Building

Integration

Interoperability

Interdisciplinary

Modeling

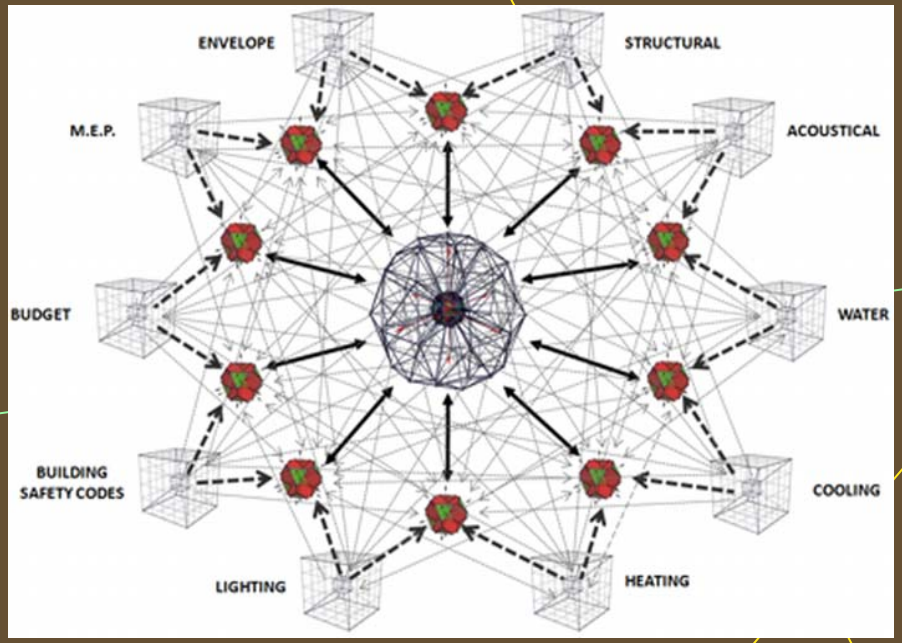
Overview

BIM in the Curriculum

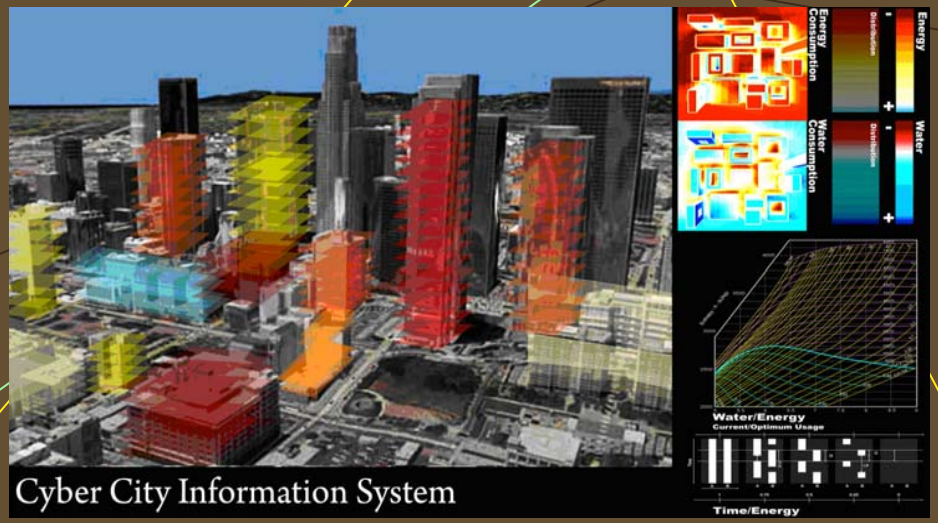
- Professional Practice
- Design Studio
- Elective: Arch 307
- Featured Course: Arch 507

Engaging the Profession

- BIM SYM 2007
- BIM BOP 2008
- BIM CON!FAB 2009
- BIM Analytics 2010
- Executive Education



