ASSOCIATION OF COLLEGIATE SCHOOLS OF ARCHITECTURE
1735 New York Avenue, NW
Washington DC 20006

Karen M. Kensek
School of Architecture
University of Southern California

Advancing education, research, and the profession at the nexus of architectural computing and building science.

BS in Architecture and B.Arch, MIT, 1984
M.Arch, University of California at Berkeley, 1986
ACADIA Service Award 2000
Tau Sigma Delta Medal for Distinction in Teaching, 2003
Phi Kappa Phi, 2004
NCARB Prize, 2007
Revit Building Information Modeling (BIM) Experience Award for USC, 2008
AIA TAP Building Information Model Awards for B III M (Building Integration Interoperability Interdisciplinary Modeling), Honorable Mention.
USC Mellon Mentoring Award, 2013
ACSA Creative Achievement Award, 2014
AIA CC, AEP Educator Award, 2014
Design Intelligence, Most Admired Educator, 2015
Latrobe Prize finalist, 2015
AIA California Council, Presidential Citation, 2016
Latrobe Prize finalist, 2017
Fellow, Center for Excellence in Teaching, University of Southern California, 2018

Professor Karen M. Kensek is a world-class teacher. She has created almost a dozen new courses, and has modified existing courses many times to keep up with technology. She is a revered figure among the students, and admired by her colleagues. She is a teacher's teacher, and many of her former students are now faculty members. She is consistently the best teacher in among the more than 100 faculty in the USC School of Architecture, and is the teaching benchmark for the faculty annual review committee.

Kensek's career has centered on exploring the rich possibilities that bridge the worlds of computational science and architecture. In doing so, she has explored how research in academic settings is translated and processed by the profession (and vice versa). When she began her career more than 35 years ago, she represented the exceptionally rare woman in a architecture computing and building science, and she has provided a positive role model for thousands of female architecture students with interests in technology. Technology is fundamentally transformational as it disrupts, reformulates, and redirects. These lead to changes in the practice of architecture, and the professional adaptation to technology rewrites the agenda for future research. She has examined these phenomena from the beginning stages of my career, and she provided leadership to bring first-generation Computer-Aided Design (CAD) into design practice and education by being among the first to actively integrate the use of the computer into the architecture design studios and publishing early papers about its use. Kensek represents one of a generation of thinkers who fostered the rise of CAD in architecture and actively engaged the profession and educational institutions by providing a vision of where we should be headed, why it was important, and how to get there. Her work also emphasizes sustainable design and integrates it with design computation. Her commitment to research, teaching, and service reflects my deep commitment to the institutions, people, and processes that support improvements to the physical environment in which we live.

TEACHING

Major technology-induced changes have transformed the teaching of future architects. Classes that she taught 30 years ago in 3D modeling, rendering, and animation and later 3D printing, scanning, and laser cutting were innovative at the time. Students learned techniques that put them at the forefront of the profession. Concurrently, she was instrumental in coordinating the exposure, training, and integration of digital design into the core classes, and she also provided instruction to other faculty. Computer-aided design and fabrication is now ubiquitous; it is difficult to believe that at one time, conscious effort had to go towards its implementation. She has taught engineering, archaeology, urban planning, theatre, and cinematic arts students in addition to architecture students. Her teaching reflects back into her research, and the research informs the teaching (e.g. a presentation to fellow faculty "BIM and Sustainability -- steps towards more integrated teaching" at the Society of Building Science Educators 2008 Retreat, UK). Kensek has won a number of teaching awards and receives excellent reviews for her courses that are continuously evolving to keep ahead of the curve with technological developments. The work of her students has been published many times, exhibited, and won several awards. The National Council of Architectural Registration Board (NCARB) has given both a grant (2012, co-PI) and an award (2007, co-PI) for the integration of professionals in a new course (special topics in building science) and graduate studios (sustainability issues). In 2013, she received the prestigious USC Mellon Mentoring Award.

Real-world emphasis for now and the future

Digital media augmented and disrupted centuries old design practices. In response, Kensek tailors her teaching so that students gain appropriate exposure to current software and a clear understanding of the relations between the tools of the architect with those of the contractor and consultants, while maintaining an "eyes-to-the-future" position so that students are engaged well beyond computer training and leave the class with a deep understanding of digital media. She introduces innovative tools in her classes, sometimes being the first in the country using them for education.. In addition, due to her commitment to green design, a strong thread of BIM Analytics is present in her assignments. In 2010, she spearheaded an entry for a national AIA TAP BIM award that included courses that she had designed and implemented and strategic initiatives for engaging the profession. The School received a national AIA TAP Honorable Mention for outstanding new curriculum development incorporating BIM and integrated practice delivery concepts.

Individual skill building and teamwork

Technical skill building is a necessary part of teaching that includes my having to gauge individual student learning styles and adapting my methods to be most effective. Increasingly important, however, is teamwork. Although sometimes difficult to implement, she added assignments where students work together to solve problems as partners or role players where students might serve as an architect, contractor, MEP or structural engineer, or even the client. Her teaching excellence has been recognized with several awards.

RESEARCH

Digital, parametric, and data based methodology assists designers to not only generate form-based solutions, but also to use real world constraints and drivers such as solar geometry and energy simulations to develop powerful, innovative designs. Kensek's research is focused on the combination of conceptual design parametrics, building information modeling, and performance-based design for the advancement of building science and sustainable architecture. It is anchored in computation and the building sciences, specifically the use of digital tools to examine the behavior of buildings.

Two linked paths: digital media and building science.

