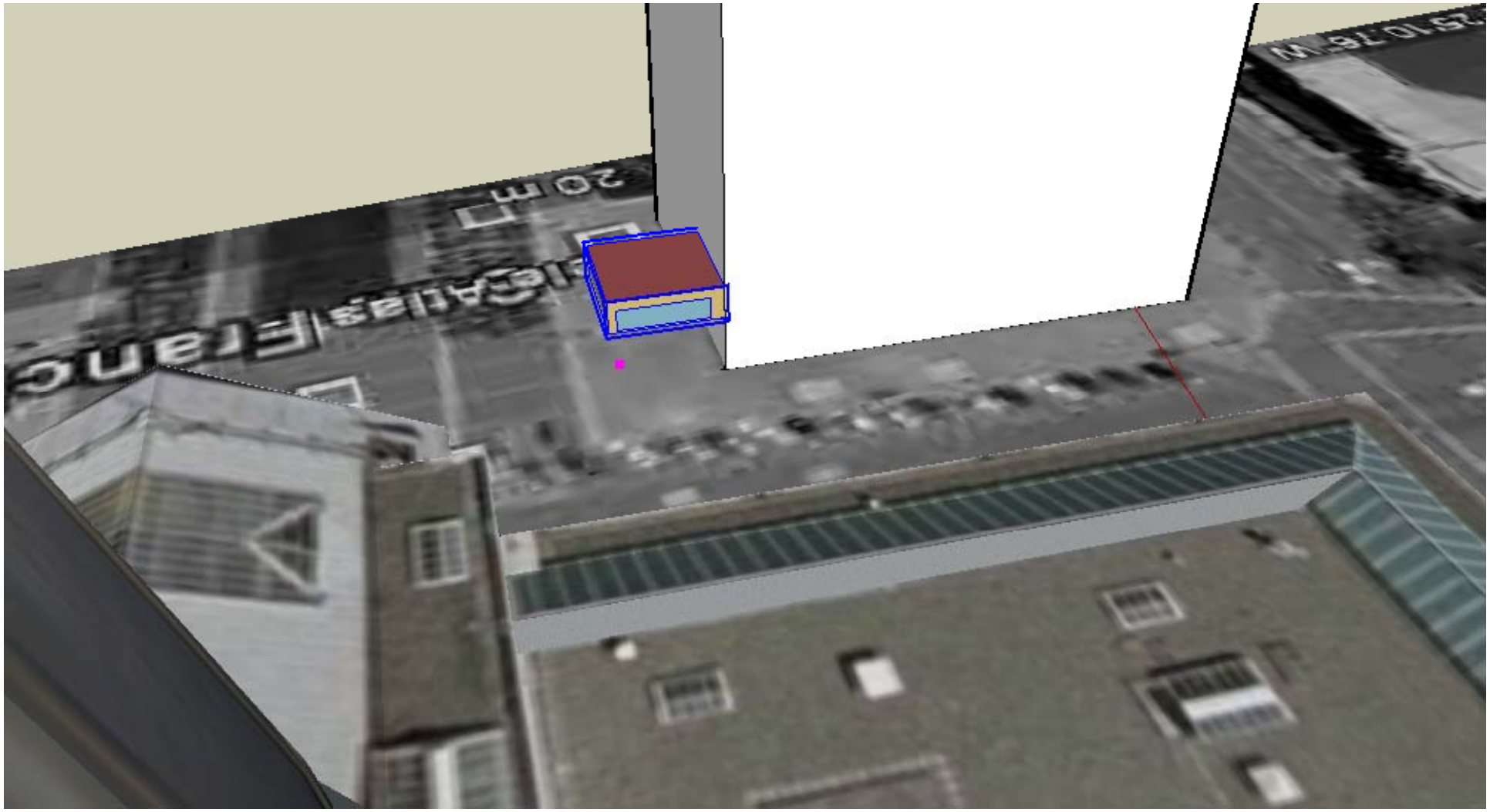
3D Warehouse model



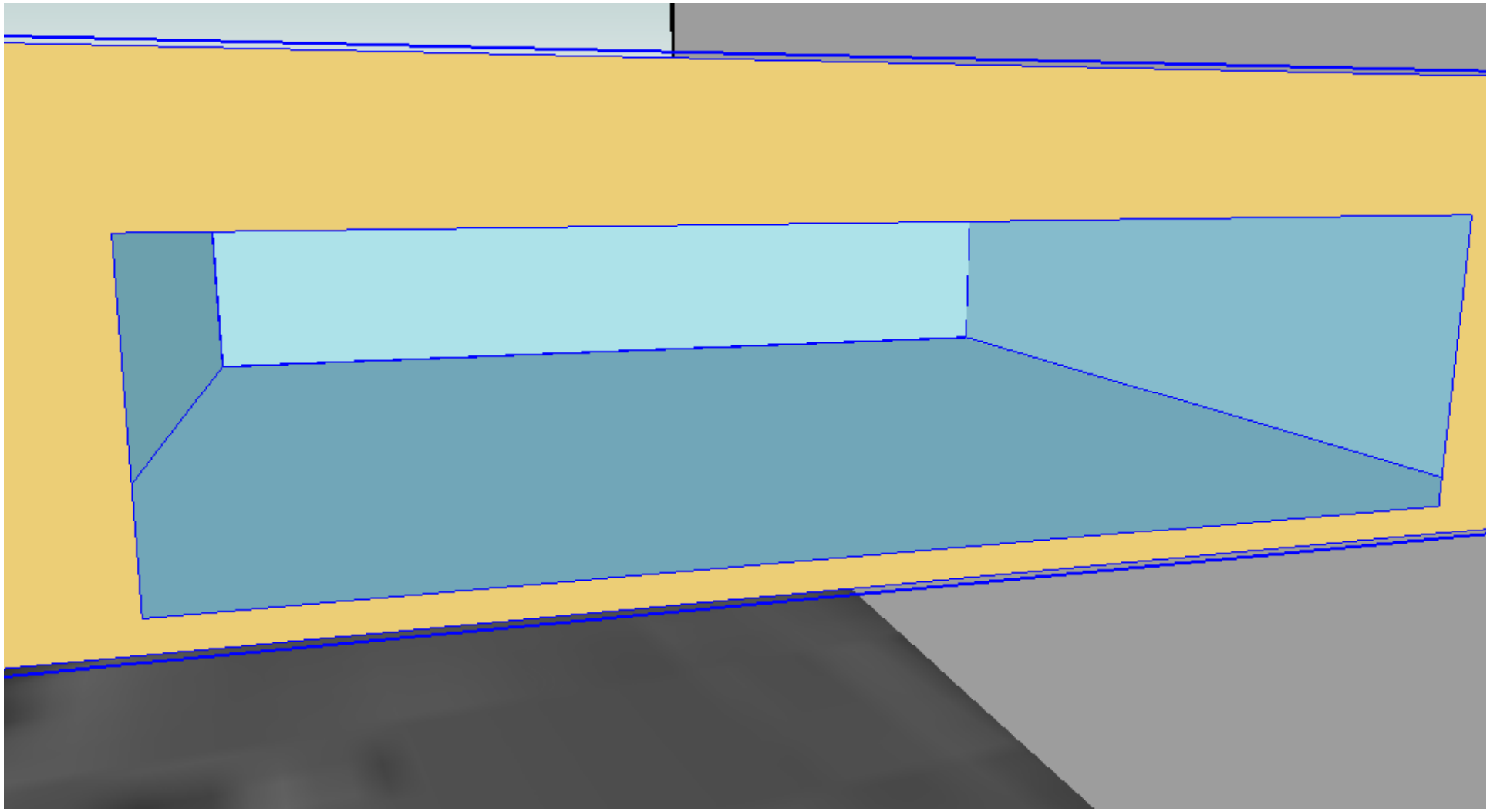
Sketch a new building



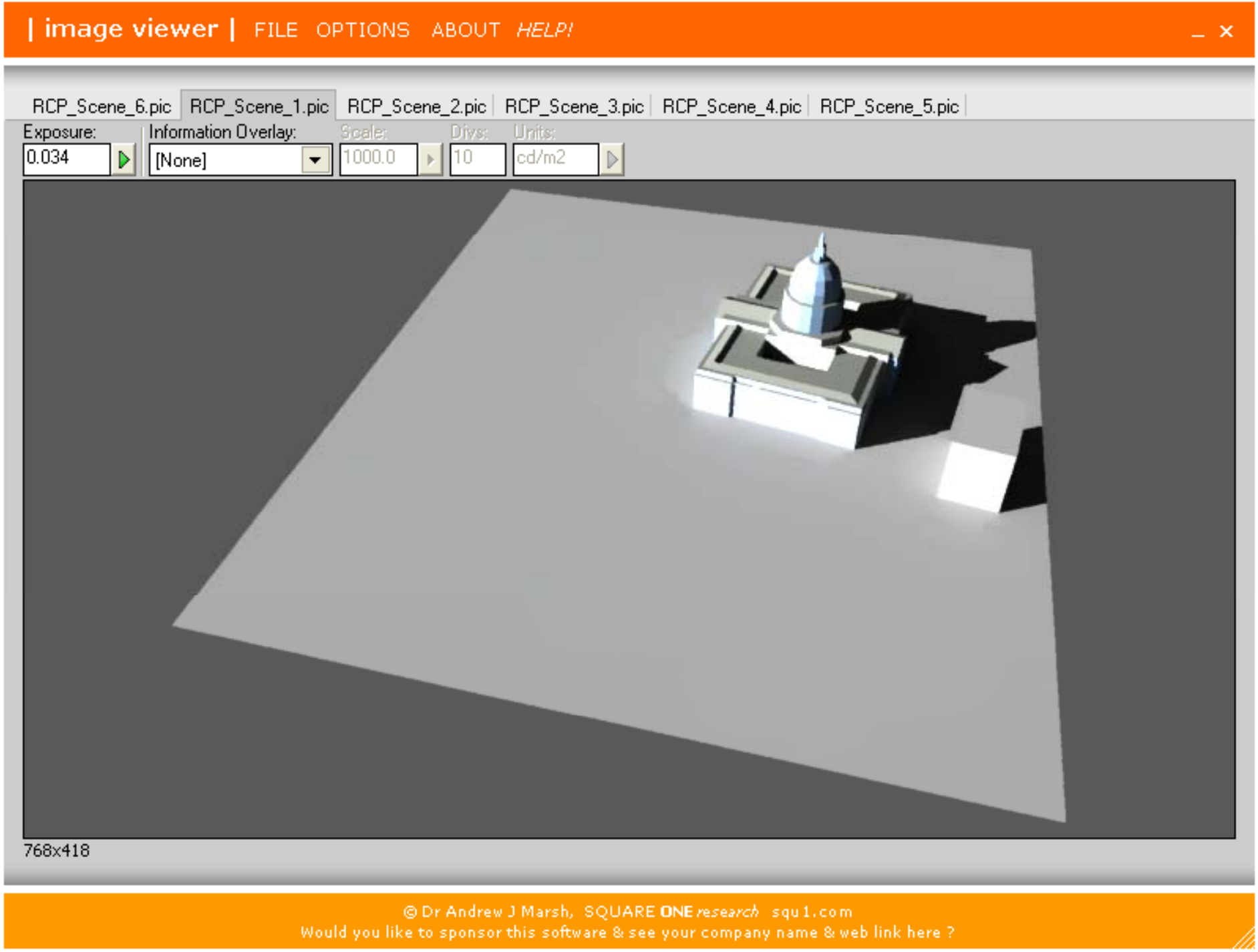
Build a single ‘office’



Simple wall of glass



Export to Radiance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RCP_Scene_6.pic
RCP_Scene_1.pic
RCP_Scene_2.pic
RCP_Scene_3.pic
RCP_Scene_4.pic
RCP_Scene_5.pic
Exposure:
0.034
Information Overlay:
[None]
Scale:
1000.0
Divs:
10
Units:
cd/m2
768x418
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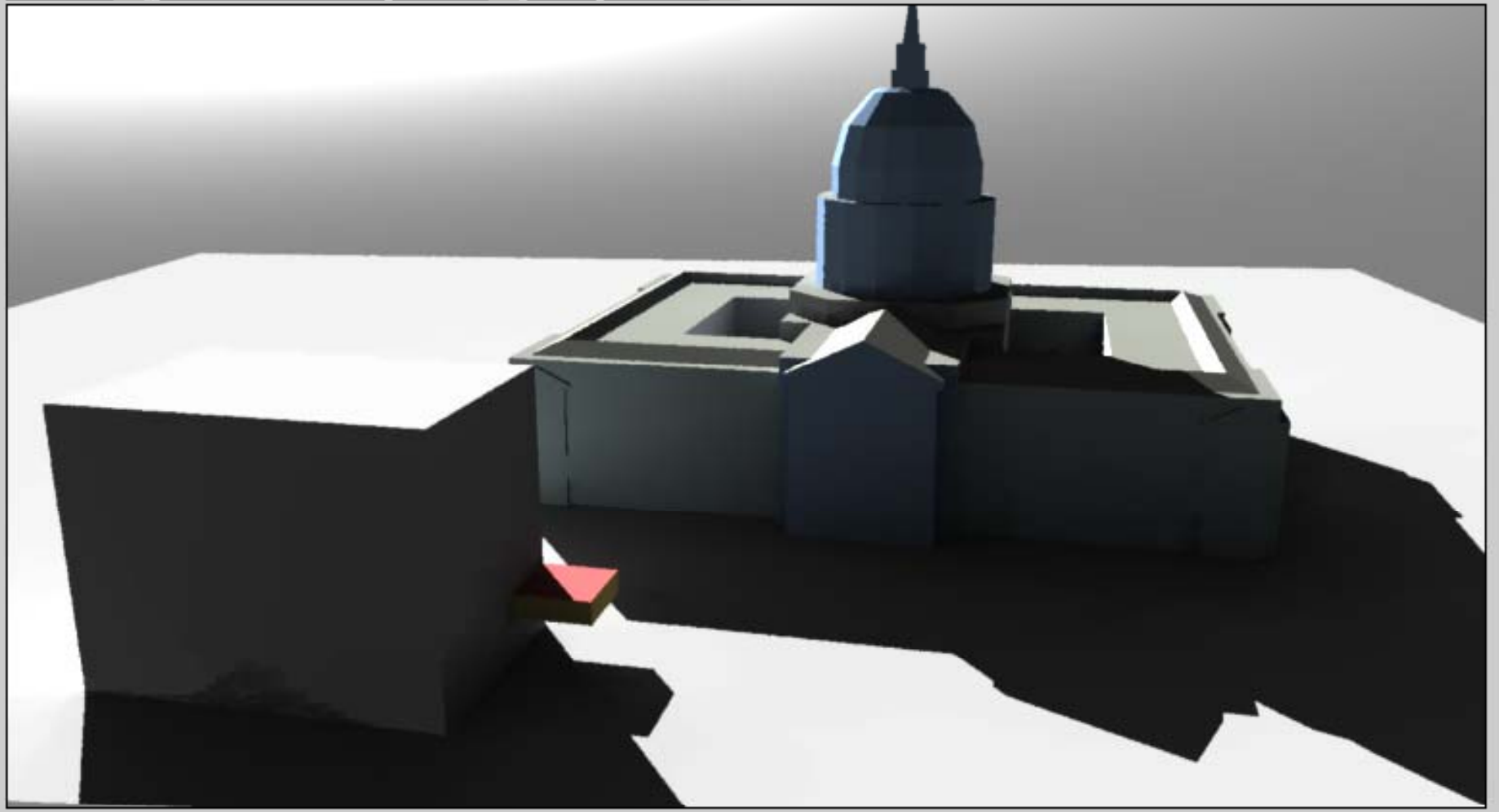
| image viewer | FILE OPTIONS ABOUT *HELP!* _ x

RCP_Scene_6.pic | RCP_Scene_1.pic | RCP_Scene_2.pic | RCP_Scene_3.pic | RCP_Scene_4.pic | RCP_Scene_5.pic

Exposure: 0.048 | Information Overlay: [None] | Scale: 1000.0 | Divs: 10 | Units: cd/m2