Hakop Musayelyan, MArch thesis



Mehdi Khalesi, MLArch project idea

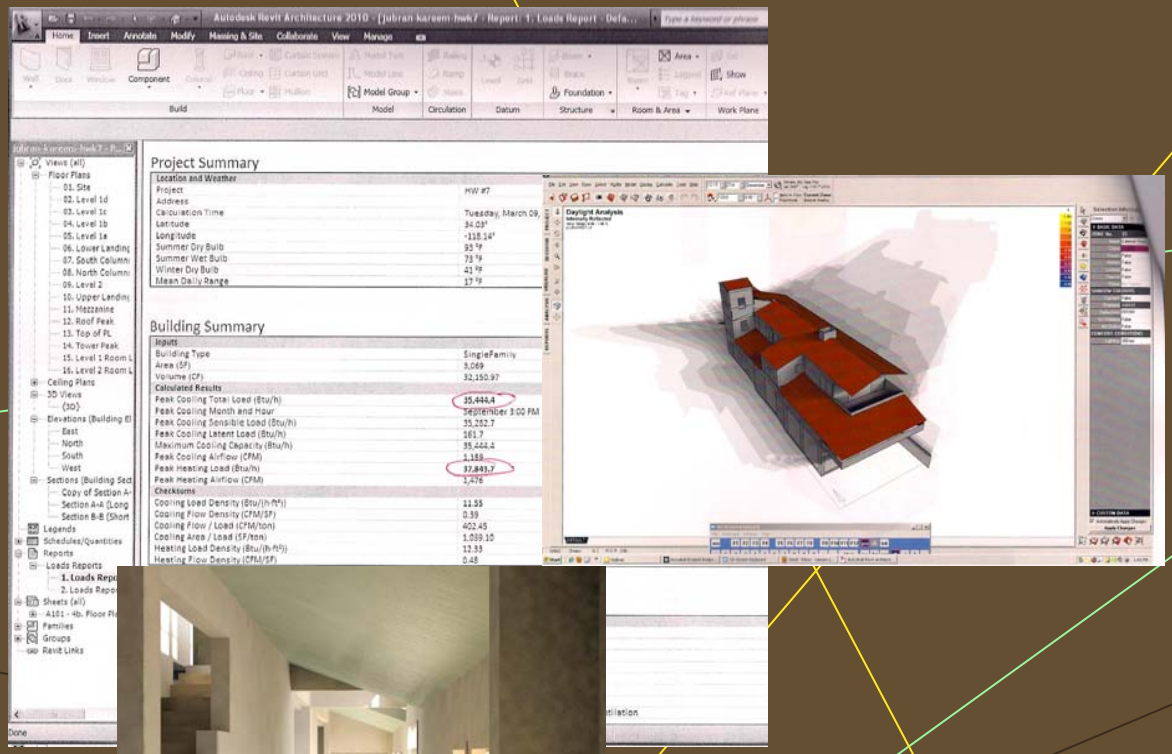
Overview

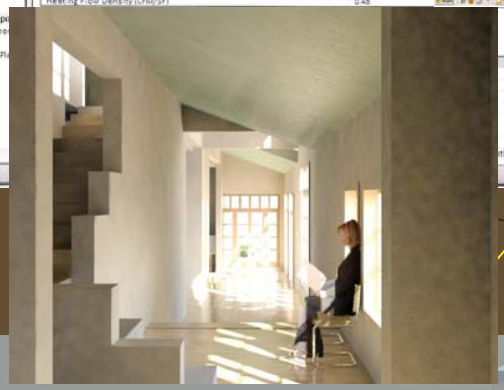
The AEC professions were often the early leaders in building information modeling (BIM), and many universities were caught unprepared. More recently, the universities have responded to the swift and broad adoption of BIM technologies throughout the profession and are now providing coursework to help educate future professionals. No single approach to BIM curricula will suffice. Rather than concentrate on a single strategy, a vision is being developed that includes at its core the recognition that the building delivery professions and academia must be better integrated and that communication and interoperability are key components.

We believe that BIM technology should be broadly integrated throughout the curriculum; advanced seminars should stress interoperability, interdisciplinary, and sustainability components; and that the schools have a mission to outreach to the profession through conference hosting, executive education, and being receptive to the profession providing advice to the academy.

BIM in the Curriculum

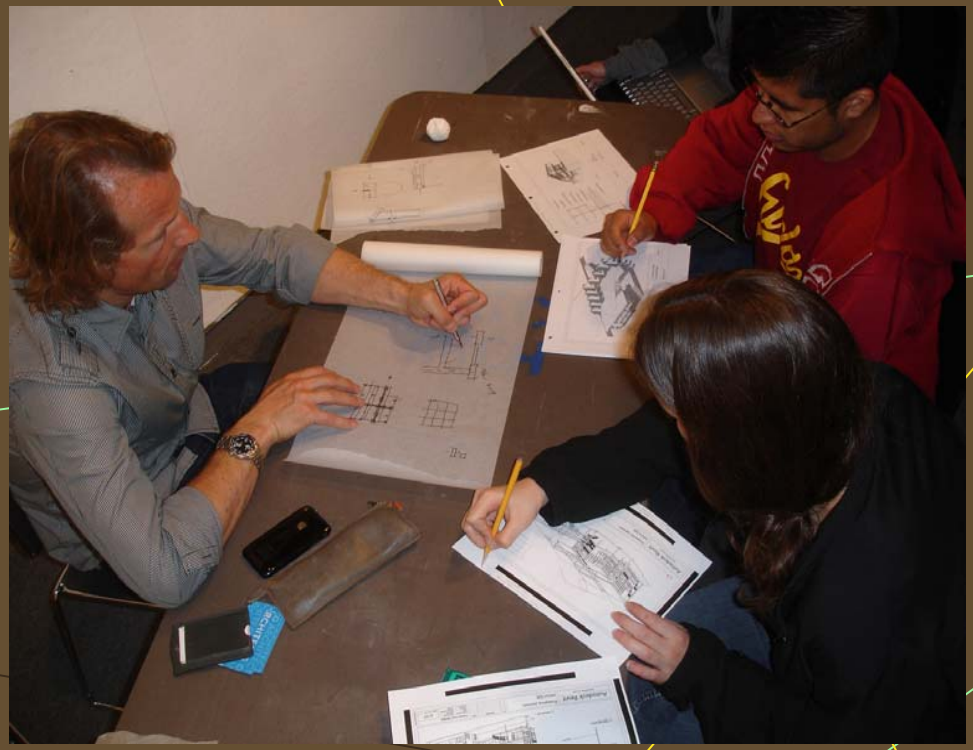
To be enthusiastically accepted by students, BIM education must be presented as a part of the full curriculum of the architecture program. It is important to integrate BIM education throughout the curriculum from the earliest stages, especially in non-computing courses, but also not neglecting specific elective courses where teaching can go into more depth with the overload associated with the design studio. Although this section only briefly summarizes a required professional practice course and BIM in the design studio, graduate students at the Masters and PhD level are developing BIM based thesis projects. More detail will be given to a specific elective course.