Kensek's early research projects followed parallel but linked paths. The emergence of digital media technology in architecture led to my research and development of CAD implementations in a wide range of venues: the design studio, computer aided manufacturing/fabrication, digital reconstructions (modeling, rendering, and animation) of ancient buildings, and the study of ambiguity in data sources. Her initial building science research included the development of a virtual/augmented reality control system prototype, web-based tools (lighting, thermal comfort, wind, sustainability), and the digital solar envelope (with USC Professor Emeritus Ralph Knowles). Broader acceptance of computing in architecture opened possibilities for deepening of my research focus. Initially, CAD primarily captured existing design processes and provided ways to make them more efficient. As CAD evolved, it morphed into a new species, known now as Building Information Modeling (BIM), a paradigm substantially different from CAD and other types of threedimensional modeling. BIM is an integrated, virtual design database informed by the architecture, engineering, construction, and operations industries that consists of three-dimensional parametric objects and allows for interoperability between the modeling and simulation software. It is best imagined as a 3D model that is created of building components such as walls, windows, columns, doors, etc. that have characteristics like R-value, solar heat gain co-efficient, steel, cost, manufacturer, etc. Her recent book, *Building Information Modeling* (Routledge, May 2014) includes chapters on the fundamentals of BIM and its implementation in the profession, but also includes a discussion of issues beyond essential BIM that have immediate and future impacts on the profession including BIM Analytics. BIM Analytics is the fusion of building information modeling with building science. Kensek examines the use of building information modeling with simulation and analysis, how this affects specific processes in the profession, its implementation, and current impediments and gaps in its adoption. The profession benefits from this research area as it not only critically examines current practice, but offers inventive methodologies for designing high performance, sustainable buildings.

BIM as a tool for sustainable design

Kensek's work in BIM Analytics addresses underlying building science research in several ways including simulation studies that predict the performance of buildings. She has received several research grants that have supported this work. For example, the USC James H. Zumberge Faculty Research & Innovation Fund (co-PI, 2008), sponsored interdisciplinary research on GIS+BIM for urban-scale computer aided sustainable design. A recent paper ("Urban Energy Modeling: GIS as an Alternative to BIM," ASHRAE/IBPSA-USA, with MBS student Sehrawat, 2014) provides a useful way of visualizing data to evaluate energy indicators and building energy characteristics for an urban area. This offers owners, agencies, and local governments a method for more quickly assessing energy consumption within a certain error range. For example, the Los Angeles 2030 District organizers could use this tool to predict energy consumption in the District for the setting of performance goals as an initial step in determining realistic measures for lowering energy consumption for existing buildings. Another opportunity to link BIM and sustainability occurs in the early stages of design when architects use software tools that are quick-to-learn and easy-to-use to explore multiple design alternatives that minimize environmental impact. A grant from Southern California Edison (SCE, PI, 2011-12) funded work on several sustainable design topics: determination of glare; shade trees effects on energy usage of buildings; calibration of buildings for retrofits; early energy design studies on window shape, orientation, and location, and the calculation of solar heat glazing coefficient (SHGC) for tilted windows. The latter discovered problems with the prescriptive path not accounting for solar angles in ASHRAE 90.1 (ASHRAE STANDARD: Energy Standard for Buildings Except Low-Rise Residential Buildings) and provided one solution that could lead to eventual changes in the code (see also Won Hee Ko, “Tilted Glazing: angle dependence of direct solar heat gain and form-fitting of complex facades.” Committee: Schiler, Kensek, Miller, Otto, Simmonds, 2012 MBS thesis). I have published a number of additional papers on the results of SCE grant and other research.

Karen was a co-PI a grant by Southern California Gas (SoCalGas) to fund university research on passive and low energy strategies to assist the non-residential commercial market in achieving sustainability, zero net energy (ZNE), and thermal comfort. It is critical for reducing energy consumption to explore passive design strategies at the beginning of the design process. Her component of this research project is developing and assessing simulation-based design workflows capable of evaluating the performance of multiple passive environmental design alternatives in early stage design through the use of BIM. In addition, at later stages of design architects may be willing to trade-off quick and easy for better accuracy and the ability to perform optimization methods. The research also addresses a current drawback with BIM Analytics: the lack of true interoperability between the modeling and energy software

Translating research to practice

In addition to the scholarly work produced, Kensek provides leadership and a voice on innovative topics to building industry professionals with other media: AECbytes Viewpoint website, ("Scripting and Coding for BIM”), on-line magazines (e.g. “A Recipe for an Interactive Façade,” AUGI World), and symposia held at USC that bring together both educators and professionals. There have been thirteen annual BIM symposia (2007–2019). Themes have included education; sustainable design; construction and fabrication; analytical modeling and evidenced-based design; BIM management, implementation, coordination, and evaluation; the future of BIM both from academic and professional viewpoints. The American Institute of Architect’s Technology in the Architectural Practice (AIA TAP) Knowledge Community has webcast several of these sessions because of their direct value to the profession.

Contributing to the knowledge base

Kensek has published scores of papers in peer reviewed journals and conference proceedings, written technical papers and edited compilations, and been invited to give presentations and submit papers, and hundreds of citations attest to the relevance of my work. This work is often done in collaboration with other faculty and graduate students as is typical in our field. In the 2014 edited volume Building Information Modeling: BIM in Current and Future Practice (Wiley, 2014, lead co-author), Karen brought together cutting-edge leaders of BIM research, discussing the sub-topics of analytics, design thinking, reasoning, comprehensiveness, the profession, and speculations (including my own chapter on “Analytical BIM: BIM Fragments, Domain Gaps, and Other Impediments”) and assessing the current practice and research directions of building information modeling.

SERVICE

When carefully planned, service can be a method of expanding teaching and promoting collaborations for research. Kensek's internal and external service commitment often directly supports my research and teaching. She is an active and productive member of committees, have taken leadership roles in those dealing with computer integration in courses and facilities, and has been a representative on University committees. She considers service to the profession extremely important because it enriches the connections between academia and the profession and provides a conduit for life-long learning. Her work outside of the university illustrates the dual nature of a professional school in a research university – a commitment to inquiry and service to the practice of architecture.

Service to national and international research organizations

ACADIA, through its long established history and stellar researchers and educators, provided intellectual rigor to the blossoming field of digital design and continues to be leading academic organization in my research area. Kensek served in several leadership roles in that organization including President (1995 – 96), co-editor of the ACADIA Quarterly (1993-7), technical co-chair of the 1992 ACADIA conference, and an elected member of the Steering Committee / Board of Directors several times. She was the first recipient of the ACADIA Award of Excellence in Service (2000). She has also been a paper reviewer for over a dozen conferences, book chapters, and book proposals; a grant reviewer for the Israel Science Foundation (ISF); and one of the founders of the Los Angeles chapter of the International Building Performance Simulation Association (IBPSA, 2012).