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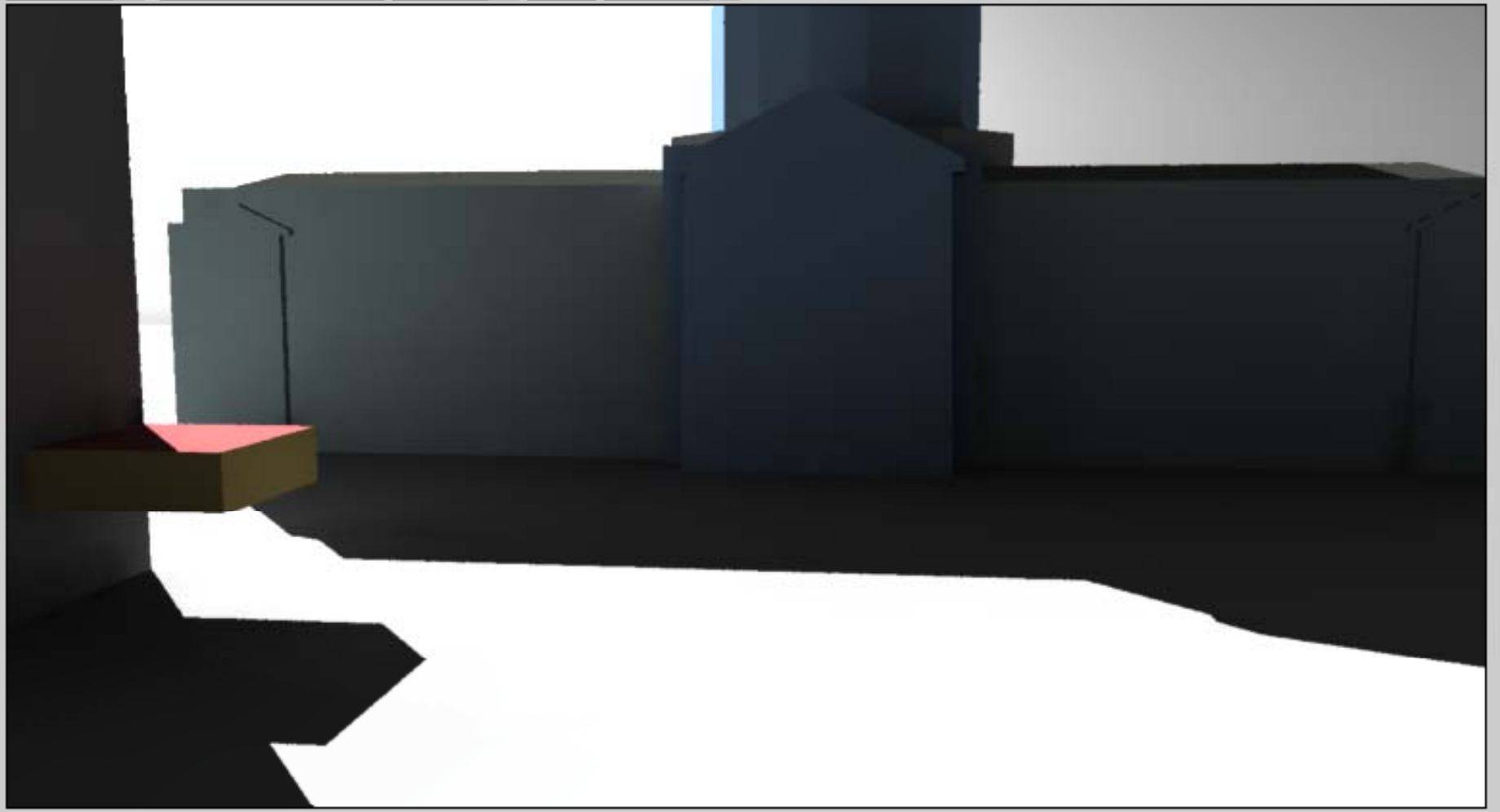
| image viewer | FILE OPTIONS ABOUT *HELP!* _ x

RCP_Scene_6.pic | RCP_Scene_1.pic | RCP_Scene_2.pic | RCP_Scene_3.pic | RCP_Scene_4.pic | RCP_Scene_5.pic

Exposure: 0.052 | Information Overlay: [None] | Scale: 1000.0 | Divs: 10 | Units: cd/m2



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| image viewer | FILE OPTIONS ABOUT *HELP!* _ x

RCP_Scene_6.pic | RCP_Scene_1.pic | RCP_Scene_2.pic | RCP_Scene_3.pic | RCP_Scene_4.pic | RCP_Scene_5.pic

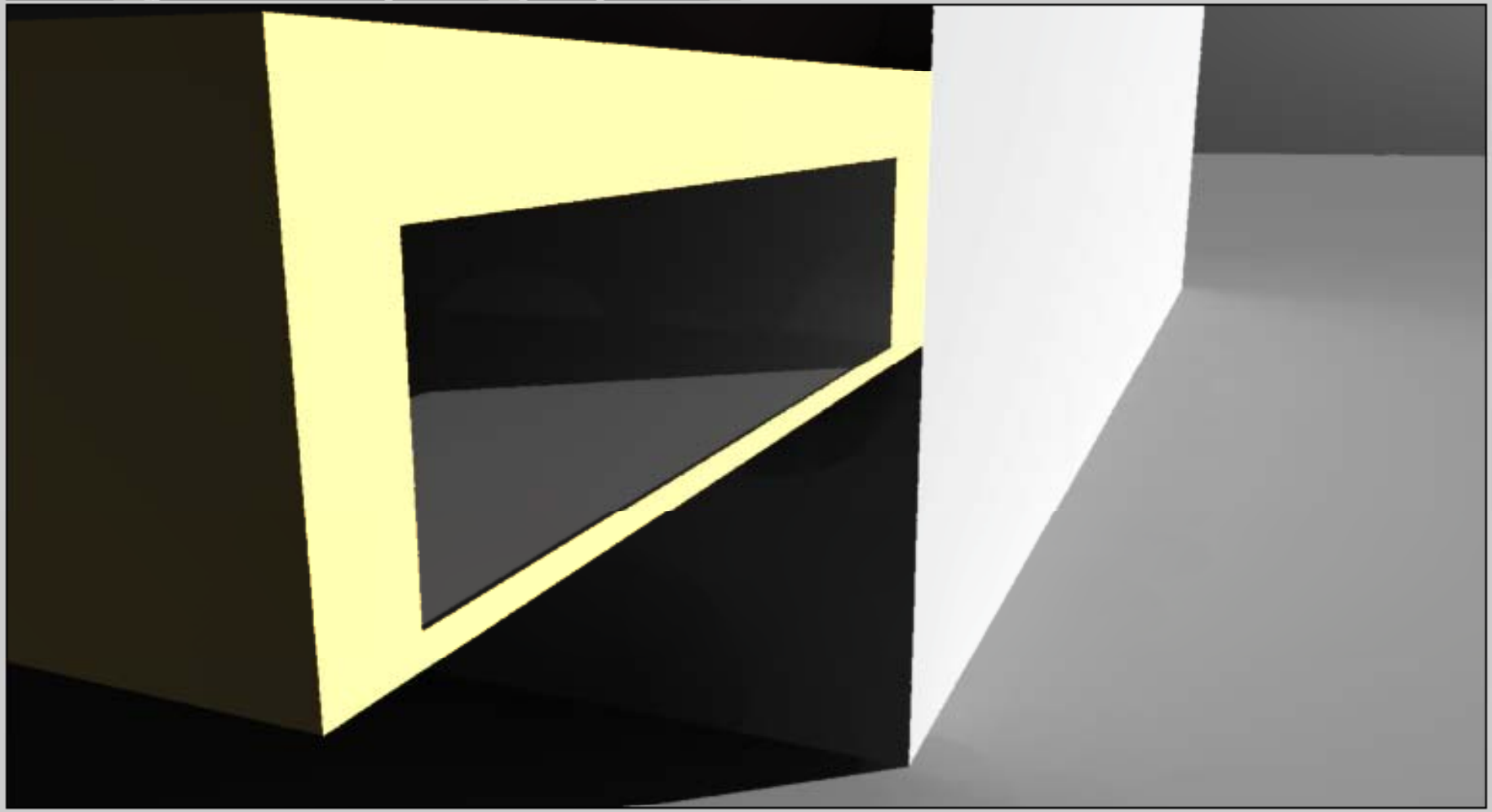
Exposure: 0.026

Information Overlay: [None]

Scale: 1000.0

Divs: 10

Units: cd/m2



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| image viewer | FILE OPTIONS ABOUT *HELP!* _ x

RCP_Scene_6.pic | RCP_Scene_1.pic | RCP_Scene_2.pic | RCP_Scene_3.pic | RCP_Scene_4.pic | RCP_Scene_5.pic

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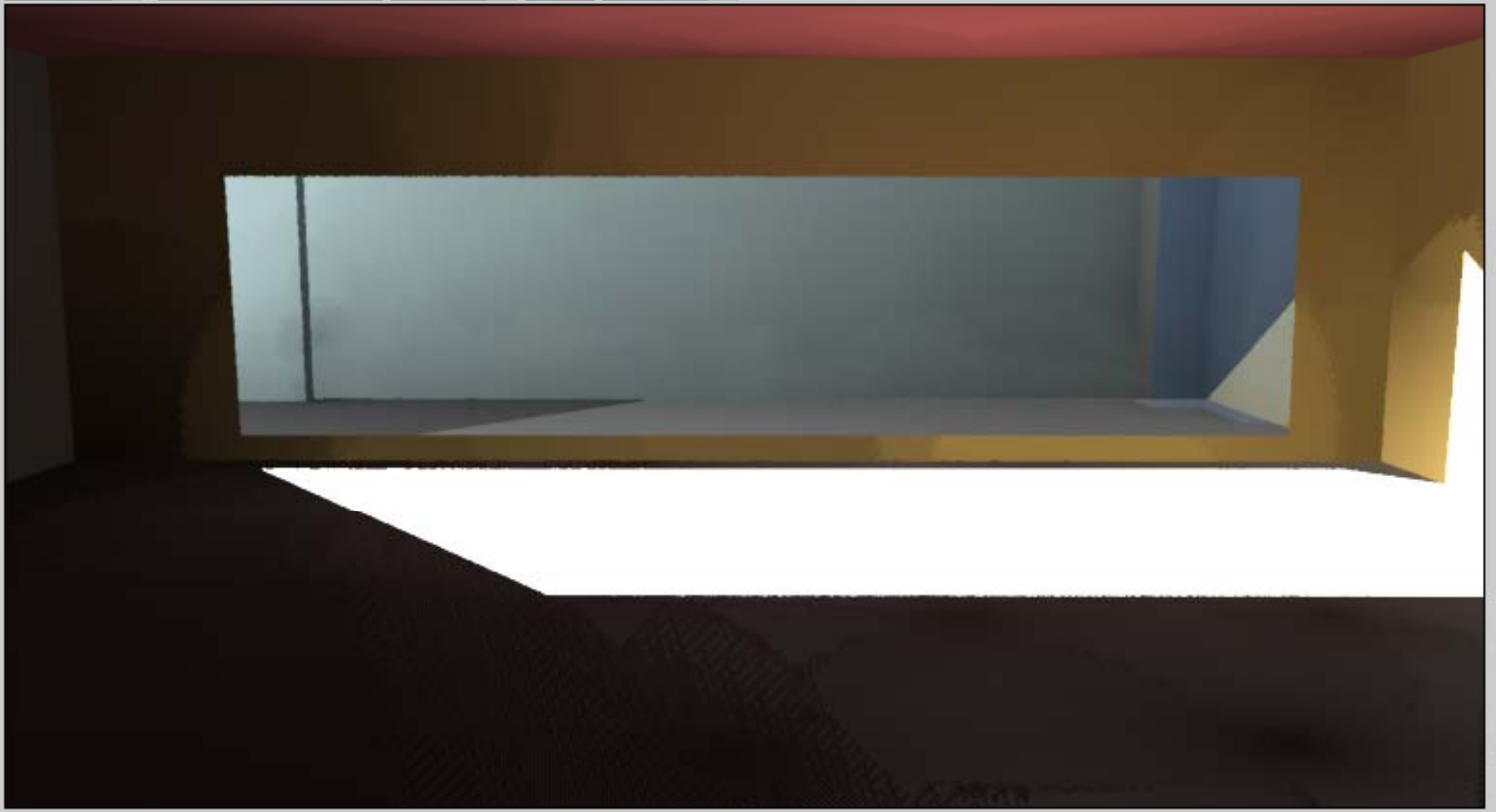

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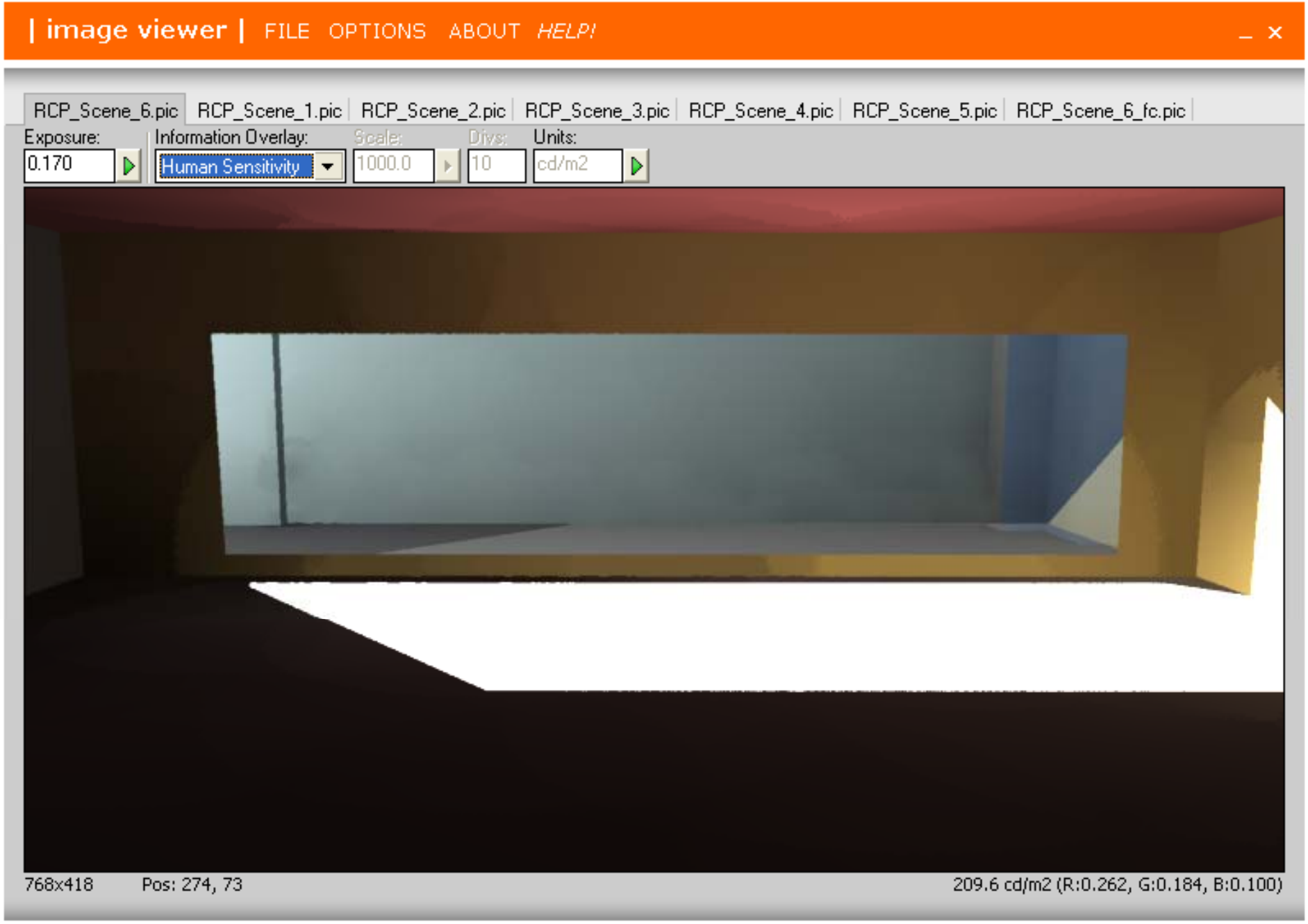