Kareem Jubran, Arch 507, house, interior rendering, shadow range study, heating and cooling loads

BIM in the Curriculum



Fabian Kremkus, CO Architects, with students

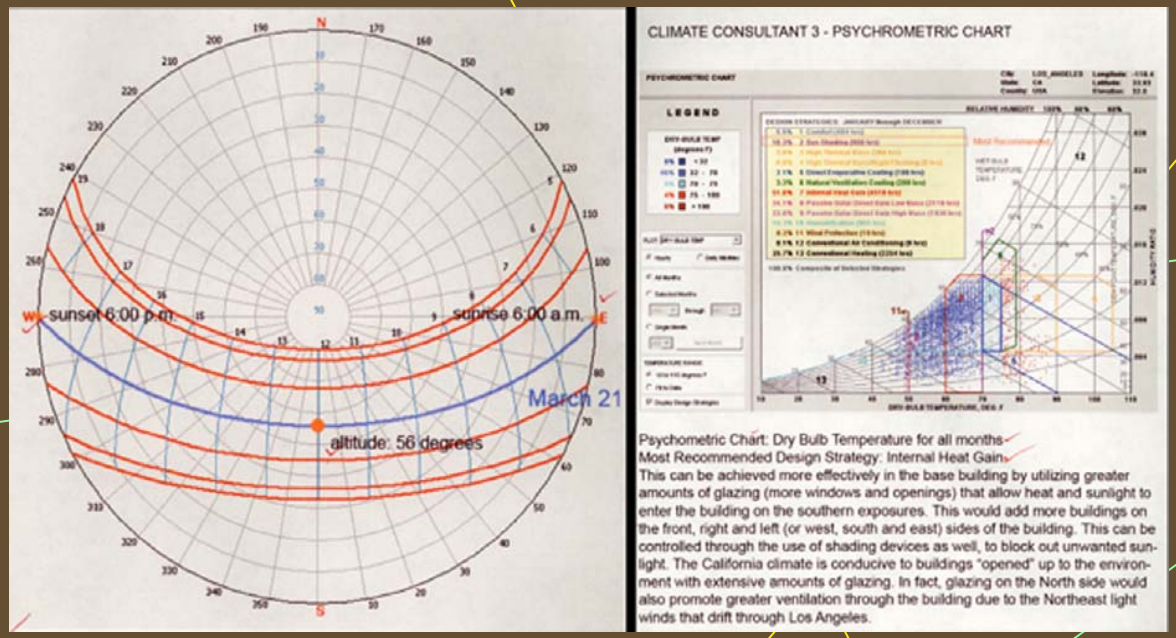
Paolo Leon, instructor Prof. CL

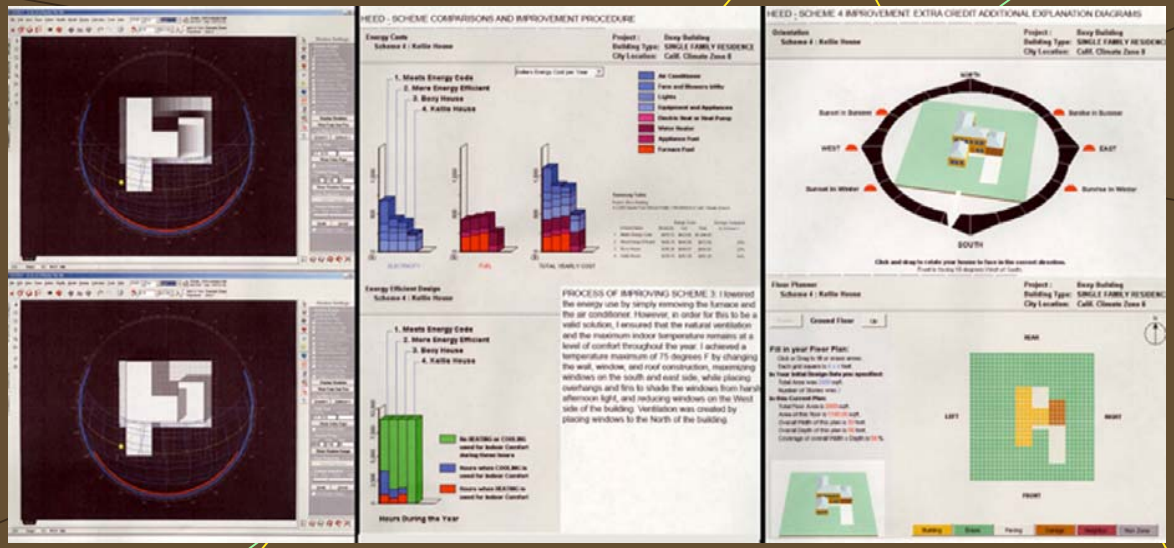
Professional Practice

The School experimented with extending the scope of the NAAB required professional practice content to include BIM. “The course concentrates on the comprehensive manner in which architects communicate built form with technical documentation. This includes a review of the regulations that relate to the creation of construction documents including permitting, review and regulatory agencies, planning and building codes. The lab portion of the course uses BIM as a tool to develop the skills to create comprehensive, fully coordinated, and dynamic construction documents.” (course description). Four professors are collaborating on this course (JE, JD, DG, KK). With an NCARB grant, JE has been able to augment the course with presentations and desk crits from professionals.

Design Studio

BIM technologies are being applied by some students in their graduate and undergraduate design studios. In this bottom-up approach, students have proactively decided that BIM is part of their design process. Hand drawings, physical models, and other methods of representation are integrated with the BIM model. Similar to the CAD debates more than two decades ago, there continues to be controversy and heated discussions over its use.





Part of homework assignment 5: sun path, climate, energy

BIM in the Curriculum

Elective: Arch 307

One of the first implementations of BIM teaching is its inclusion in the elective introductory computer course. The architecture and construction professions are currently facing at least three important transformations: the integrated practice, the re-emergence of sustainable design, and BIM. BIM is a digital paradigm shift, in many ways similar to that of the CAD revolution of the 1980s.