Service to professional organizations

The American Institute of Architecture (AIA) is the professional voice of the architecture profession, and Kensek is actively involved at several levels. Since 1990, she has participated in the creation and chairing of local chapters, lead outreach seminars to the membership, chaired the AIA TAP Research Committee, and collaborated on the NotLY (Not Licensed Yet) program to encourage designers to become licensed architects. The latter won an ACSA Creative Achievement Award in 2014. She has also been selected to speak several times at AIA National Conventions.

TEACHING EVIDENCE

A letter to Karen Kensek from the Associate Dean as directed by the Gold Committee of the USC School of Architecture regarding Prof. Kensek as one of the “best-of-the-best” teachers.

USC School
Of Architecture

August 16, 2019

Karen M. Kensek
Professor of Practice
School of Architecture
University of Southern California
Los Angeles, CA 90089-0291

Dear Karen,

I consider the School of Architecture at the University of Southern California to be among the very best in the United States. A major component of the success of our great school is the truly outstanding teaching of our faculty.

While it is certainly true that our faculty is exceptionally strong overall, there are a small number of full-time and part-time faculty who stand out as the very best even among this elite group.

After careful review, the Gold Committee of the USC School of Architecture has identified you as being among the best-of-the-best teachers on our faculty.

I am honored to be able to recognize your outstanding contributions to the educational mission of our school, and I thank you sincerely for the extraordinary efforts that I know it takes to stand out as one of the very best among the more than 100 faculty members in the USC School of Architecture.

Sincerely,

Douglas E. Noble, FAIA, Ph.D.
Chair of the Ph.D. Program and Co-Founder of the CLIPPER Lab
dnoble@usc.edu

University of Southern California
Watt Hall 204, Los Angeles, California 90089-0291 • Tel: 213 740 2723 • Fax 213 740 8884 • http://arch.usc.edu

TEACHING EVIDENCE

STUDENT COMMENTS

Grammar and spelling errors left in original student comments. These samples are from among literally hundreds and perhaps thousands over the past 30 years or more.

“Karen is an engaging teacher with energy and enthusiasm about the subject matter. She is very responsive to e-mails and was always willing tio offer hlp outside of class.”

“Karen is extremely knowledgeable regarding the subject matter and is very effective in stimulating student in =terest in BIM related issues.”

“Karen is incredibly enthusiastic and engaging. She made the class thoroughly enjoyable and effectively sparked our interest and creativity.”

“She is an AWESOME teacher. Even if it was hard for me in the beginning, Karen is a great teacher.”

“She makes the classes very interactive classes and is very knowledgeable.”

“Best instructor I’ve met in USC. The course is well-organized.”

”She made sure that all the students had an excellent grasp of the material before completing the course.”

“Karen is incredibly receptive to students.”

“Karen Kensek’s lab of ARCH520 course was extremely organized and assignments while time-consuming were well laid out. She clearly cares about students learning and put a lot of effort into the course.”

“She is serious to work. She is willing to spend lots of extra time on helping students learn. She always changes her teaching method in order to let students learn more. She is really a wonderful teacher.”

“Amazing instructor. Very attentive.”

“Inspires + strengthens my work. Really pushes me to improve myself.”

“Karen is amazing. I wish she taught more of my classes.”

“She was excellent ***** Learn such a lot in the 15 weeks of clas. It has been one of the highlghts for me @ USC. We need many more student-friendly professors like her.”

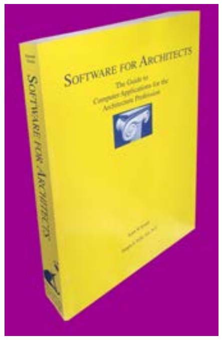
“How might this instructor improve his or her teaching effectiveness? Not sure this is possible.”

“She is an A++ professor. I truly admire Karen for her hard work and dedication to her students.”

“You are definitely the best professor! In all senses. You teach fun courses, you explain great, you make it interesting, and you really make USC’s name.”

Architectural Computing Pioneer

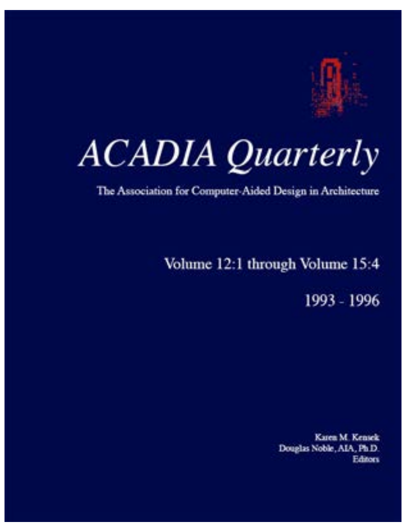
DESIGN COMPUTING LEADERSHIP
Committee co-chair for AIA Los Angeles Computer Committee for nearly 20 years. AIA Technology and Architectural Practice Knowledge community for decades. Created the first comprehensive catalog of software in "Software for Architects: Computer Tools for the Architecture Profession" in 1990 (yellow book cover below).



BUILDING INFORMATION MODELING BOOK (Co-Edited with Douglas Noble)
Building Information Modeling: BIM in Current and Future Practice, Wiley, 2014

AIA COMPUTER COMMITTEE and AIA TECHNOLOGY in ARCHITECTURAL PRACTICE
With Douglas Noble, founded the AIA East Bay Computer Committee (1980's) and the AIA Los Angeles Computer Committee (early 1990's). These committees eventually were transformed and merged with other national AIA units to form the current Technology and Architectural Practice knowledge group. USC received an AIA TAP award for our work integrating computing into the curriculum.