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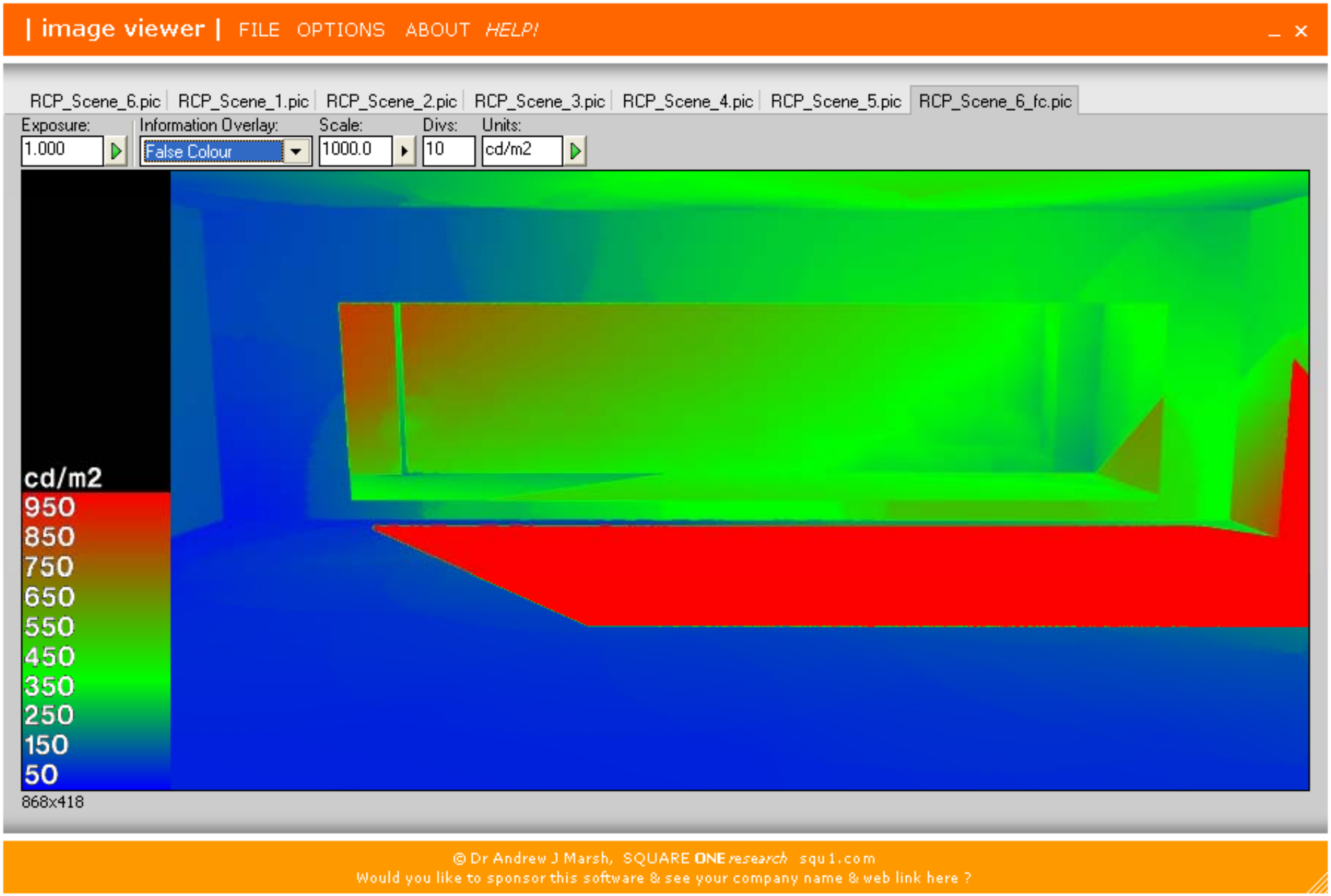
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RCP_Scene_2.pic
RCP_Scene_3.pic
RCP_Scene_4.pic
RCP_Scene_5.pic
RCP_Scene_6_fc.pic
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Information Overlay:
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Scale:
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Divs:
10
Units:
cd/m2
cd/m2
950
850
750
650
550
450
350
250
150
50
868x418
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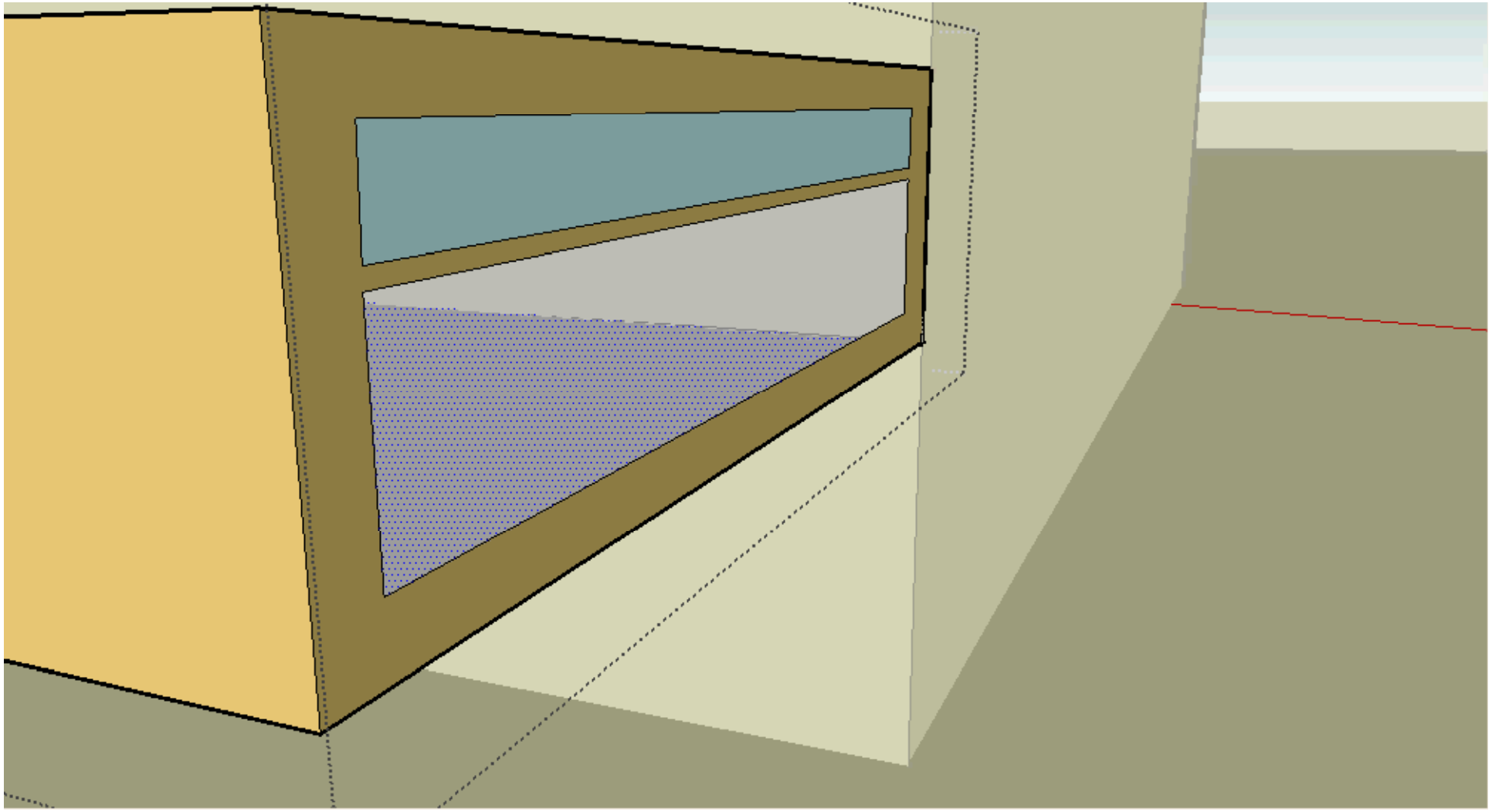
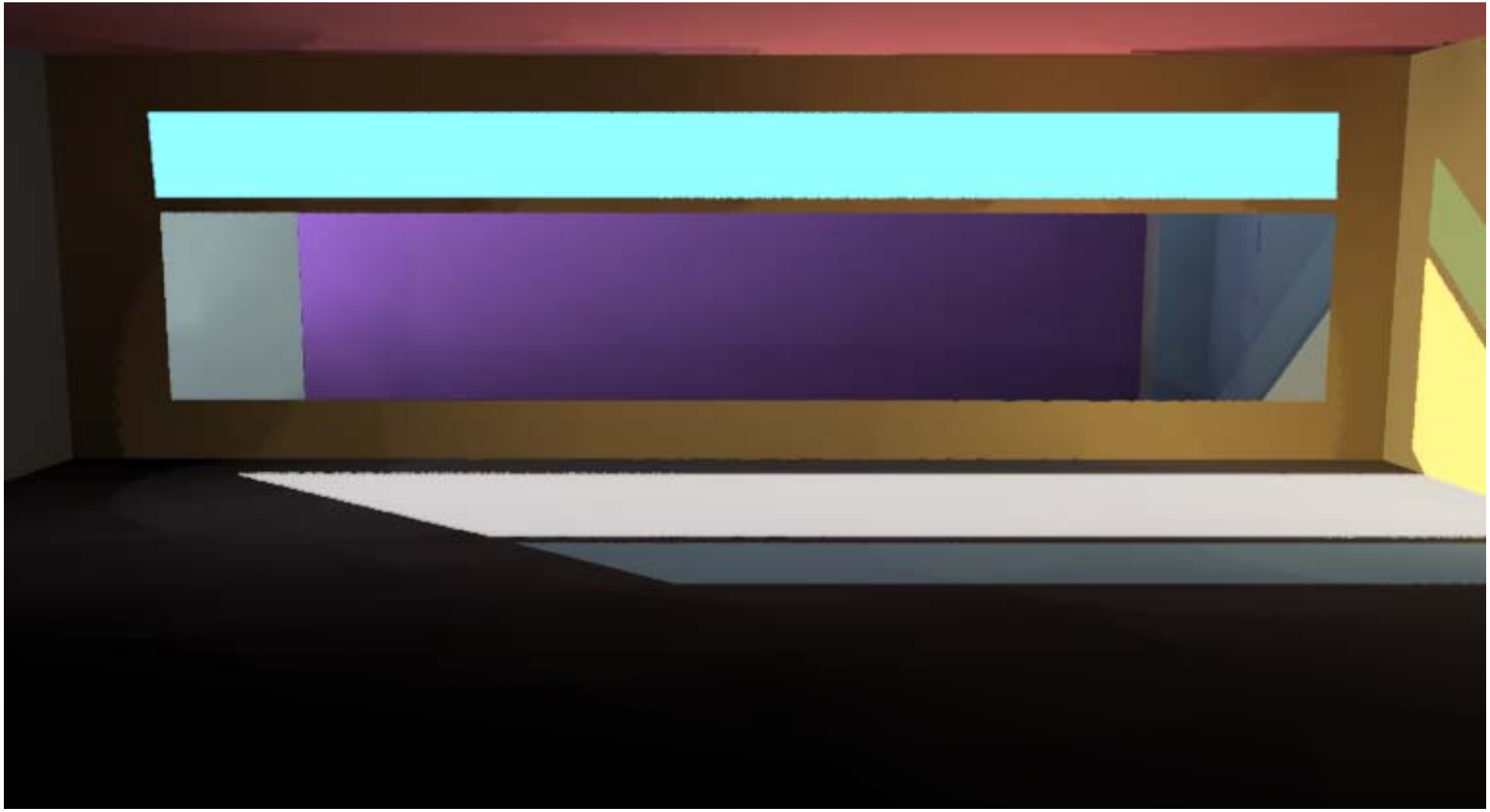
Alternative glazing pattern