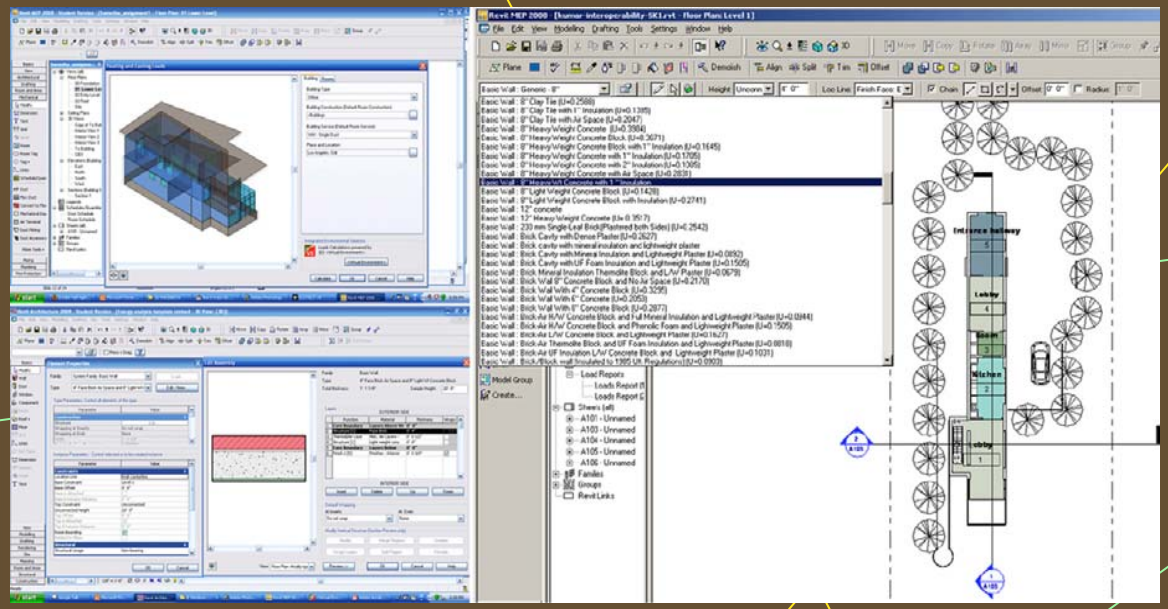
Concurrently, there has been increasing sophistication, accuracy, and user friendliness of software available for analytical modeling including, sun paths and shadow calculation, structural engineering, lighting, energy calculations, ventilation, and sustainability issues. There has been an increased desire and ability to provide a better integration between geometric and analytical models, a "complete" virtual building model that contains the necessary information to predict its behavior.

This course explores what BIM is and how it relates to being a virtual description of a "real building" and then briefly examines the intersection of BIM and sustainable design. It is the latter where the students are again exposed to ideas of solar access, weather tools, basic energy concerns, and carbon footprint calculations.

BIM in the Curriculum

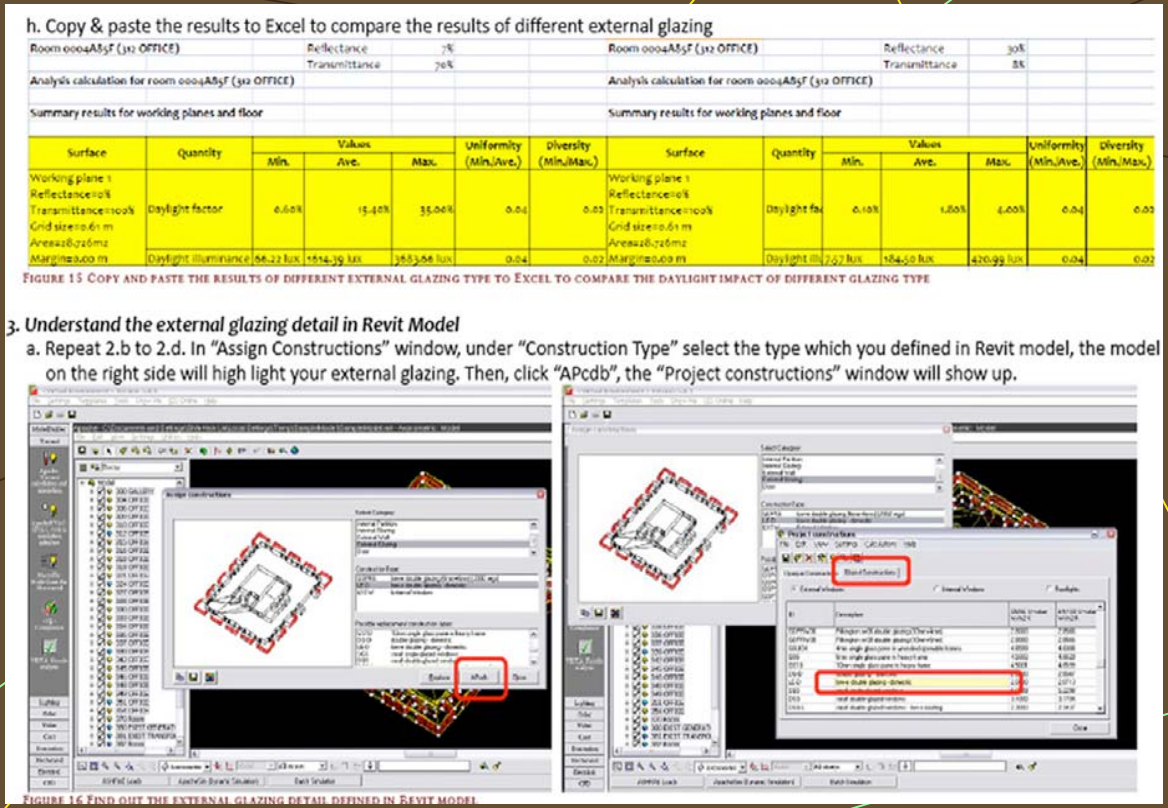
Featured Course: Arch 507

In many respects, this graduate course mirrors issues faced in the undergraduate course: 2d/3d coordination, parametric families, and sustainable design. The first time the course was offered, there was a determined emphasis on BIM's potential to be used for communicating and transferring building geometries to analytical tools that could test assumptions and design ideas. Students explored intra/inter operability with energy tools (IES, Green Building Studio, and Ecotect), modeling and rendering tools (3ds Max and Google Earth), structural design, tools within the BIM program itself (shadow casting, green material databases), and others. Professionals came in with case studies to explain how the different factors contributed to creating a building.