ACADIA: The ASSOCIATION FOR COMPUTER-AIDED DESIGN IN ARCHITECTURE
Served at various times as President, elected Steering Committee member, and even newsletter editor (many years ago). Organized and served as technical chair for the 1993 ACADIA conference with Douglas Noble and Richard Norman.



ACADIA Quarterly

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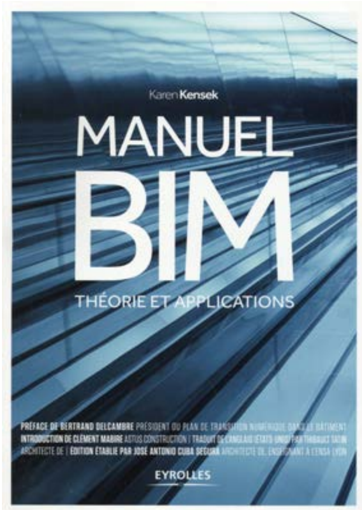
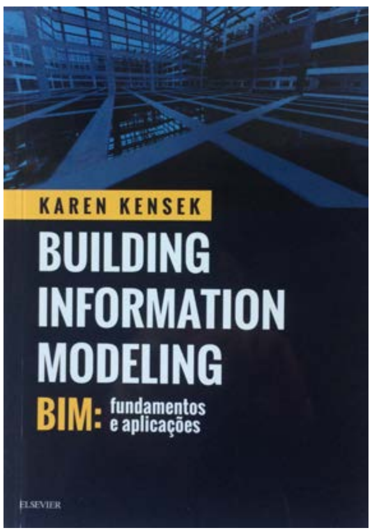
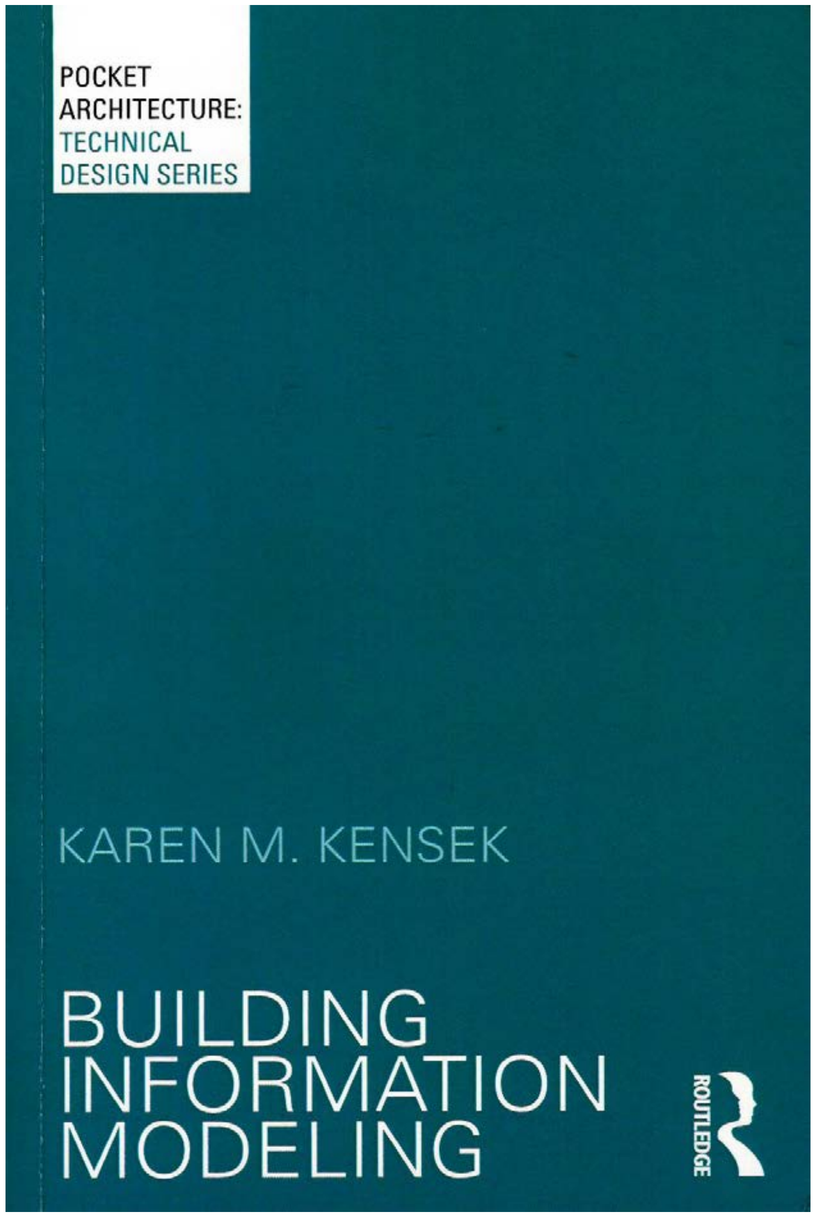
Building Information Modeling: BIM Publications