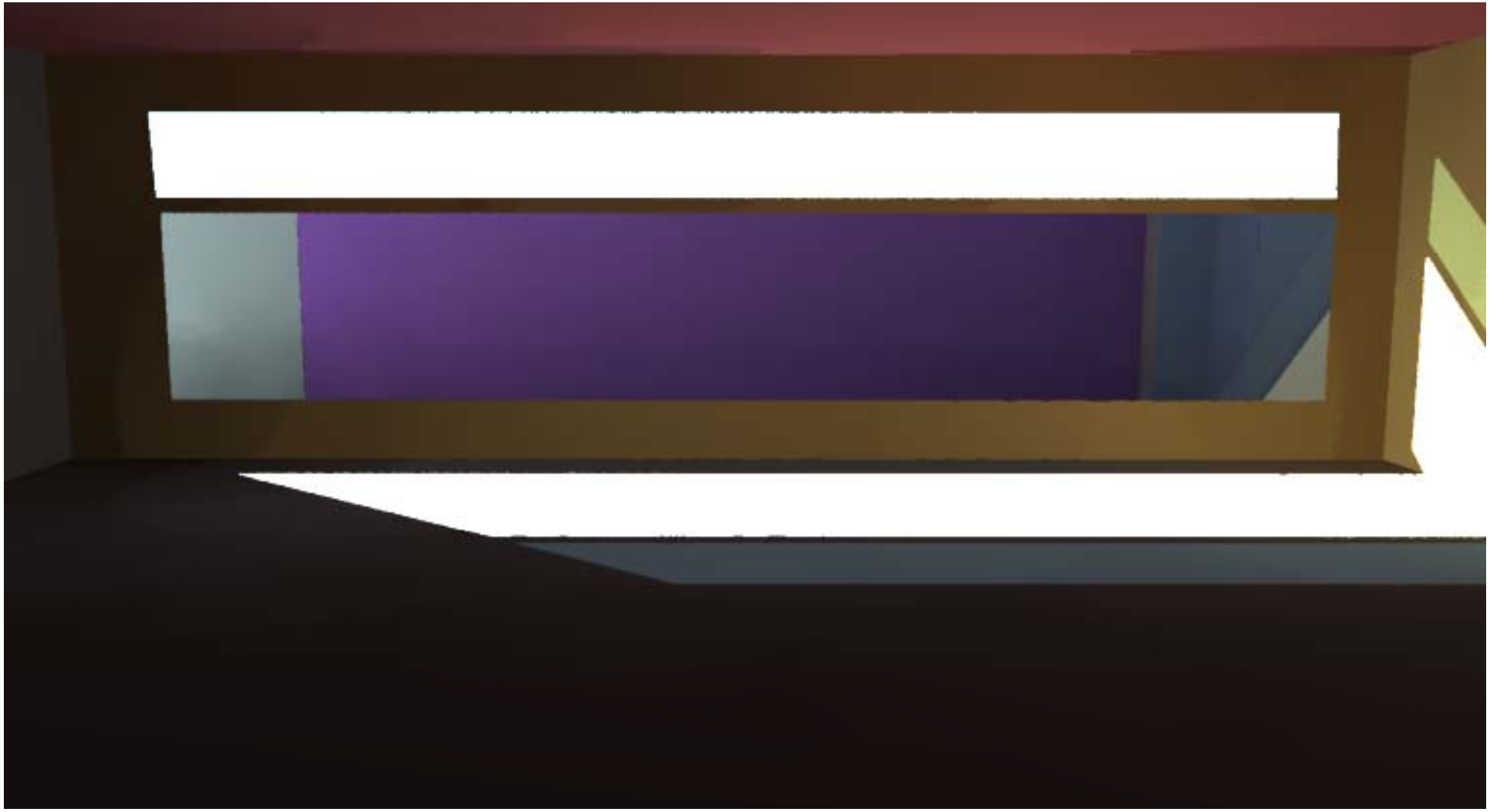


Alternative glazing pattern

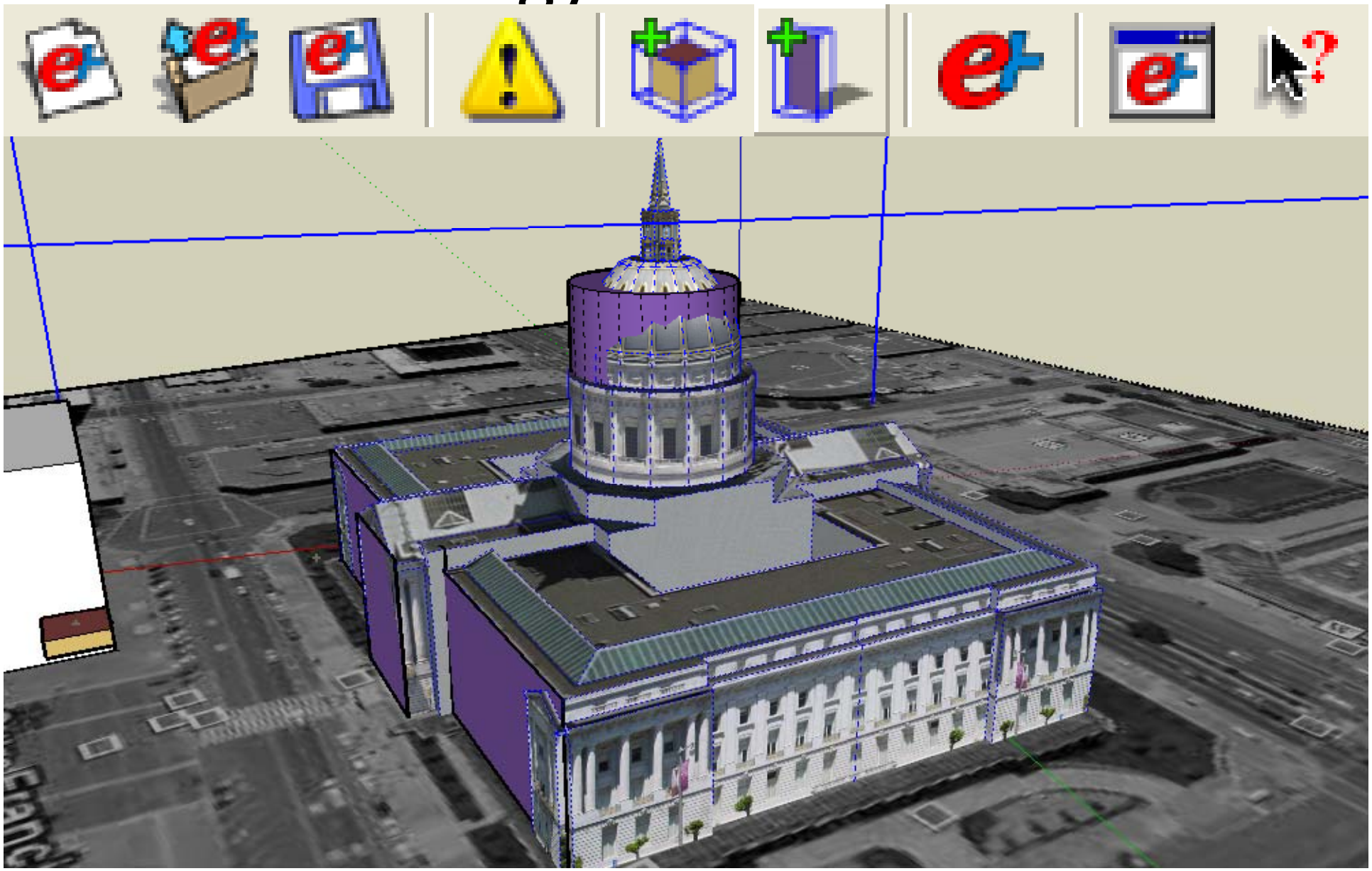
Interior render

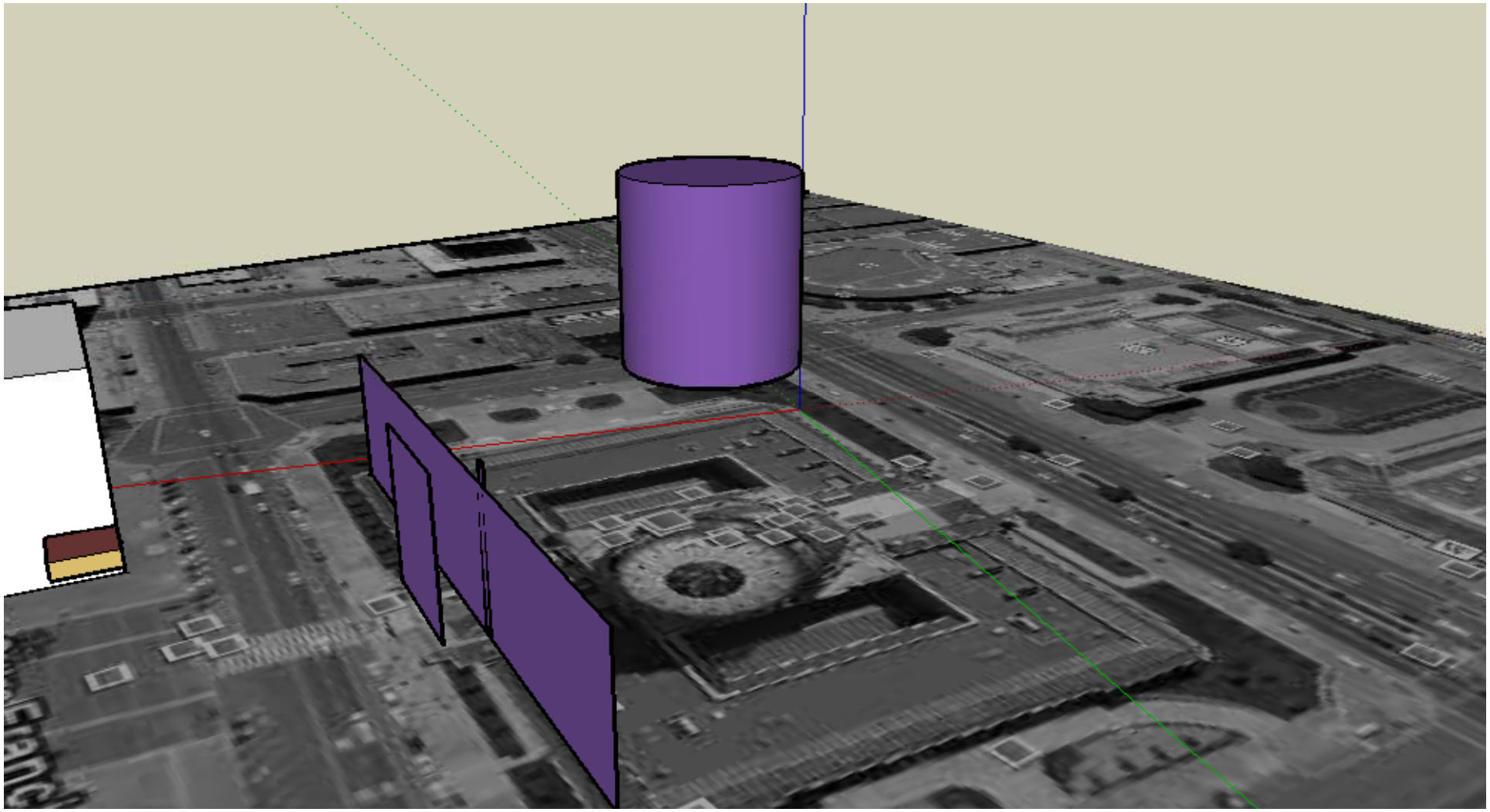


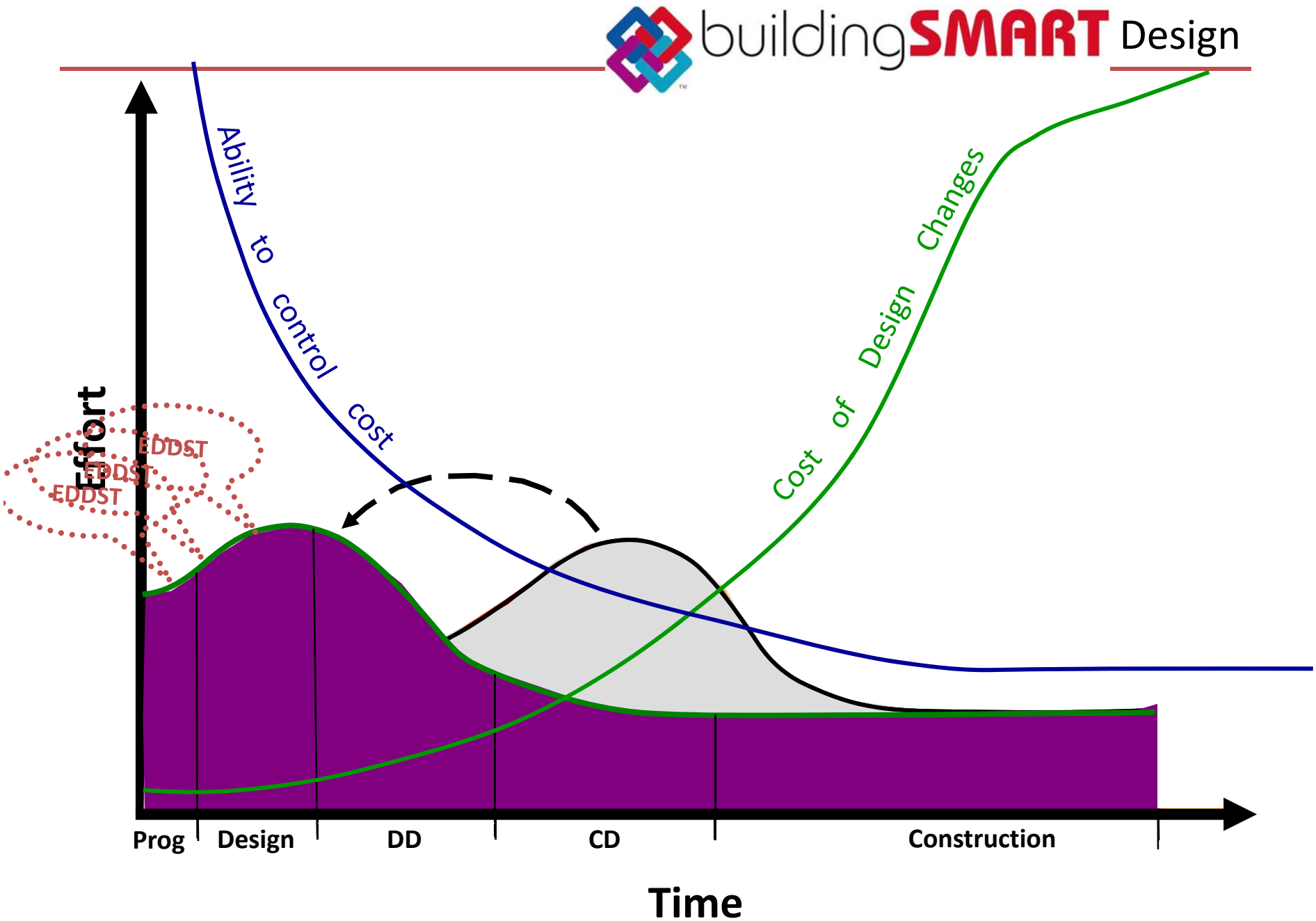
Different glass type



Energy+ simulation







Courtesy of Patrick MacLeamy, HOK

*COM*FEN prototype

(‘Commercial’ = NOT residential/industrial)

‘Sketching’ performance

NOT sketchy performance

COMFEN

- Bring capabilities to surface of:
  - Energy+
  - Radiance
  - …
- Use: Window 5/6 BSDF
- Refer to LBNL IAQ / Comfort etc measures of performance
- Provide examples of best practice in modelling
- Stand alone
  - SketchUp
  - Revit?
  - Microstation?
  - Archicad?
- Rapid answers
- Extensible
- Allows expert ‘under the hood’

So what?

http://www.commercialwindows.org/

- Enhances and is compatible with:

‘Next Wave’ of Simulation/

- Early design analysis tools – more and more capable and comprehensive
- Lots of research work on the ‘simulation sketch’
- Cloud computing running multiple analyses in the background at cents per cpu minute
- A need for a comprehensive coordinator - COMFEN
- IFC’s and the market negotiating a settlement on data quality and availability

Yes, but…

So what?

LEED EQ Credit 8.1, Daylight & Views: Daylight 75% of Spaces - 1 Point

OPTION 1 — SIMULATION

- Demonstrate through computer simulations that 75% or more of all regularly occupied spaces areas achieve daylight illuminance levels of a minimum of 25fc and a maximum of 500 fc in a clear sky condition on September 21 at 9.00 am and 3.00 pm; areas with illuminance levels below or above the range do not comply. However, designs that incorporate view-preserving automated shades for glare control may demonstrate compliance for only the minimum 25 fc illuminance level.

Lighting *as if people mattered*

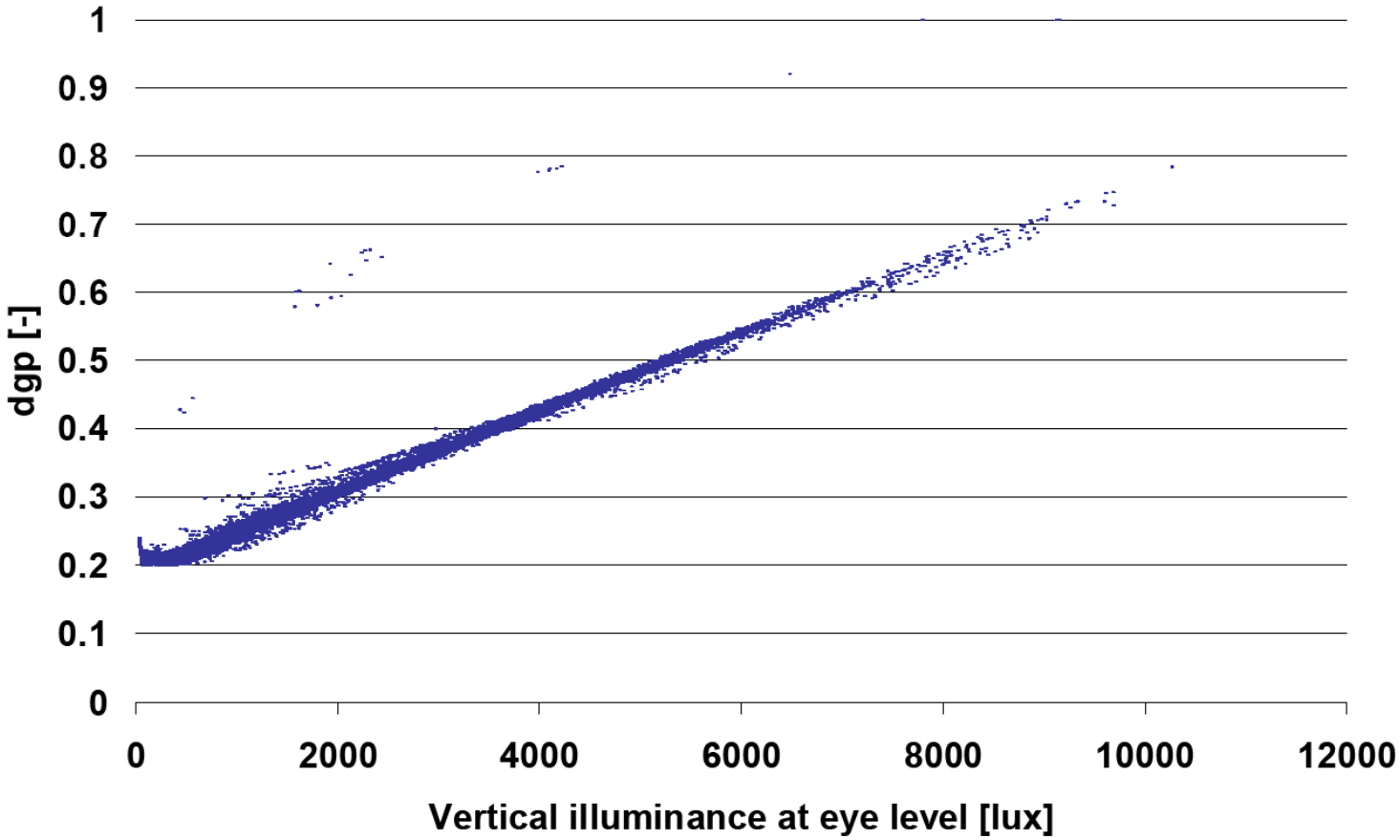
Good lighting quality is said to exist (Veitch et.al..1997) "*..when a lighting system supplies light in support of:*

- ***Visual quality*** *i.e. it creates good conditions for seeing*
- ***Post-visual performance*** *(task performance and behavioural effects other than vision) i.e. it supports task performance or setting- appropriate behaviours*
- ***Social interaction and communication*** *i.e. it fosters desirable interaction and communication*
- ***Mood state*** *(happiness, alertness, satisfaction, preference) i.e. it creates a situationally-appropriate mood*
- ***Health*** *i.e. it provides good conditions for health and avoids ill-effects.*
- ***Aesthetic judgements*** *(assessments of the appearance of the space or the lighting) i.e. it contributes to the aesthetic appreciation of the space."*

Lighting Quality: Glare / Contrast?

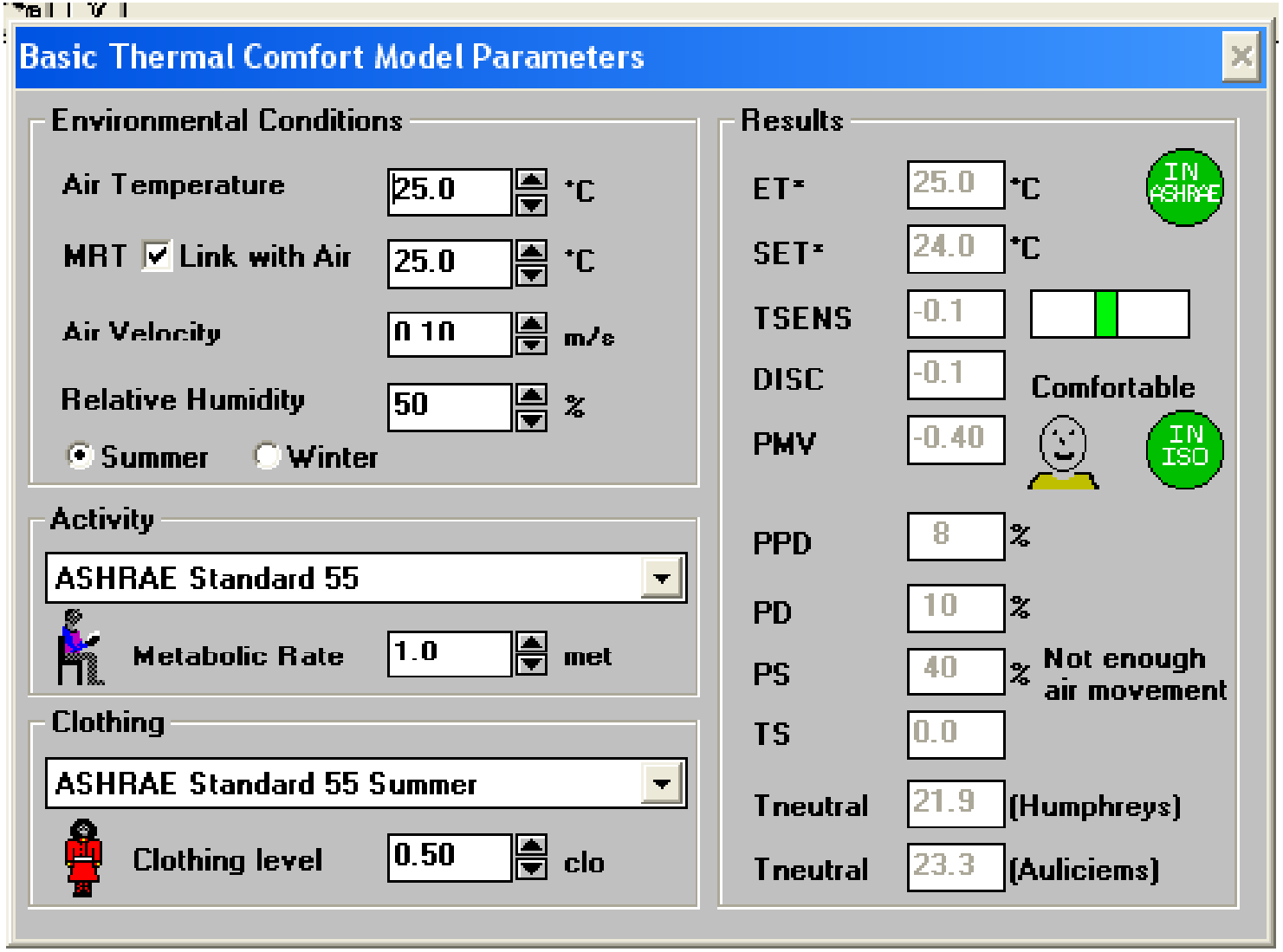
- Fuller Moore states the following (maximum) limits to contrast between surfaces within the field of view in his book "*Concepts and Practice of Daylighting*" :
  - *3:1 between the task (book on a desk) and the adjacent surroundings (the desk)*
  - *10:1 between the task and more remote lighter surfaces*
  - *20:1 between fenestration (windows) and adjacent surfaces (the reveal or wall surround)*
  - *40:1 anywhere in the field of view*