Sumedha Kumar, wall assemblages

Eve Lin, glazing comparison



h. Copy & paste the results to Excel to compare the results of different external glazing

Room 0004A85F (312 OFFICE)		Reflectance	7%
		Transmittance	70%
Analysis calculation for room 0004A85F (312 OFFICE)			
Summary results for working planes and floor			

Surface	Quantity	Values			Uniformity (Min./Ave.)	Diversity (Min./Max.)
		Min.	Ave.	Max.		
Working plane 1 Reflectance:80% Transmittance:100% Grid size:0.61 m Areas:28.726mz Margins:0.00 m	Daylight factor	0.00%	15.40%	35.00%	0.04	0.03
	Daylight illuminance	56.22 lux	1514.39 lux	3583.56 lux	0.04	0.02

FIGURE 15 COPY AND PASTE THE RESULTS OF DIFFERENT EXTERNAL GLAZING TYPE TO EXCEL TO COMPARE THE DAYLIGHT IMPACT OF DIFFERENT GLAZING TYPE

Room 0004A85F (312 OFFICE)		Reflectance	30%
		Transmittance	8%
Analysis calculation for room 0004A85F (312 OFFICE)			
Summary results for working planes and floor			

Surface	Quantity	Values			Uniformity (Min./Ave.)	Diversity (Min./Max.)
		Min.	Ave.	Max.		
Working plane 1 Reflectance:80% Transmittance:100% Grid size:0.61 m Areas:28.726mz Margins:0.00 m	Daylight fa	0.10%	1.85%	4.00%	0.04	0.03
	Daylight illu	7.57 lux	184.50 lux	420.99 lux	0.04	0.02

3. *Understand the external glazing detail in Revit Model*

a. Repeat 2.b to 2.d. In "Assign Constructions" window, under "Construction Type" select the type which you defined in Revit model, the model on the right side will high light your external glazing. Then, click "APcdb", the "Project constructions" window will show up.

FIGURE 16 FIND OUT THE EXTERNAL GLAZING DETAIL DEFINED IN REVIT MODEL

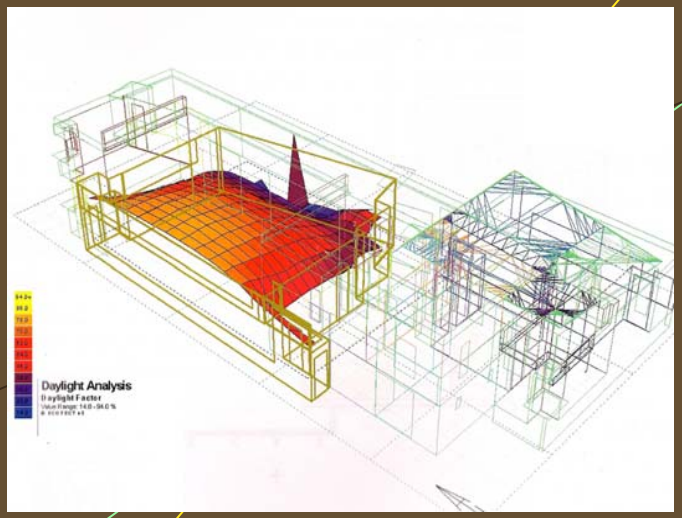
Sustainable

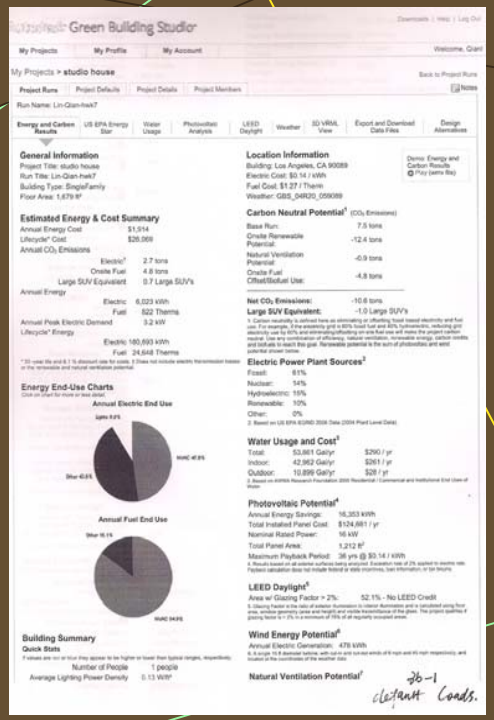
BIM in the Curriculum

Featured Course: Arch 507

A second incarnation of this course maintained the essential principles of BIM and sustainable design, but focused more strongly on the opportunities afforded by the development of architectural parametric families. Combining two technologies, parametric modeling and performative calculations, building information modeling has the opportunity to enhance and enable architects and engineers to explore many concepts early in the design process. For example, by adding data to the parametric objects, it is possible to produce digital models that allow for sustainable design studies on areas such as water collection, energy savings, CO2 reductions, and daylight harvesting.