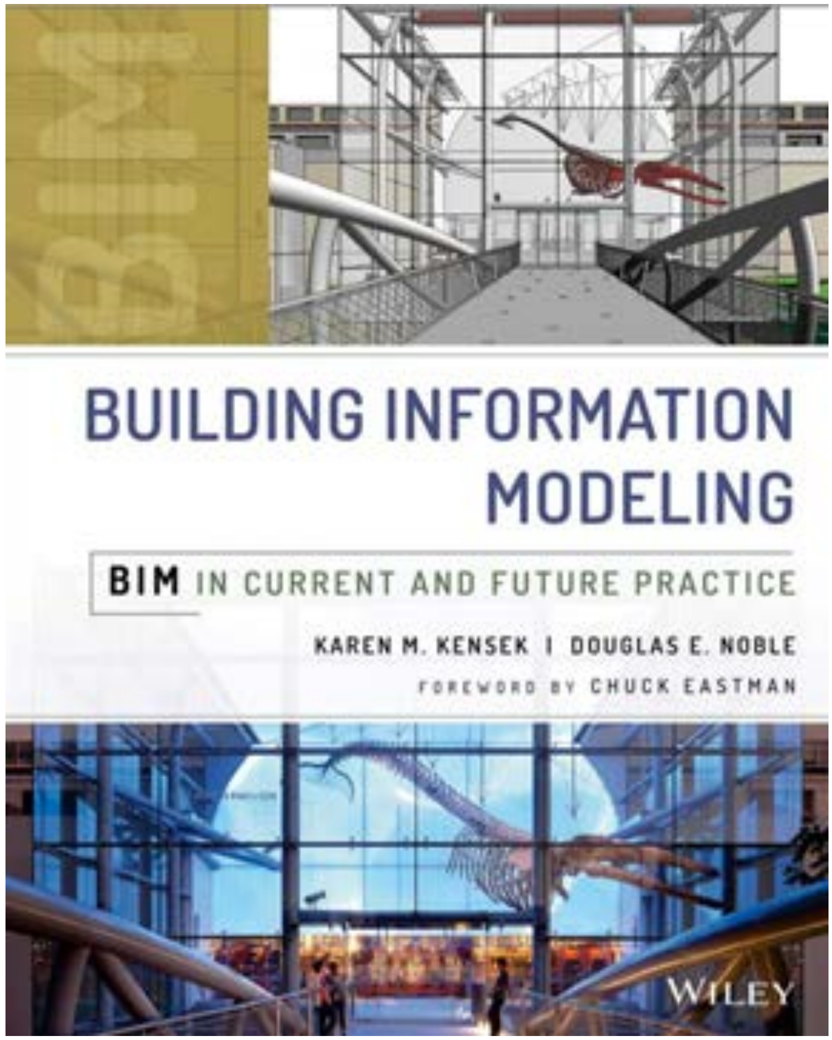
BUILDING INFORMATION MODELING
Kensek's book is now in four languages, with an Arabic version nearing completion. This book is used a a texbook in her ARCH507 and ARCH607 courses.







Building Information Modeling: BIM Publications



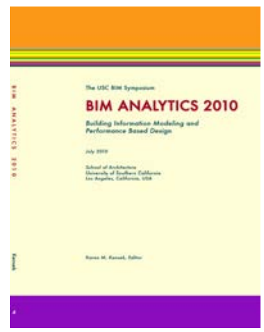
Building Information Modeling: BIM Conferences

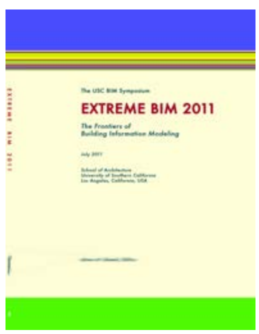
CLIPPER^{3d} LAB

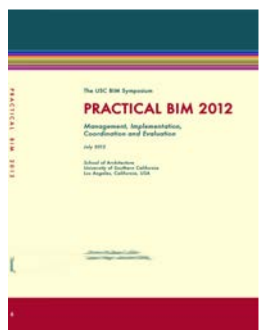
Co-founded the CLIPPER^{3d} LAB at USC with dozens of hardware and software grants in support of a teaching and research computing lab in the USC School of Architecture. The CLIPPER^{3d} LAB was designed to support computing and physical tools as a laboratory for knowledge-based building design and analysis.

USC BIM CONFERENCES

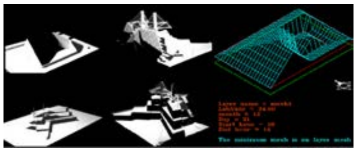
Just completed the 13th Annual USC BIM conference, attracting over 400 people from around the world. Most of these BIM conferences include a printed proceedings. Each year, Karen invites a dozne or more students to participate in the conference preparation and delivery, and students are always welcome in the conference for free.







Solar Envelopes



RALPH KNOWLES AND THE SOLAR ENVELOPE

Co-taught studio with Ralph Knowles (originator of the Solar Envelope concept). Recently completed an edited collection of the most important writings by and about Knowles and his solar envelope. Supported the solar envelope concept with software development, graduate research, and publication.

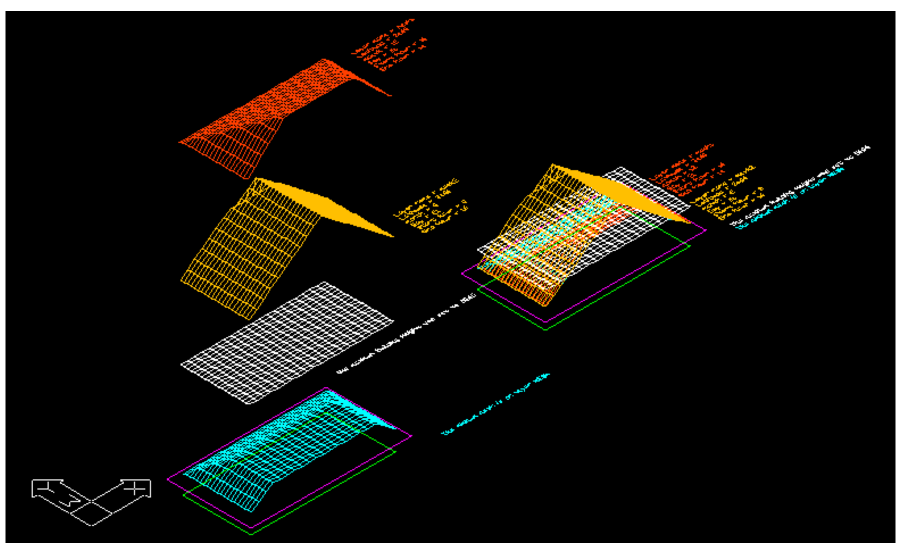

American Solar Energy Society
SOLAR 2013

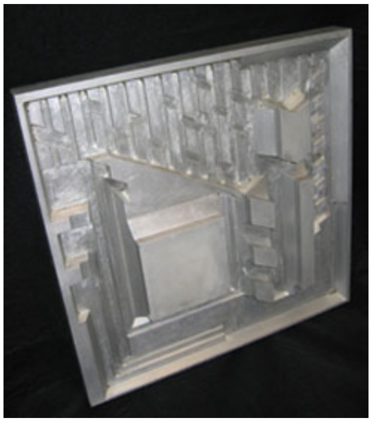
SOLAR ACCESS ZONING + BUILDING INFORMATION MODELING