Daylight Glare Probability

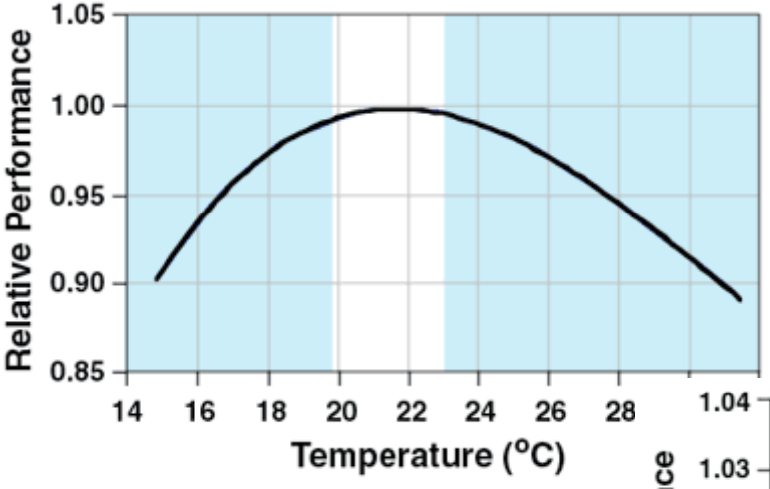


Source: Jan Wienold: paper to the IBPSA conference Beijing, 2007

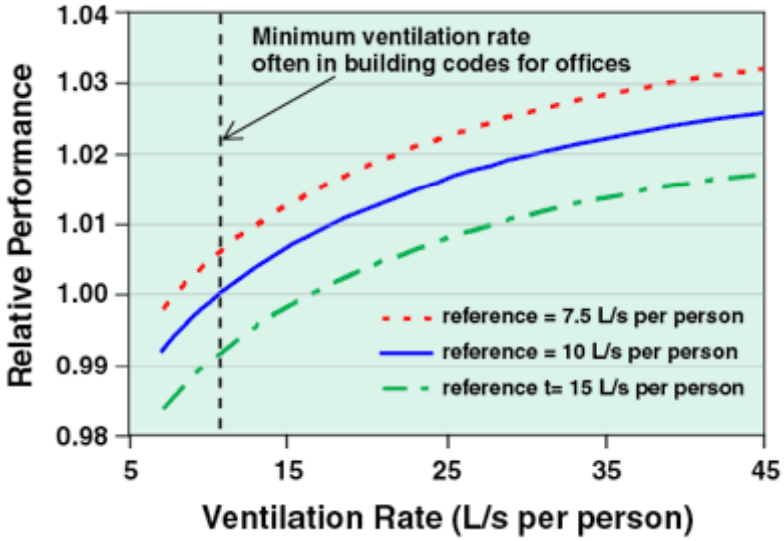
Heating/Cooling *as if people mattered*



Performance/productivity…

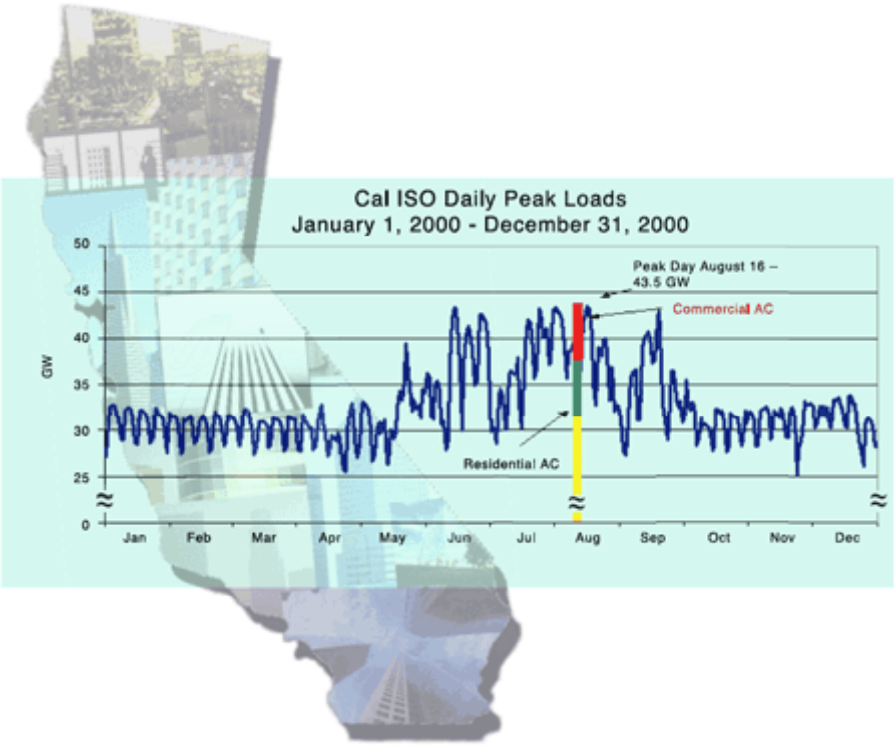


Daylight + Light Quality



Source: Bill Fisk, LBNL: www.iaqscience.lbl.gov

Demand response …

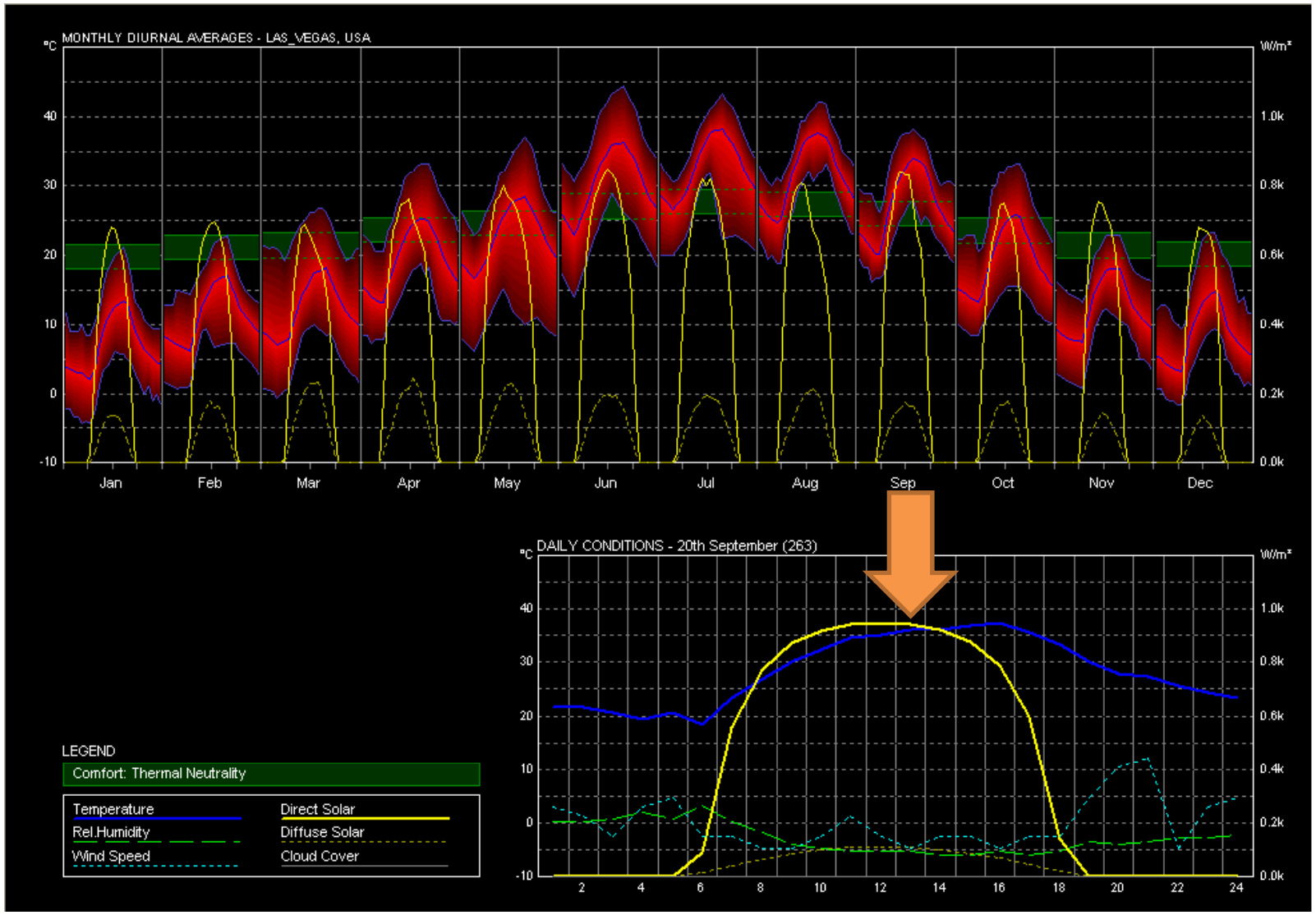


Source: Mary-Anne Piette, LBNL: http://drrc.lbl.gov/

But…

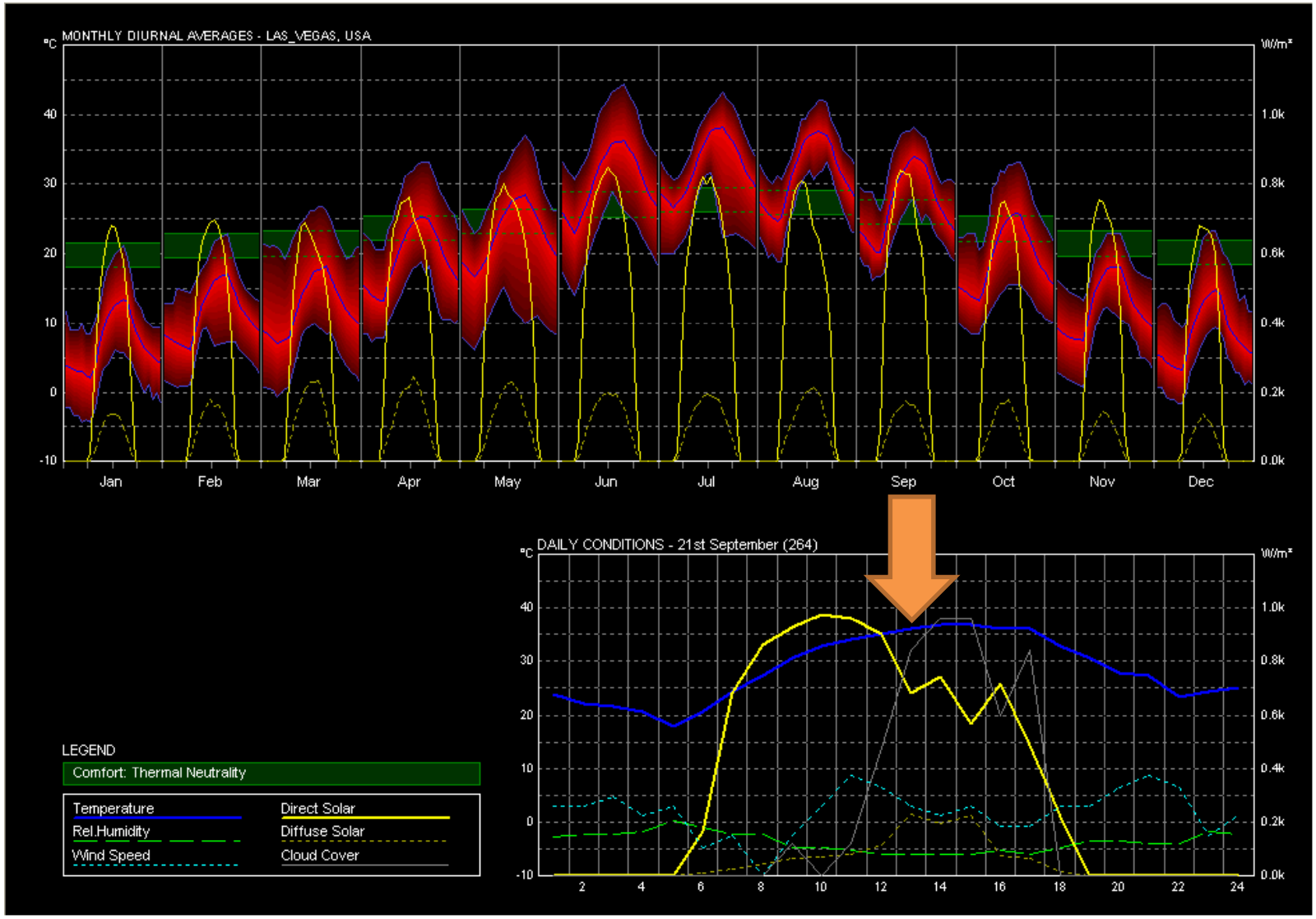
Weather Tool

Quality data is an issue: LEED Daylight simulation in Las Vegas: which day?



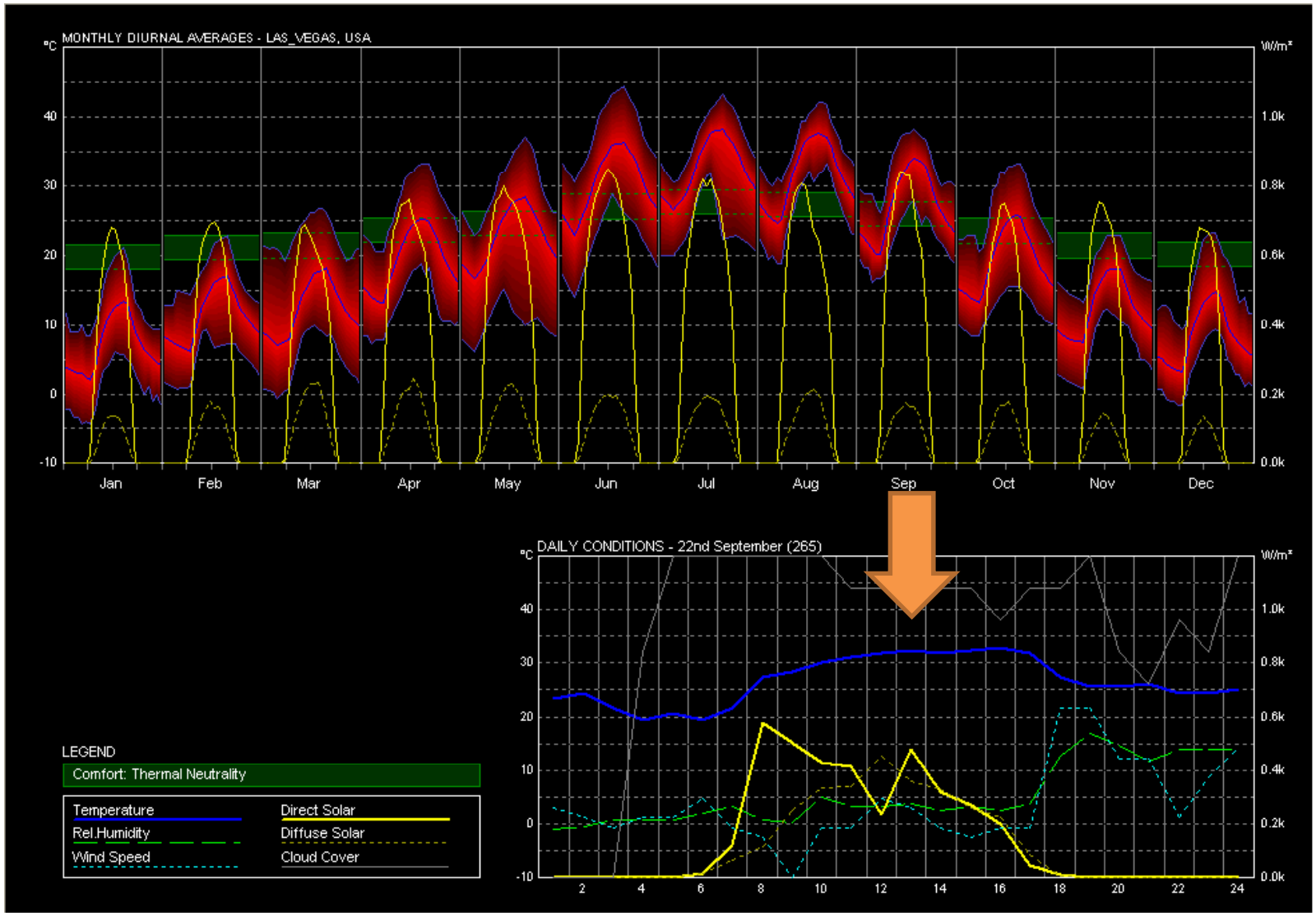
Weather Tool

Quality data is an issue: LEED Daylight simulation in Las Vegas: which day?