Qian Lin, homeworks 3 and 7



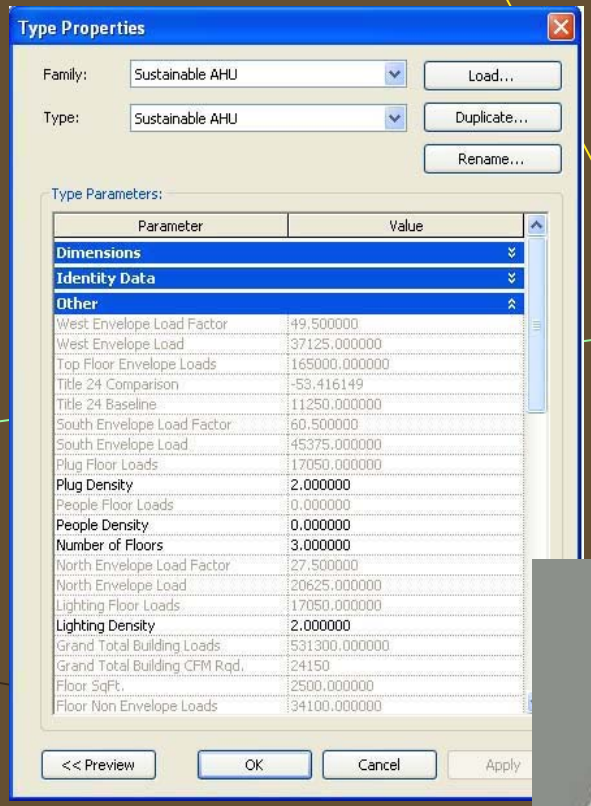


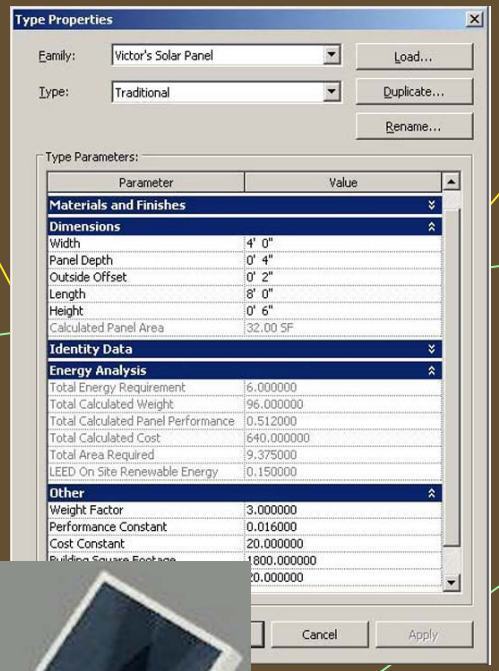
Performative

BIM in the Curriculum

Featured Course: Arch 507

As is typical with student homework assignments, the results ranged from simplistic to interesting, from “the family doesn’t work” to “this is an excellent idea.” A list of their submitted proposals included the following (there were duplicates): solar panels, rainwater collection tanks, operable louvers and sun screens for window shading, bike racks for LEED points, low-E and dual glazing window specification, recycling bins, solar hot water heaters, wind turbines, light shelves and skylights, roof ponds, mechanical air handling units, green roofs, Trombe walls and straw bale construction, solar powered radiant floor, low flow toilets, and “compost bins + easy LEED Revit families points.”





Victor Asperez, solar panel caluclator and air handling unit

North Envelope Load = (Btu/h) = North Envelope Load Factor * Bldg. North Length
East Envelope Load (Btu/h) = East Envelope Load Factor * Bldg. East Length
West Envelope Load (Btu/h) = West Envelope Load Factor * Bldg. West Length
South Envelope Load (Btu/h) = South Envelope Load Factor * Bldg. South Length
Floor Envelope Loads (Btu/h) = (North Envelope Load + South Envelope Load + East Envelope Load + West Envelope Load)
People Floor Loads (Btu/h) = Floor SqFt. / People Density * 250
Floor Non Envelope Loads (Btu/h) = (Lighting Floor Loads + People Floor Loads + Plug Floor Loads)
Building Envelope Loads (Btu/h) = (Floor Envelope Loads * (Number of Floors - 1) + Top Floor Envelope Loads
Grand Total Building CFM Rqd.(Cubic Feet per Minute) = Grand Total Building Loads / (1.1 * 20)
OSA Height (Feet) = sqrt((Grand Total Building CFM Rqd. * 0.2 * 1 SF) / 150 / 4)
AHU SA Height (Feet) = sqrt((Grand Total Building CFM Rqd. * 1 SF) / 150 / 4)