Karen Kensek
Alicyn Henkhaus
University of Southern California
School of Architecture, Watt Hall #204
Los Angeles, CA 90089-0291

ABSTRACT

1. INTRODUCTION





Freeman Archive and Mold

FREEMAN HOUSE ARCHIVE (supported by a grant from the Graham Foundation)
Prof. Kensek led a team in a specially created course to develop this important work. The Freeman House is a Frank Lloyd Wright Textile block house owned by the USC School of Architecture. The project was to complete a 3200 page, seven volume collection of all known documentation related to the house, including original drawings and sketches, correspondence, and historic structures reports. The house was photographically documented at a very high level of detail. Archive team members include Ben McAlister, Douglas Noble, Karen M. Kensek, and Celesta Vera. A number of original documents were available only at USC, and many of these documents were uncatalogued or stored hidden in locked cabinets.

FREEMAN HOUSE FACADE REPLACEMENT MOLD
The reconstruction of the mold to cast new Freeman House blocks for the building envelope. Five-year effort: techniques involved laser-scanning, CAD-CAM, materials analysis, and physical manufacturing in the school woodshop

CAD/CAM METHODS IN SUPPORT OF HISTORIC PRESERVATION: A CASE STUDY OF THE FREEMAN HOUSE BY FRANK LLOYD WRIGHT

Douglas Noble, AIA, Ph.D.

Karen M. Kensek

Keywords: CAD/CAM, historic preservation, textile block, Frank Lloyd Wright

Abstract

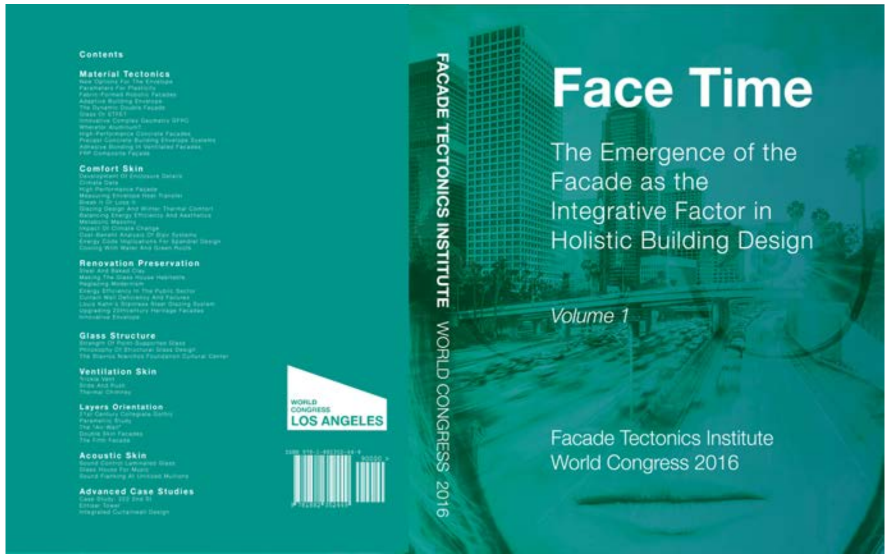
Resumen

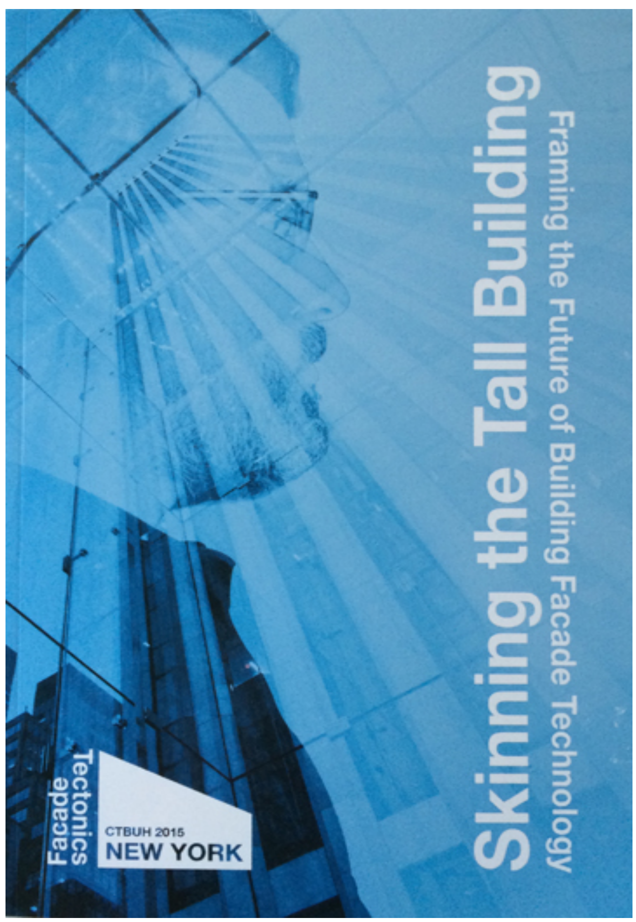
Background

The Building Enclosure

CO-FOUNDER: THE FAÇADE TECTONICS INSTITUTE
The An international organization dedicated to the advancement of the arts and sciences of the building enclosure. Organized many conferences, prepared dozens of papers, and edited several books and journal on the subject.

The Building Enclosure





Computation and Sustainable Design

EXAMPLE RESEARCH PAPERS

Kensek's research links architectural computing and sustainable design. These are just three examples from a collection of morethan 20 research papers on the subject.