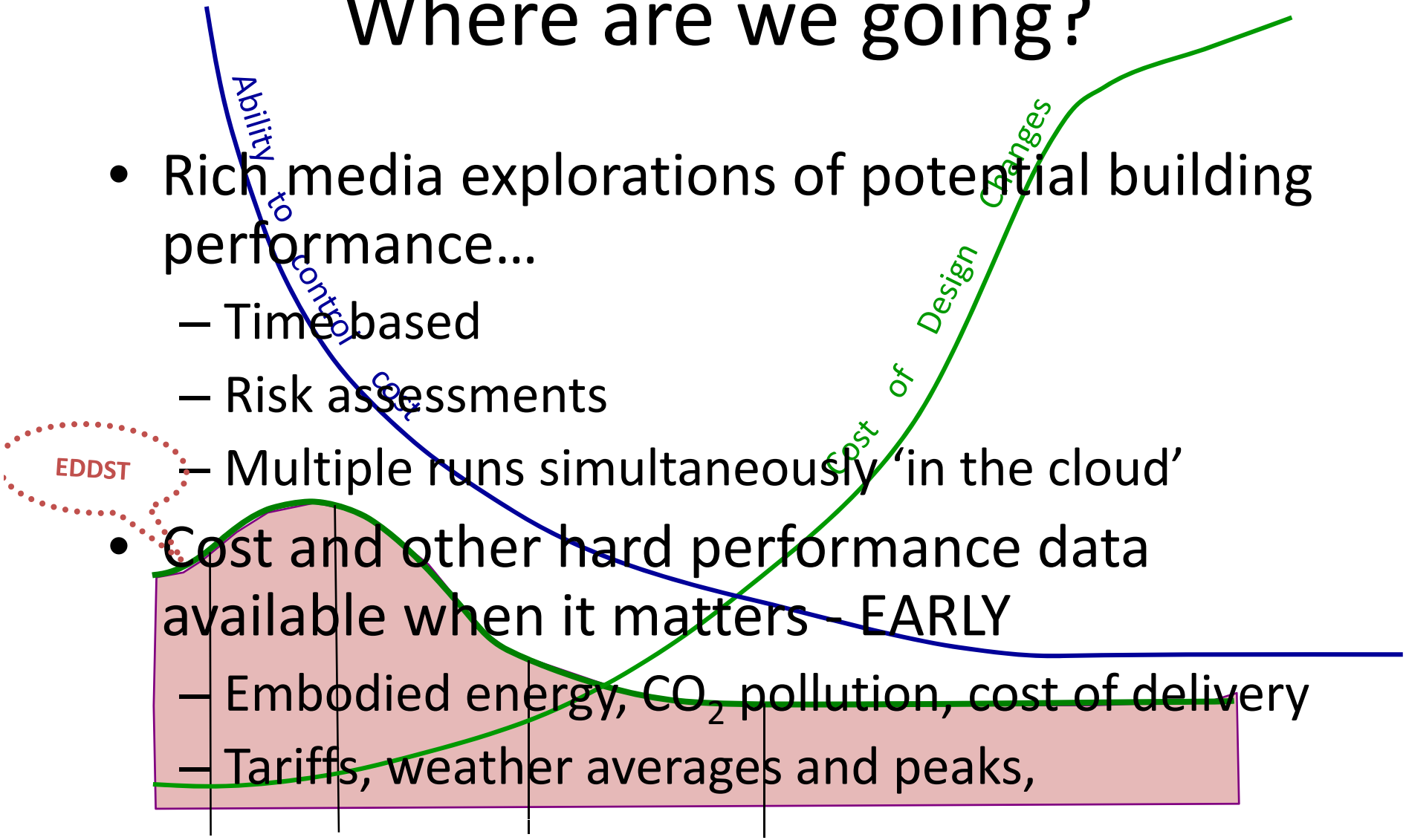


Weather Tool

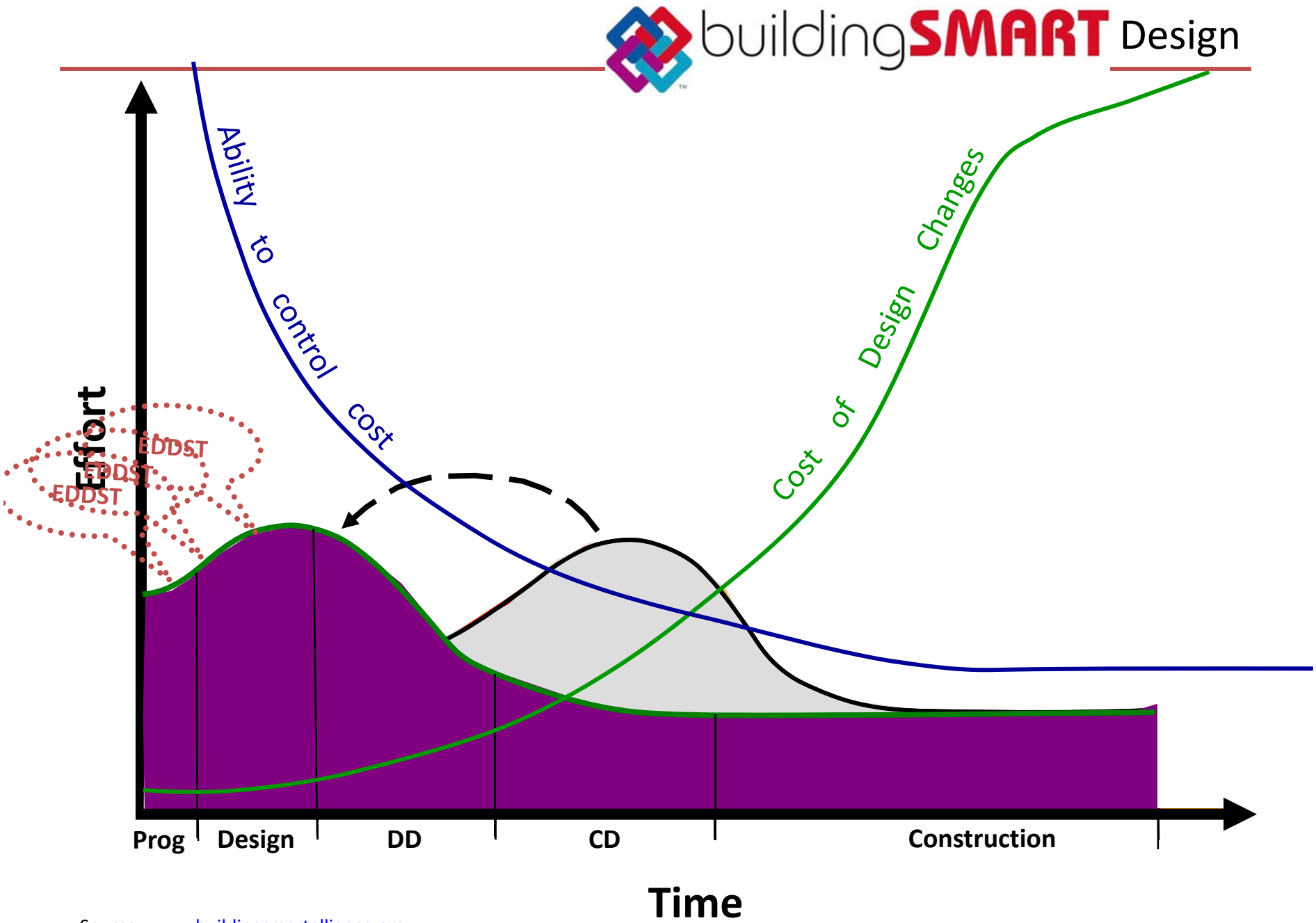
Quality data is an issue: LEED Daylight simulation in Las Vegas: which day?



Where are we going?



- Rich media explorations of potential building performance…
  - Time based
  - Risk assessments
  - Multiple runs simultaneously 'in the cloud'
- Cost and other hard performance data available when it matters - EARLY
  - Embodied energy, CO_2 pollution, cost of delivery
  - Tariffs, weather averages and peaks,

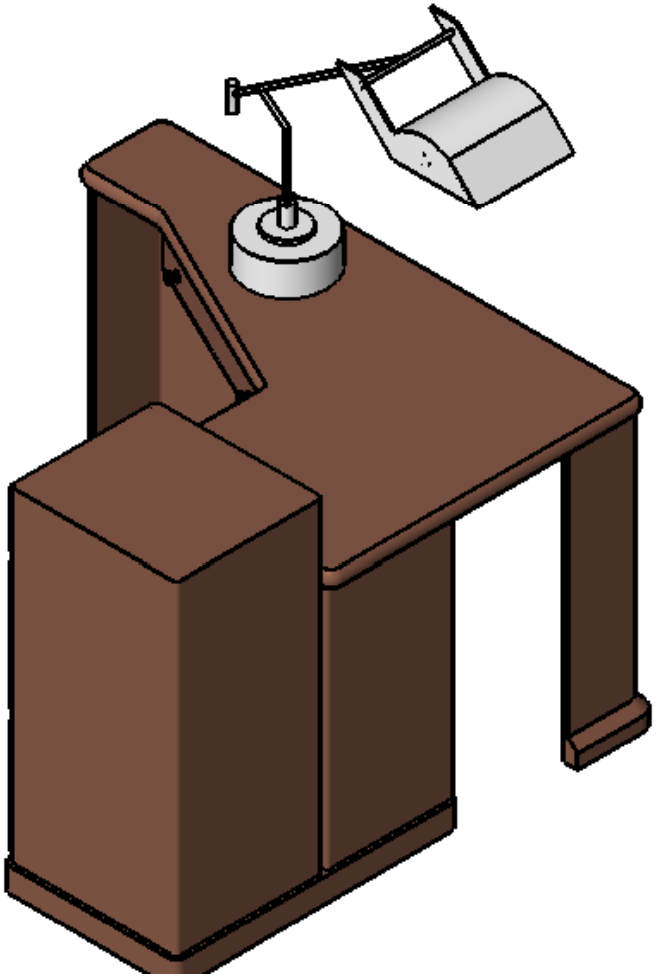


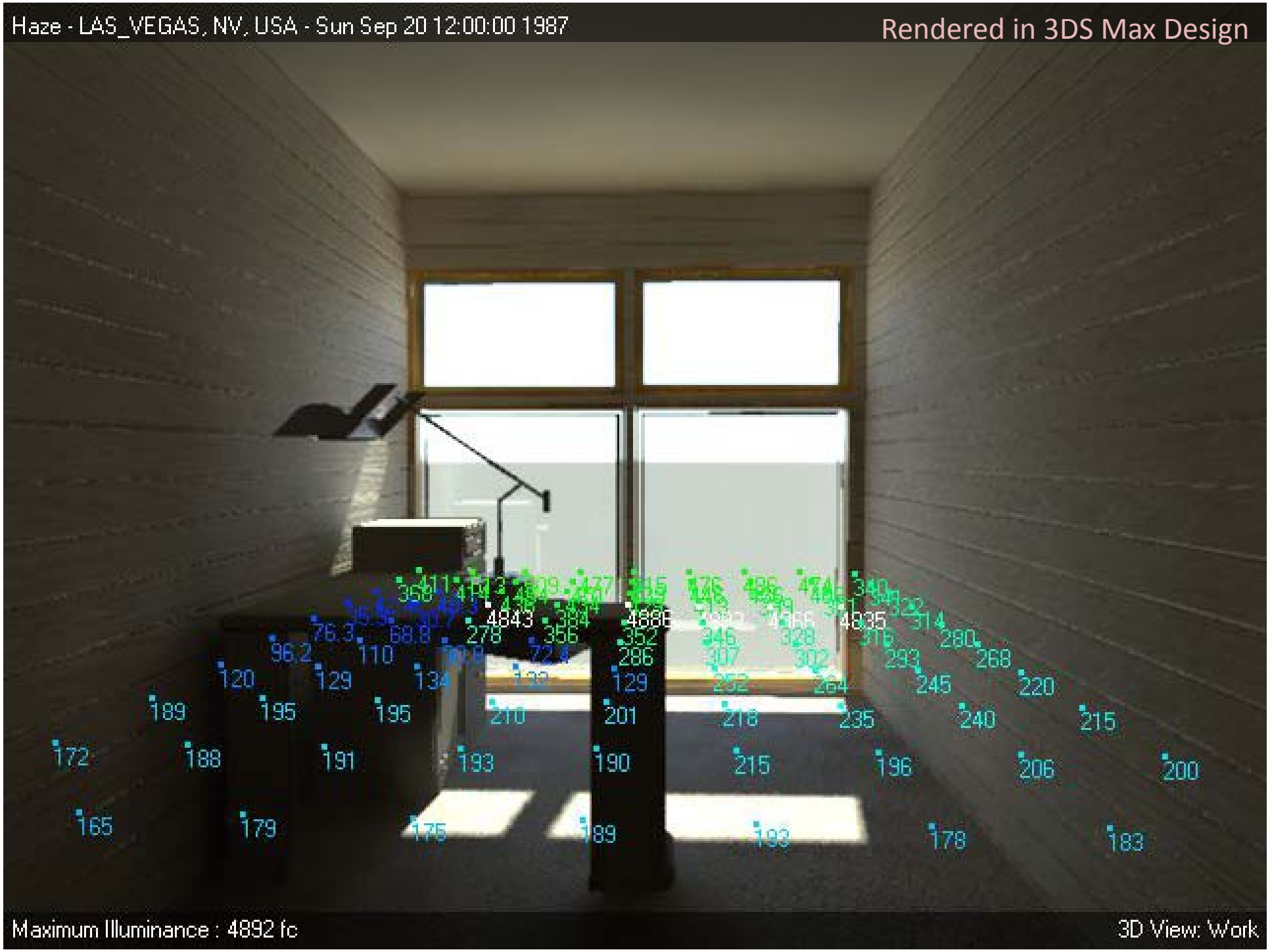
Source: www.buildingsmartalliance.org

Courtesy of Patrick MacLeamy, HOK

LBNL Test facility in 3ds Max

Steelcase Data –
imported from REED




Haze - LAS_VEGAS, NV, USA - Sun Sep 20 12:00:00 1987
Rendered in 3DS Max Design
Maximum Illuminance : 4892 fc
3D View: Work

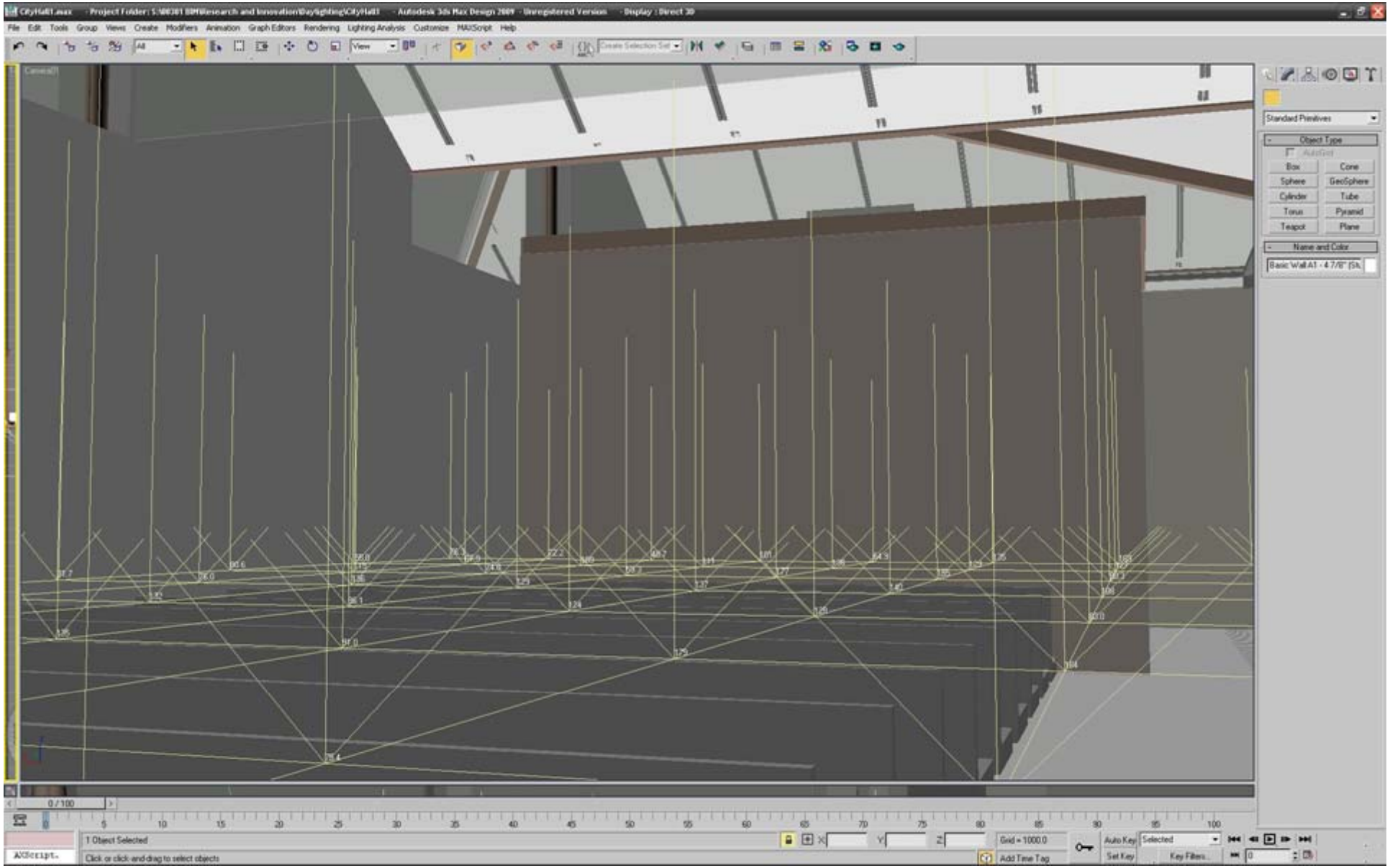
Glare? Visibility?