Parametric

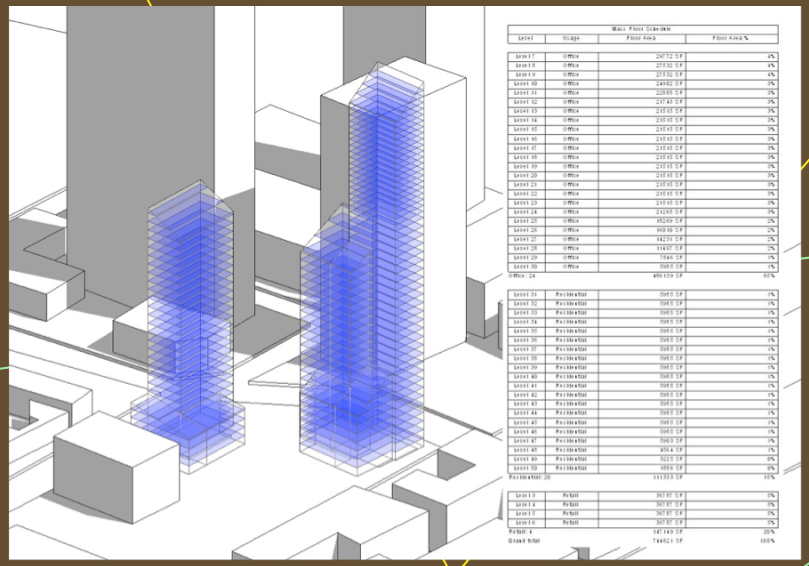
BIM in the Curriculum

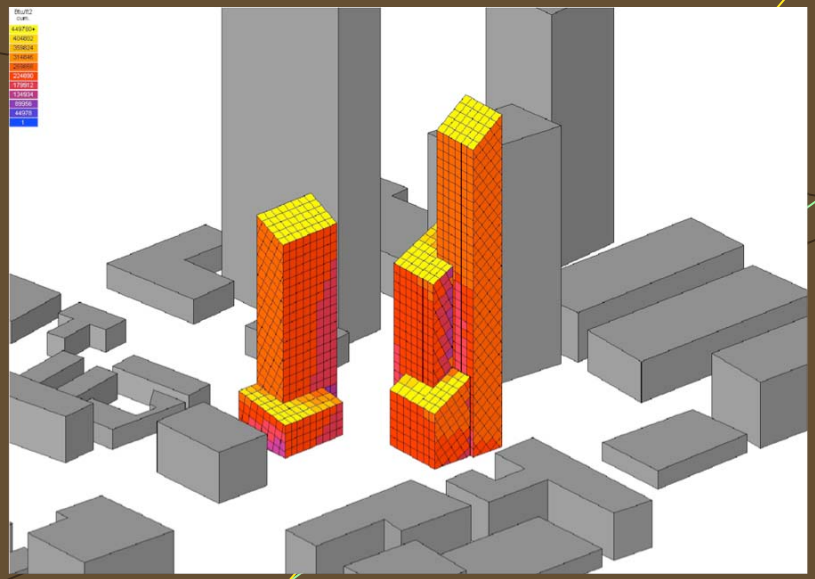
Featured Course: Arch 507

A third version of the course is currently underway. It still focuses on 2d/3d coordination, interoperability with sustainable design tools, and parametric design. Due partly to a strong presence of construction management and civil engineering students in a class dominated by architecture graduate students, additional emphasis has been added on the role of BIM from design to construction to facilities management. The students will be developing case studies based on the following summary description: "One stumbling block in seamless integration of BIM in the AEC industry has been gaps in the transfer of information between the major players. Interview a key BIM coordinator at an architecture firm about a specific project that they have completed or is near completion. You will also interview another person at a construction firm that worked on the same project. You will discover and report on how the BIM model was created and then passed on to the next stage of its development, what problems occurred, and how to improve this process."

HNTB field trip in preparation for architect and contractor BIM interviews

Interdisciplinary





BIM in the Curriculum

Featured Course: Arch 507

Its final project is currently underway that seeks to bridge the divide between design and performance. The students are developing simple conceptual massing studies that are informed by insolation studies client programmatic requirements including day lighting and photovoltaic energy generation. The main objective is not to produce one design, but to instill in the students the importance of iterative design development using BIM and performance based tools.

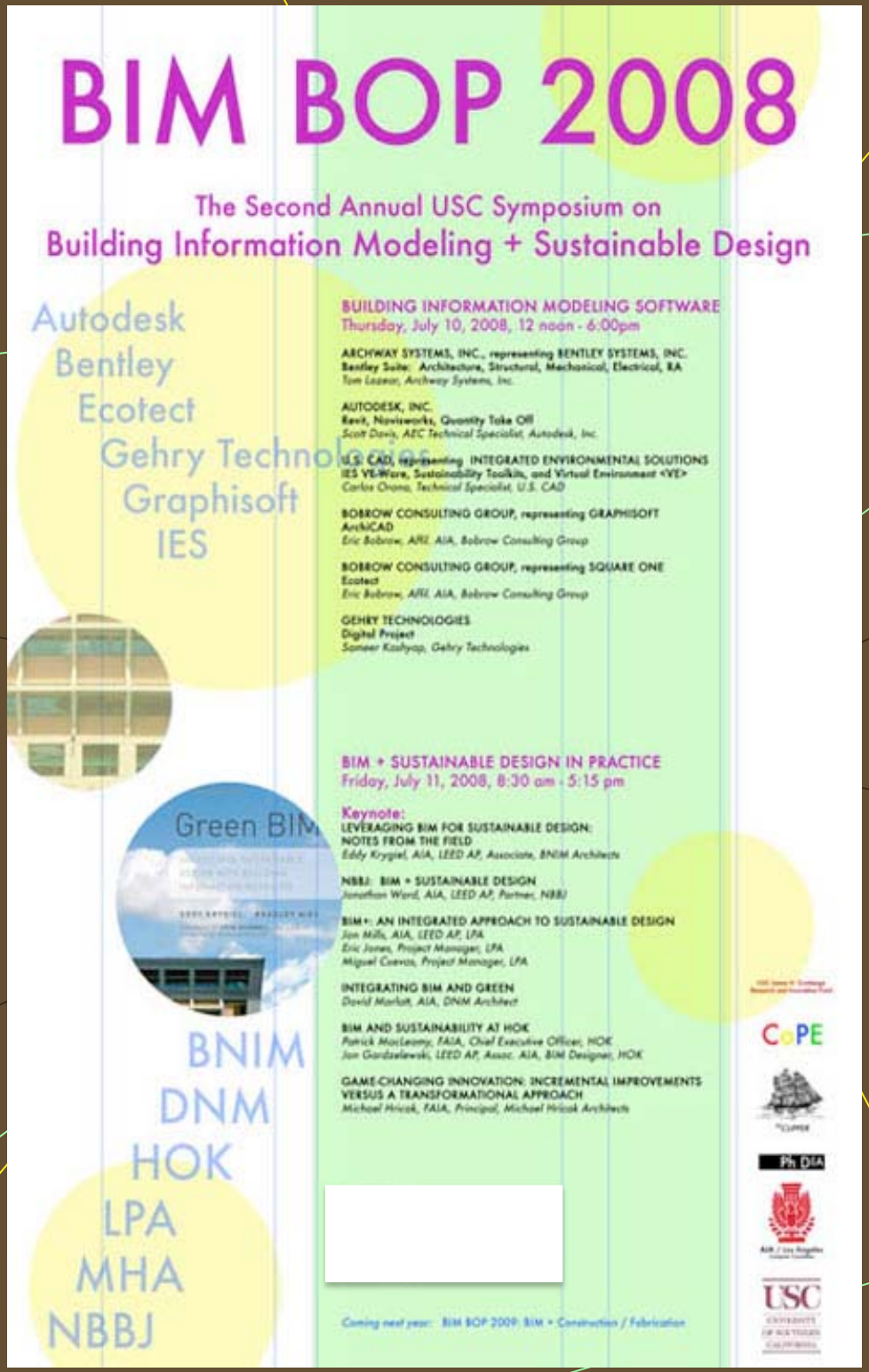
This project has just been given to the students; these images are from the assignment handout showing importance of insolation and size of floor plates for initial design study. Images by Shenyuan Guo.