Journal of Sustainability Education

BIM as a Framework for Sustainable Design[1]

Karen M. Kensek, University of Southern California, School of Architecture

Abstract

Climate change, water scarcity, and environmental degradation are issues that should be addressed by architects. To do so, they must have the knowledge and skill to create innovate designs, predict their performance, use the feedback to make adjustments, and construct buildings properly. Although far from perfect, there are many digital tools to help architects and their consultants do this. The profession has also seen a growing use of digital models, especially in the form of building information models (BIM). BIM has many attributes that make it useful for the architecture/engineering/construction profession, especially its inherent nature as a 3d virtualization that can be used to exchange information with other software. As BIM is a growing part of the architecture profession, learning its use is imperative by students. It is also possible to encode pertinent data in the BIM and export the information to simulation programs to create predictions for future energy usage, CO2 emissions, daylight availability, water usage, natural ventilation, and other analytic models. Students who are learning about BIM have the opportunity to examine its usefulness as a framework for sustainable design. This paper describes assignments in two BIM courses that lay down groundwork for acceptance of BIM's role in enabling sustainable design. It demonstrates that classes can provide an opportunity to prepare future architects for the environmental challenges that await them even when the major subject matter of the course is mainly focused on other topics. Eventually, like CAD, BIM will diffuse into the design studio and the profession, negating the need for its specific teaching. Perhaps classes like these will encourage stealthy diffusion of simulation based methods that help to predict the performance of buildings in the hope of producing more sustainable architectural designs.

Keywords

BIM, building information modeling, sustainable design, pedagogy, performance assessment tools

Introduction

If one accepts the premise that sustainable design is a moral imperative, then it is critical that architecture courses are infused with knowledge that allows students to design environmentally friendly buildings. This applies to all the courses that students take, although the depth of instruction about sustainable design and emphasis would vary amongst them. This paper describes how the instructor has taken two building information modeling (BIM) courses and added a sub-theme of performance-based simulation into some of the assignments. These courses are electives (one undergraduate, the other graduate) that focus on BIM: 2d/3d coordination, parametrics, and interoperability. It is with the latter two topics, parametrics and interoperability, where issues of sustainable design have been inserted into the courses' agenda.

Fortunately, BIM is very well suited in some regards for the inclusion of sustainable design calculations. Although one could add other topics into a BIM course such as construction or facilities management or even office management and legal issues, interoperability issues associated with the 3d model are well exemplified by simulation programs. In addition to the discussions associated with file types, open standards, and the 3d model as a database, one can reinforce environmental concepts of energy consumption, day lighting, and the uncertainness of the results while providing instruction in software that students may later use with their studio design projects.

---

[1] Kensek, Karen, "BIM as a Framework for Sustainable Design." *The Journal of Sustainable Education*, the Geography of Sustainability, case study, on-line, http://www.jsedimensions.org/, 2012.

2008.1 42 [CADERNOS DE PÓS-GRADUAÇÃO EM ARQUITETURA E URBANISMO]

Sustanable Design Through interoperability: Building Information Models (BIM) and Energy Analysis Programs, a Case Study

KENSEK, Karen Marie, Associate Professor, University of South California, USA kensek@usc.edu

KUMAR, Sumedha, Master of Building Sciences Student, University of South California, USA, sumedhal@usc.edu

1 Abstract

Building information modeling (BIM) is being marketed as one possible solution in providing architects a tool to help with sustainable design, a descriptive building component tool that would provide the missing link between CAD programs and performative energy analysis programs. The intent of this study was to assess whether BIM software was robust enough to allow seamless interoperability of its building model with the analytical model. The BIM software used for the study was Autodesk Revit MEP [AUTODESK] and for energy analysis IES <VE> [IES] was chosen because of its integration with Revit MEP. The other part of the study improved upon the MEP-IES interface by building a Revit template file, designed as a "patch" to address the gap between these programs. This template file defined a set of Revit MEP families that derived their values from the IES Apache construction database. This template file could be imported into a Revit project, making the BIM model more accurate and informative, when used in conjunction with IES <VE>.

2 Introduction

Building information modeling (BIM) technology has an increasingly significant role to play in the architecture, engineering, and construction (AEC) industry today. Its strength lies in being a multifaceted, data rich model that provides the user with a database of building information including items like wall, window, floor, and roof types. One intent of having this wealth of data about the building is to allow the architect the ability to share these characteristics with other features of the program such as preliminary cost analysis, take-offs of sustainable materials, and scheduling. It also allows the possibility of linking to other software programs.

Software interoperability is the ability of two or more systems or elements to exchange information. Interoperability should ideally be a seamless exchange of data among software tools, eliminate the need for duplicate data generation, and

Journal of Creative Sustainable Architecture & Built Environment, CSABE
Vol. 1, November, 2011

Environment Control Systems for Sustainable Design: A Methodology for Testing, Simulating and Comparing Kinetic Facade Systems

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Abstract

The primary purpose of the building envelope is to protect the inhabitants from the outside environment. Although usually static systems, facades are designed to respond to many scenarios and perform functions that can be contradictory to each other: daylighting versus energy efficiency, ventilation versus views and energy generation. By actuating the facades and making them dynamic, they can better adapt to the conditions, provide for improved comfort of the occupants, and achieve a more sustainable design by reducing the compromises needed for that balance. Facades can now sense the environment and make their own modifications in order to achieve prescribed goals. Kinetic solutions can be analyzed for their environmental benefits, compared to each other, and recommendations proposed. This project demonstrates the development of a kinetic façade system based on research, simulations, and a built prototype that improves upon current practice and provides an efficient façade for traditional curtain-walled office buildings.

Keywords: Kinetic façade, Building envelope, Shading device, Performance-based design

1. Introduction

There has been a trend in office building design to use more glass in the façade; this often necessitates methods of mitigating undesired consequences. These glass facades are desirable to designers because they offer the inhabitants views to the outside, access to natural light, and can be visually appealing. Many solutions to mitigating the negative aspects offer solutions to single problems and are not variable enough to control more than one issue at a time. Compared to a building with a static shading, daylighting, ventilating or energy generating systems or none of these at all, the use of a kinetic façade system will diminish the need for external energy expenditures by decreasing unwanted solar heat gain or loss, increasing use of natural lighting, and generating on-site energy, while also increasing the use of natural ventilation. Through the variability of the system, the façade will adapt itself to the best situation for the given environmental condition and thus increase its potential impact. Kinetic façade systems can help to mitigate environmental problems, decrease the need for mechanical systems such as HVAC systems and artificial lighting, add to the occupants' comfort, and potentially could be used to generate electricity. These kinetic systems are not intended to replace mechanical systems, but they could decrease the energy demands of the building significantly. It will be shown that a kinetic system can improve solar thermal load, daylighting, ventilation, and energy generation for typical all-glass facades in office buildings, is buildable, and can perform in a simple, efficient manner. Although a working prototype was built and tested, this paper will focus more on the research methodology.