BIM / BOP Conference USC 2008

Leading edge practitioners

Still only doing BIM piecemeal

i.e. daylight on this project/energy on another/structures on yet another – all ideas being tried; no-one attempting all ideas on one project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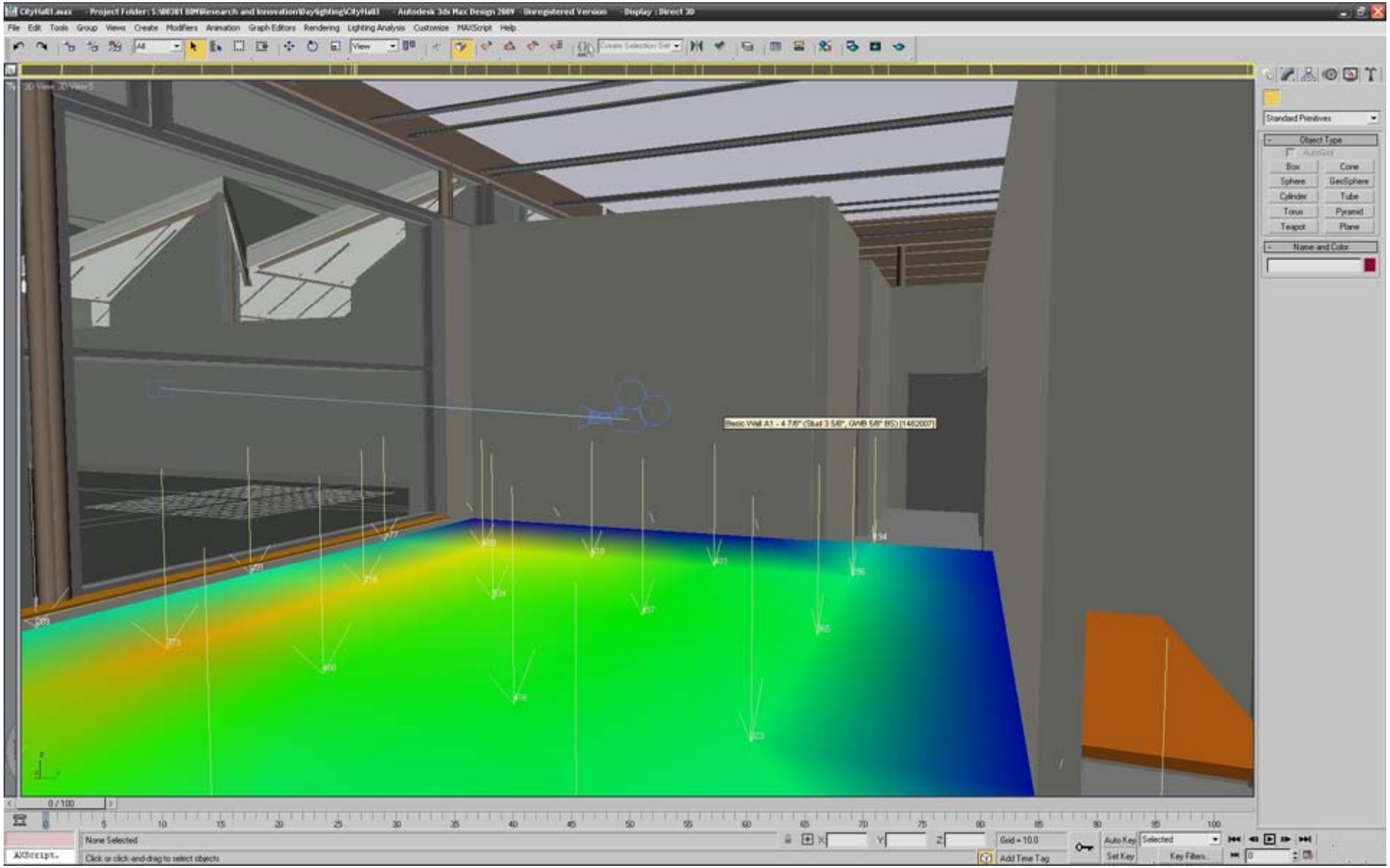
Standard Primitives
Object Type
Box
Cone
Sphere
GeoSphere
Cylinder
Tube
Torus
Pyramid
Teapot
Plane
Name and Color
1 Object Selected
Click or click-and-drag to select objects
Grid = 1000.0
Add Time Tag
Auto Key
Selected
Set Key
Key Filters...


File Edit Tools Group Views Create Modifiers Animation Graph Editors Rendering Lighting Analysis Customize MAXScript Help
Standard Primitives
Object Type
Box
Cone
Sphere
GeoSphere
Cylinder
Tube
Torus
Pyramid
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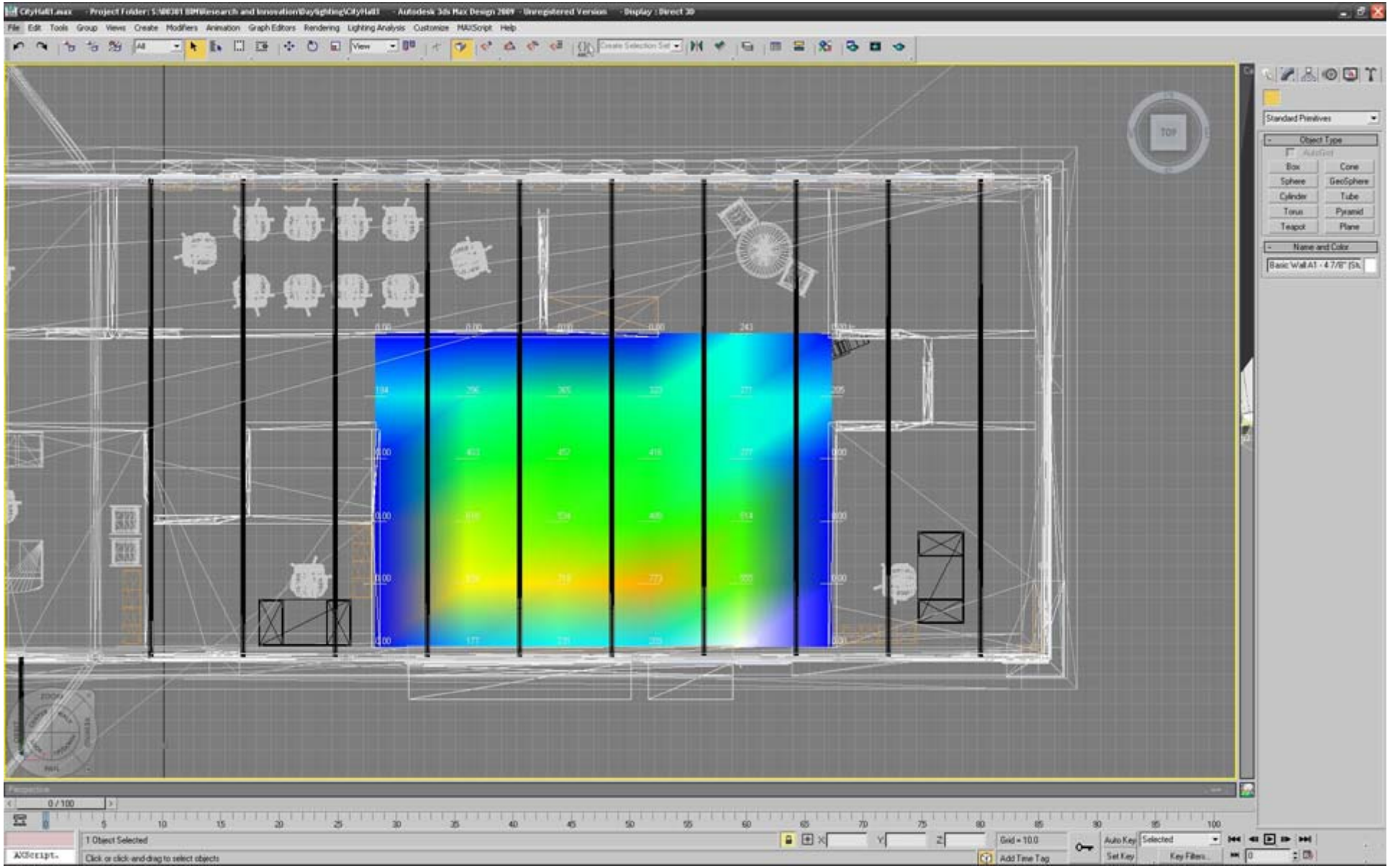
Add Time Tag
Auto Key
Set Key
Key Filters...


File Edit Tools Group Views Create Modifiers Animation Graph Editors Rendering Lighting Analysis Customize MAXScript Help
Standard Primitives
Object Type
Box
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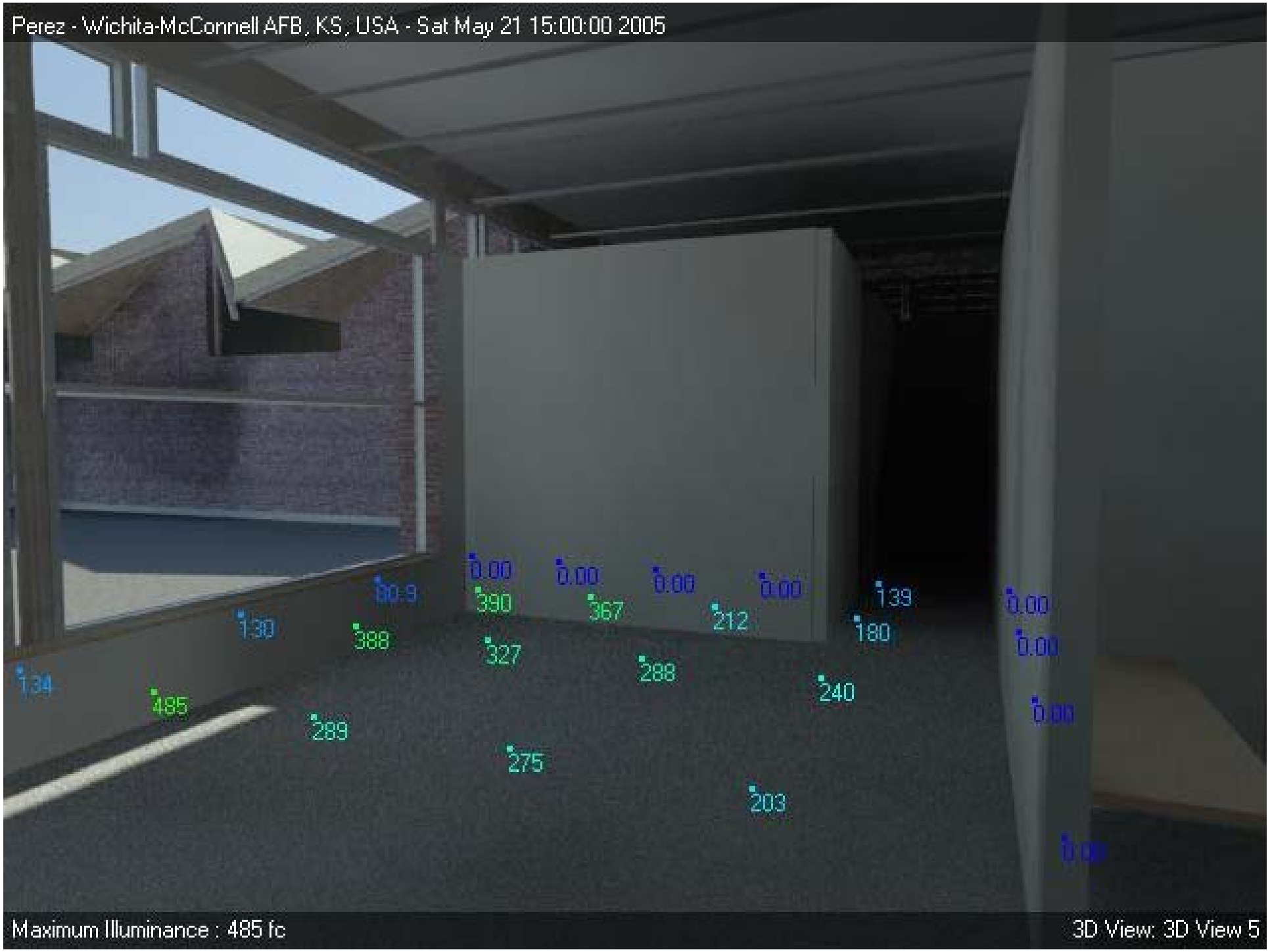
Pyramid
Teapot
Plane
Name and Color
1 Object Selected
Click or click-and-drag to select objects


Perez - Wichita-McConnell AFB, KS, USA - Sat May 21 15:00:00 2005
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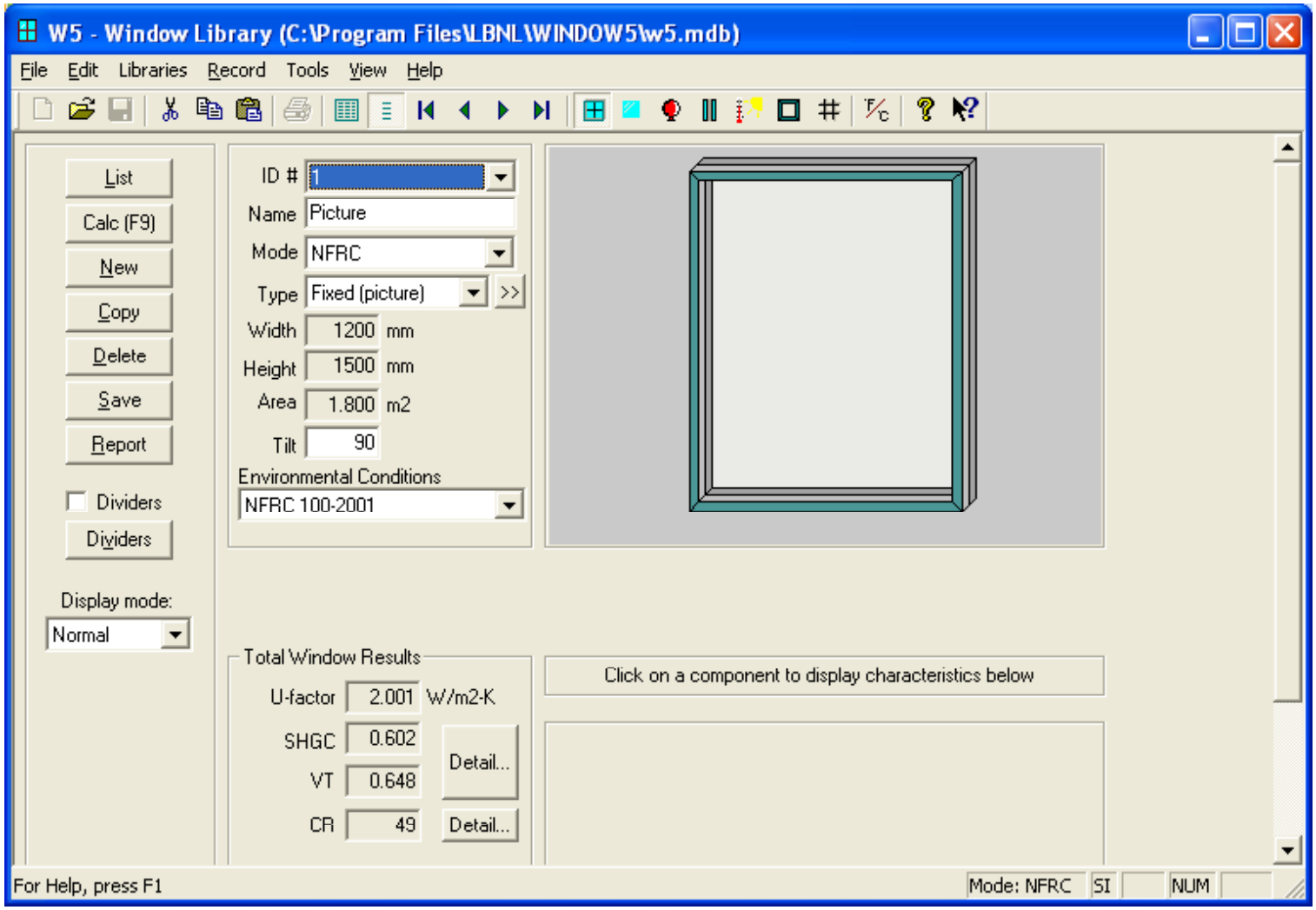
390
367
212
180
0.00
130
388
327
288
240
0.00
134
485
289
275
203
0.00
Maximum Illuminance : 485 fc
3D View: 3D View 5

What do analysts need?

RELIABLE – Quality assured - DATA

Reliable data exists…

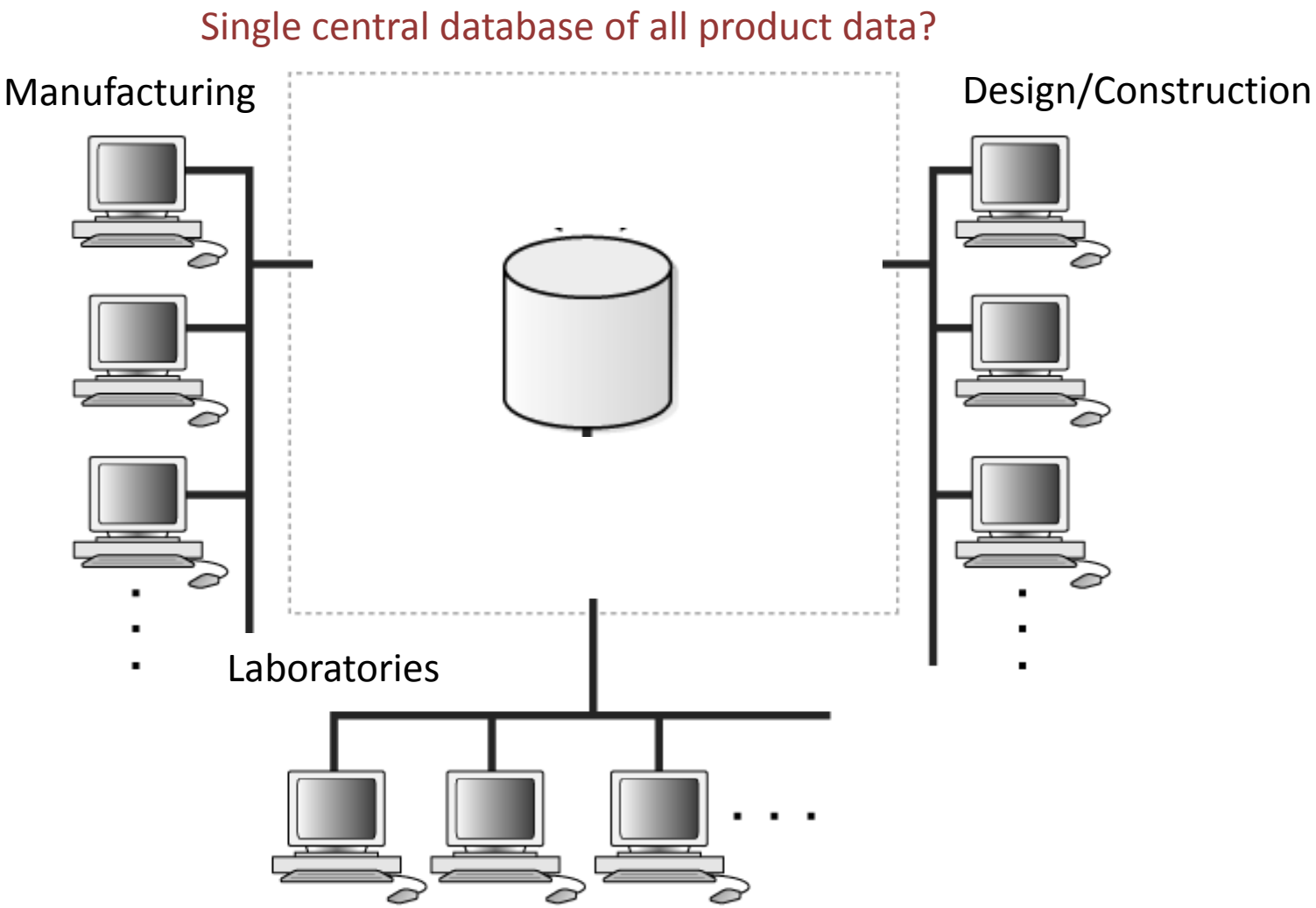
- http://windows.lbl.gov/software/
- http://radsite.lbl.gov/radiance/HOME.html



But, not enough…?