Exploration

Engaging the Profession

A University's educational mission needs to reach beyond their main constituents, the student population, to the profession. It is critical that this is a two-way flow of information. In the two examples described below, the School of Architecture has brought together professionals in sessions moderated by academics to explore BIM – the information produced in these courses and symposia inform both the profession and academia to critical issues in building information technology. Three BIM + Symposia that have been given so far will be summarized and a short introduction will be given to our newest proposal for Summer 2010, Executive Education in BIM.

Sustainable Design



Engaging the Profession

BIM SYM 2007

BIM BOP 2008

To assist architects, a range of digital tools are available to predict the energy consumption, carbon footprint, daylight availability, natural ventilation opportunity, and other important criteria in our buildings. These analytical models take us beyond hand waving and the “well-behaved arrows” of our diagrams and drawings to a scientific method of evidence based architecture. In conjunction with an increased understanding of the potential application of building information modeling and the knowledge that has been accumulated through education and experience, architects can produce more sustainable designs. The BIM SYM conference in 2007 and the BIM BOP conference in July 2008 brought together architects and educators (and students) to explore the current status of the intersection of BIM and sustainable design. By inviting large and small firms, using a variety of software, the symposium traced specific examples of how these two items could be used synergistically. The event was organized into two parts: software representatives gave an overview of their products on the first afternoon of the event, and on the second day, architecture professionals discussed how they use BIM to help design sustainable buildings.

Engaging the Profession

BIM CON!FAB 2009

Whereas the first two BIM conferences focused mainly on sustainable design, the third conference specifically explored the issues of BIM in construction and fabrication and encouraged the presenters to give team presentations that included both the architect and construction professional. This free, two day event was organized into two parts: software representatives gave an overview of their products; and on the second part of the first day and the second day, architecture professionals discussed individual case studies to demonstrate how they utilize BIM during the design, construction, and fabrication process.

THURSDAY **MORNING, July 30th**
SOFTWARE REPRESENTATIVES
Onuma, Inc
Beck Technology, Ltd.
Nemetschek North America
Bobrow Consulting Group (ArchiCAD)
Digital Vision Automation, Inc. with Diffenbaugh Construction
Solibri
Archway Systems, Inc. (Bentley)
Autodesk
Synchro, Ltd.
Optira with ESRI
Gehry Technologies

CIMEMA ARTS PRESENTATION
View by View Inc. with Gregory P. Luth & Associates, Inc. and Urban Design Group

FRIDAY MORNING, July 31st
ARUP and MATT Construction
Morley Builders
Buro Happold

FRIDAY AFTERNOON, July 31st
Gensler
Morphosis Architects, Inc
Zimmer Gunsul Frasca Architects LLP with Mortenson/Power

It is interesting to note that although BIM + construction was covered, overall there was not a full scale embracing of BIM + fabrication leading one to believe that perhaps the full range of necessary software is not communicating in a fashion that allows the building information to proceed seamlessly from the architect to contractor to fabricators. A heated debate developed between audience members and presenters late the second day as to whether or not a BIM model had to be all-inclusive or whether a strategy of multiple models made more sense.

Engaging the Profession

BIM Analytics 2010 – coming this summer

BIM isn't BIM without Information

Sequester 25-30 intelligent, articulate AEC executives in a room for two days.

Focus their thoughts and inquiry onto the future of BIM.

Watch **O**ut.

Engaging the Profession

Executive Education

"This year, USC will launch five course offerings centered on the theme of Los Angeles as a 21st century model of critical urbanism, creativity and culture. These courses will explore a set of strategically themed topics, connecting over a dozen of the most forward thinking global practitioners, politicians and urban theorists today with our own faculty. Combining keynote lectures, panel discussions, exclusive tours, and impactful classroom experiences, each individual offering crisscrosses methods, ideologies and approaches. These courses take a "thinking out-of-the-box" approach in order to equip professionals with full matrix of ideas and sensibilities to make design matter." BIM is one of five chosen topic areas: "this executive education program will showcase current best practices and will invigorate the audience through an in-depth look into BIM disasters and successes. We will demonstrate BIM implementations not only by showcasing examples, but by also exploring methods of reducing uncertainty and risk while discussing economics, legal, and management aspects. Finally, we will summarize actionable decision making tools for the owners, glimpse into research at universities, and explain the power behind parametric design." (Executive Education marketing information) Done in conjunction with Prof. DG.

Building

Integration

Students are learning that BIM is not a separate technology from design, but a completely integrated design-support activity. Faculty, students, architects, engineers, and construction professionals are recognizing that BIM requires a much tighter working relationship and that each of the participants has much to offer to the others.

Interoperability

The capability of BIM to work with analytic and representational tools offers a great opportunity for students and architects to reinforce their design capabilities. This works only if tasks of interoperability do not present major hurdles. The migration of data between systems must be nearly seamless with two-way communication between the software programs. Sustainable design is one critical area that can benefit.

Interdisciplinary

BIM tools significantly widen the opportunities for interdisciplinary cooperation, allowing for a truly integrated design process. No single profession is going to be able to advance the capabilities of BIM without enthusiasm and cooperation from all of the participants.

Modeling

When academia works more directly with the profession, the BIM revolution will be quicker and less painful than the CAD revolution.

Integrated education including both professionals and students is the key.