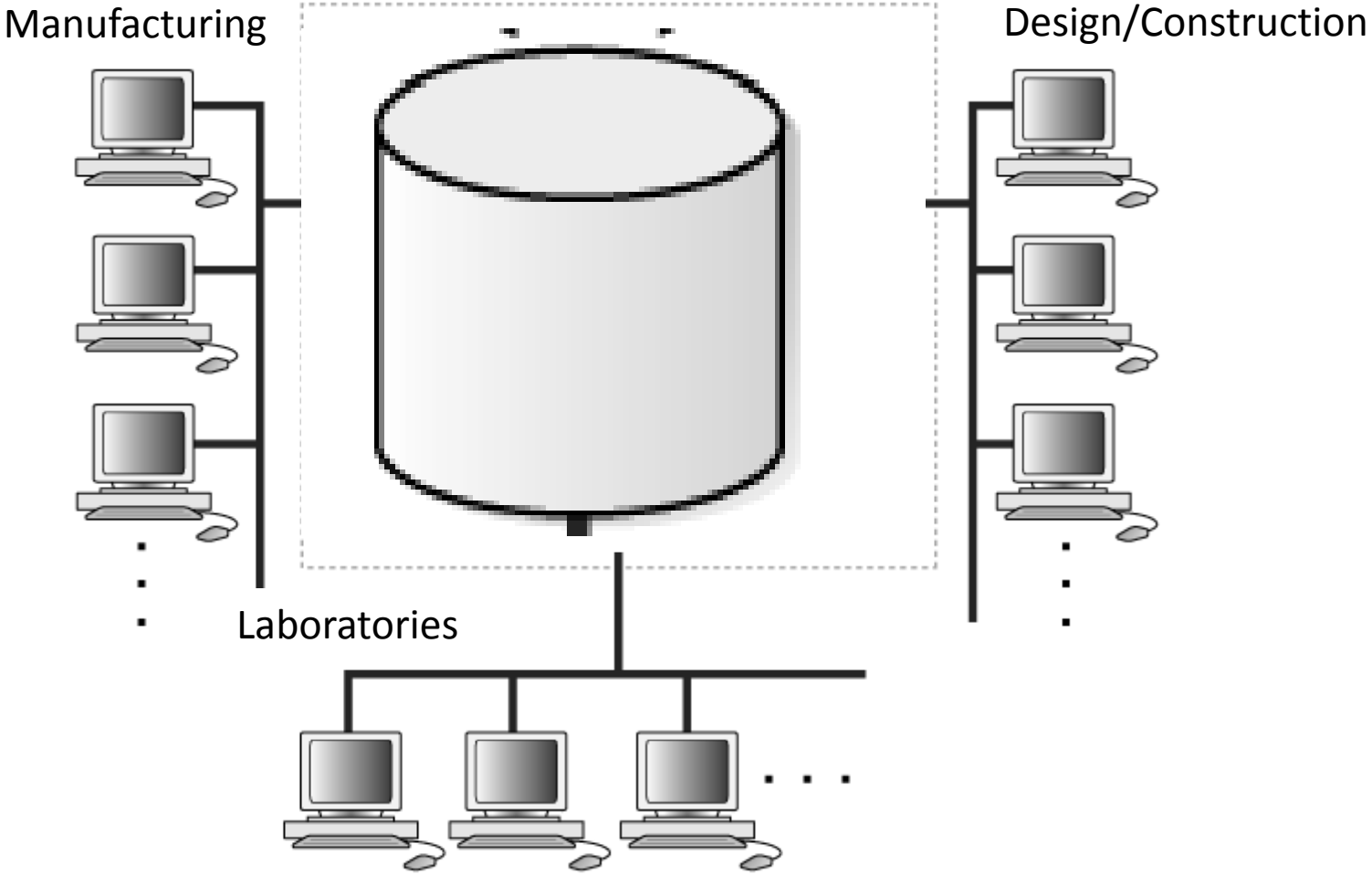
- Acoustic tile
- Brick
- Glazing & Window
- Light reflectivity
- Heat capacity + sound absorption
- Sound reduction

Scalability of Optics db?



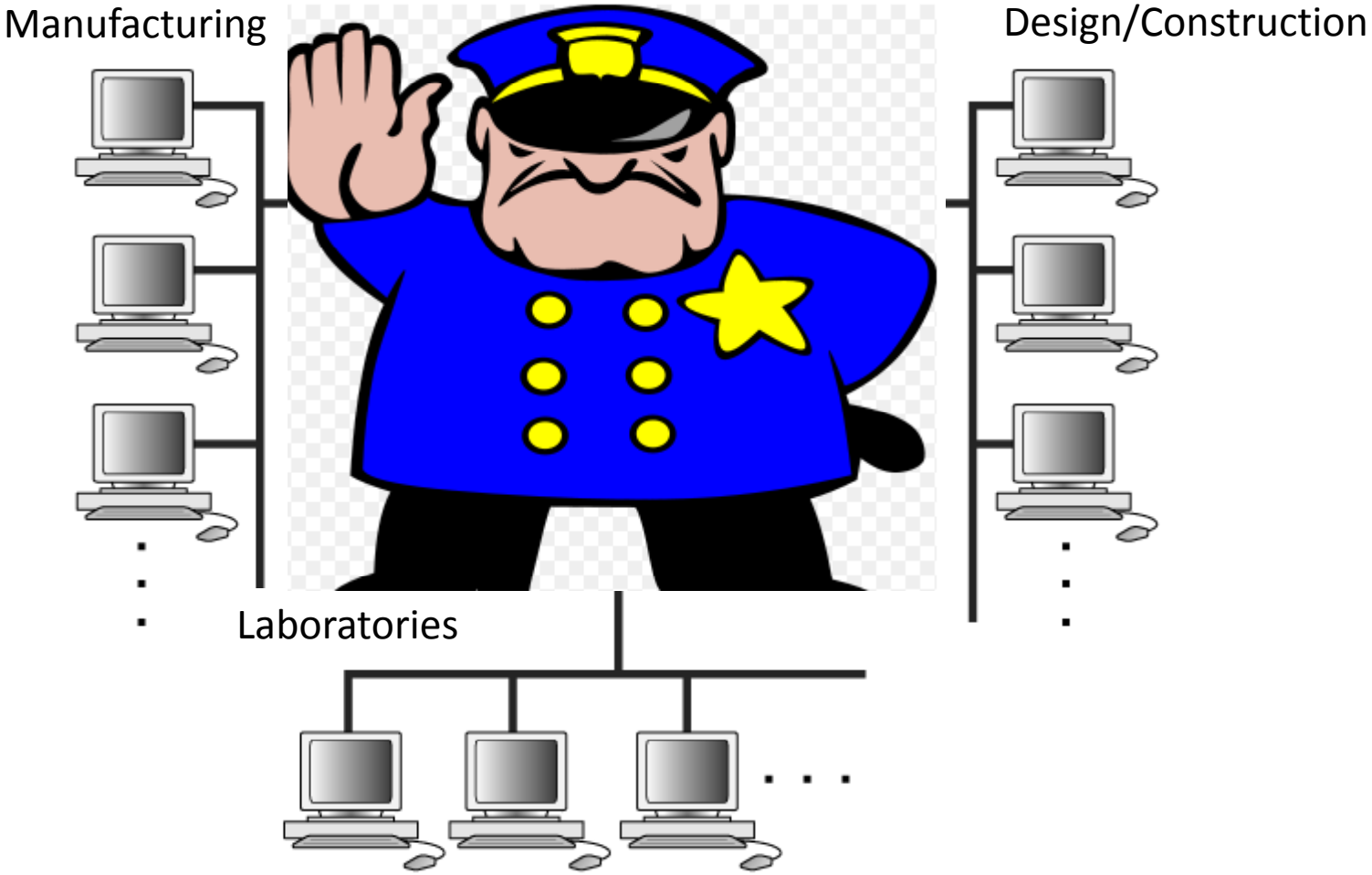
Scalability of Optics db?

Single central database is probably impossible



Scalability of Optics db?

It requires resources in quality control no one organisation can provide



Autodesk Seek - Flock

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http://seek.autodesk.com/

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Many useful data sources exist

Autodesk Seek

The online source for product specifications and design files

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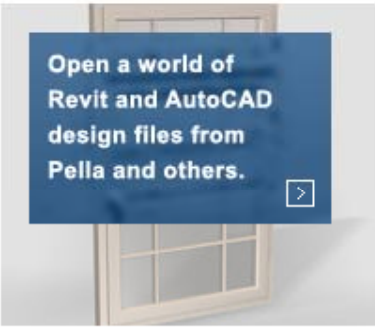

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Classifications

CSI MasterFormat 2004
CSI OmniClass 1.0
CSI UniFormat II

Featured Content

Spring Roller Projection Screen
Da-Lite Screen

Single Handle, Pull-Down, Polished Chrome Kitchen Finish
Brizo

Linear Bow Surface Mount Light Fixture, DALI Dimming Ballast
Lightolier

New Content

iLevel™(Joists/Trusses)
Revit Models Now Available for 2 Products
July 30, 2008

iLevel™ (Joists/Trusses)
24 Products Added / 28 Products Total
October 03, 2008

CS Group (Fire Doors & Railings)
10 Products Added / 10 Products Total
July 30, 2008

Manufacturers
Learn how to feature your products on

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start Search Desktop EN 10:13 a.m.

BIM Library for Autodesk R...

http://www.reedconstructiondata.com/bim/bim-library/

Customize Links | LBNL User Accounts | VUW-login | Other

Many useful data sources exist

Reed Construction Data

AIA StrategicPartner

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SmartBIM Library for Autodesk Revit

Reed Construction Data's BIM Products & Services

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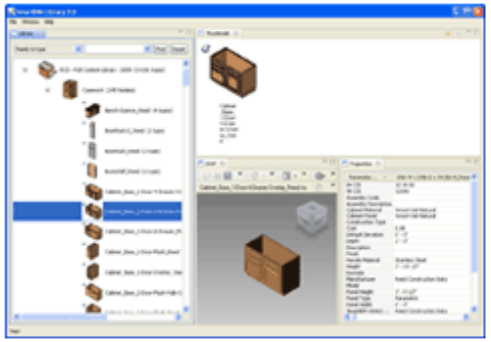
The BIM Transformation is Manageable with SmartBIM Library™ v3

The BIM movement is transforming design and giving architects more power and flexibility to realize their vision. SmartBIM Library v3 from Reed Construction Data is an cost-effective solution for Autodesk® Revit® users that:

- Streamlines design workflow
- Simplifies storage, organization and location of Revit objects
- Facilitates the generation of libraries from Revit families



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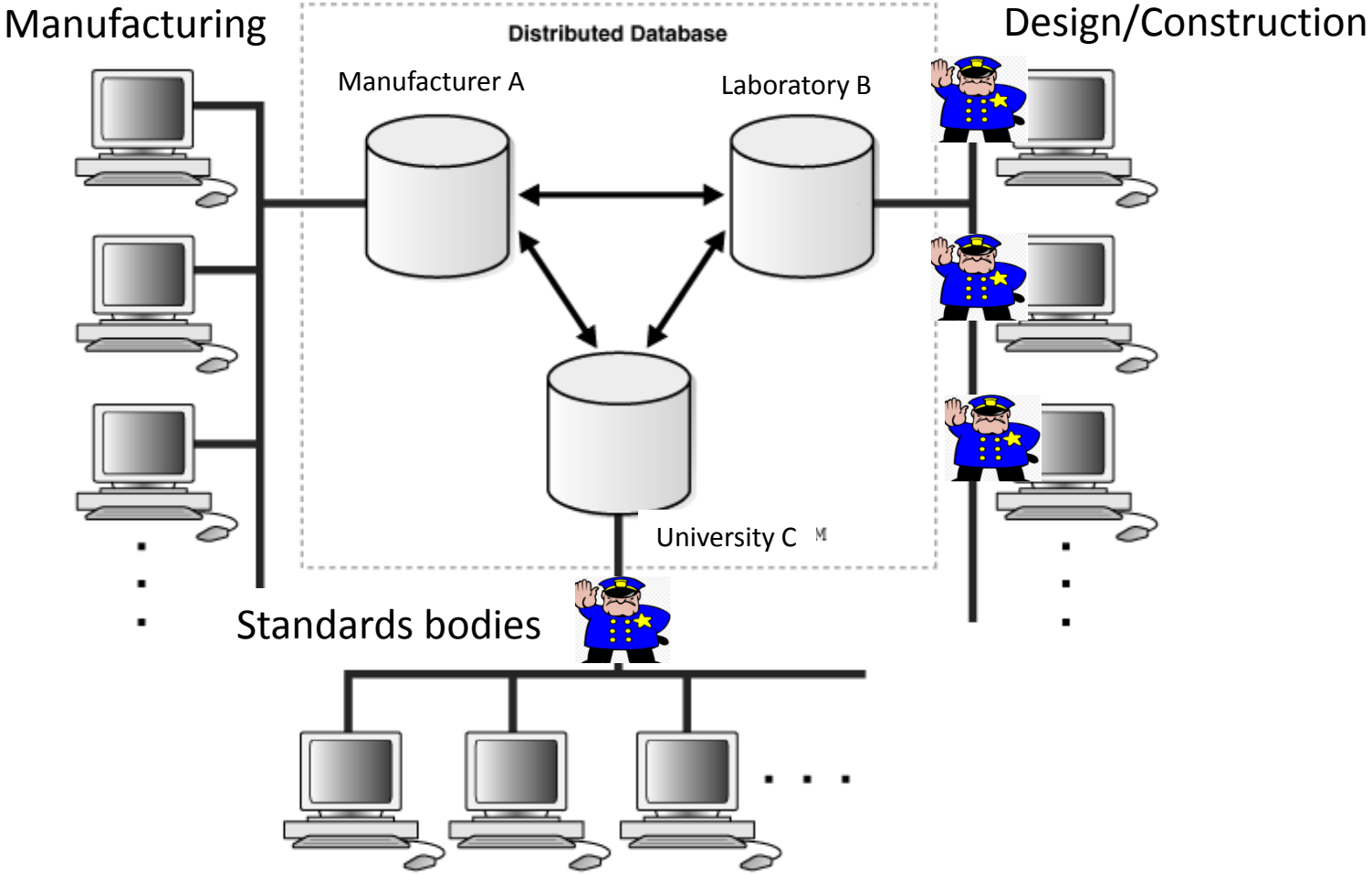
Scalability of Optics db?

What is needed is a system of data definition and many consistent databases



Material Properties Quality Assurance

- Measured values *Rating 10*
  - Window 5 / 6 from LBNL
    - http://windows.lbl.gov/software/
    - IGDB
    - Laboratory 'registered'
    - NFRC
  - Autodesk SEEK
    - http://seek.autodesk.com
  - REED Construction data
    - www.reedconstructiondata.com
- Text book values *Rating 6*
- Grad student *Rating 4*
- Manufacturer *Rating 1-2*

- Rating:
  - 10 high trust – lab
    - From reputable lab
    - From lab that has been tested
  - 6 medium trust - text
    - Probably OK
    - Needs much knowledge on part of user to use well
  - 4 low trust – grad student
    - Grad student from good college
    - Published in refereed journal
    - Not just listed on own web page
  - 2 almost no trust – mfrer
    - 2 if for property they sell
    - 1 to 0 if property not sold

Who is to take the lead?

CIS+Building Product Manufacturers

- Standards
- Measurement systems
- Data up-to-date?
- Timber vs Polystyrene
- Quality assurance?
- Ebay-like scores

The Next Wave:
Positioning yourself for the BIM future?

- a personal view of what the drivers are likely to be

- Challenge: what am I missing out?

- Challenge: help people design *as if people mattered*

michael.donn@vuw.ac.nz