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Performance-based Design

Figure 2: Project Vasari poster and larger details, Aaron Malmedal, student, Spring 2011

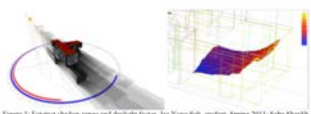

Figure 3: Ecotect shadow range and daylight factor, Jae Yong Suk, student, Spring 2011; Saba Shaykh, student, Spring 2011

Design for Environmentally Responsive Buildings: BIM, parametrics, and algorithmic design

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MOHAMED EL SHEIKH
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ABSTRACT

Parametric software tools, especially when used in conjunction with performance based simulation tools, give designers the opportunity to develop architecture in ways not imagined by architects constrained by 2d depictions or by 3d models that only contain geometric data. This presents new opportunities for the design of environmentally responsive buildings and intelligent facades. Two types of parametric design, building information modeling and algorithmic design are explored, not only as contrasting methods of interacting with simulation software, but as viable alternatives towards exploring energy efficient design in the early stages of conceptual massing. Student based case studies using Rhino and Grasshopper are presented, and Firefly is mentioned. Critical to these studies is that the participants were not adept experts, but new to the process of applying algorithmic design tools.

KEYWORDS: BIM, parametric design, algorithmic design, kinetic facades, intelligent skins

1 BACKGROUND

The building envelope is the interface between the natural exterior environment and the controlled interior environment of occupied spaces. In high-performance facades, there may be multiple levels of response that vary around the exterior façade. These may include different U-values, coatings, frit patterns, or shading devices. The increased level of variation across the façade does not have to be random, but can instead be accurately controlled by environmental data. Digital parametric and algorithmic based design can help designers not only generate form driven solutions, but also use real world constraints such as solar geometry and energy simulations to develop powerful, innovative designs.

The integration of parametric tools into the digital design process has liberated designers to choose whether or not to produce complex forms when implementing new methods of designing responsive facades. The increasing use of parametric design and digital tools in academia and practice is in part due to its capabilities of producing this variety. However, their use changes the design process and requires an initial extensive focus on developing a parametric workflow that will then allow the designer flexibility during the entire process. This new paradigm requires that architectural students think about design as a process instead of a product. "The predictable relationships between design and representations are abandoned in favor of computationally-generated complexities" (Kolarevic, 2003). The student adds scripting environments, code, and a deeper knowledge of the parameters controlling the geometry to his toolbox. Ultimately, this process increases the designer's awareness of the implications of each design decision.

Design for Environmentally Responsive Building Envelopes: BIM, parametrics, and algorithmic design 1

Fig 4: 3D model in Revit: light level is 255 (left); 3D model in Revit: light level is 75 (right). (the original house was modeled in Revit by Andrea Martinez)

6.4 Arduino Photoresistor, Dynamo, Revit (façade component)
Similar to the previous case study, the building information model responded to the changes in the photoresistor's value (Figure 5).

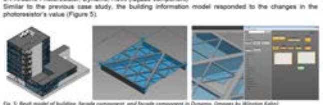

Fig. 5: Revit model of building, façade component, and façade component in Dynamo. (images by Winston Kahn)

6.5 Arduino Photoresistor, Dynamo, physical model (façade component)
In this case study, both the physical model responded to the changes in the photoresistor's value. As the light level value approaches 255, all three vertices approach a maximum extension in the physical and digital models, likewise, when the value reading is at a lower threshold, only one or two or three of the actuators or vertices are raised (Figure 6).

Fig. 6: Physical model of the façade component with zero, one, two, and three corners raised. (images by Winston Kahn)

6.6 Revit 3d model, Dynamo, Arduino servo, physical model (façade component)
The setup is ready for this case study. However, as mentioned earlier, at the time the case studies were finished, there was no supported functionality in Dynamo to output the Revit parameter values to the Arduino board.

EXAMPLE RESEARCH PAPERS

High-Performance architecture requires computational tools. Kensek has created some tools and uses other existing tools to assist students and professionals. These are example papers from among dozens.

PERFORMANCE AS A DESIGN DRIVER: A Pedagogical Approach and Online Collaborative Knowledge Network to Support High-Performance Design

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ABSTRACT

This paper presents a pedagogical approach and online collaborative knowledge network focused on strengthening the feedback loop between building design and performance. The approach supports intensive, early-stage integrative design within a framework of objective performance indicators to help ensure that architecture students develop the ability to design resource efficient projects that simultaneously support the comfort, health, and well-being of occupants. Developed with support from a 2012 National Council of Architectural Registration Boards (NCARB) Award for the Integration of Practice and Education, the method additionally seeks to better integrate professional knowledge and expertise into design studios early in the design process and continuously throughout, to aid students on project-specific problems, and to guide them with feedback at appropriate stages. To enable more effective communication and collaboration around these objectives, the online knowledge network performance-and-form.com was developed and informed through an assessment of faculty, practitioner, and student needs. The site is a fully-featured discussion forum and social network, allowing users to subscribe and post to specific topics, share digital materials, and form groups to communicate around specific design problems, questions, and interests. The paper discusses the application of this pedagogical approach as a flexible and adaptable overlay to existing project-based design studio formats as well as more broadly across and between schools of architecture.

KEYWORDS

Pedagogy, collaborative learning, teaching technology, high-performance design, social network

INTRODUCTION

Integration of a broad range of sustainability and technical performance concerns in the design studio, as well as throughout design institutions, is needed to align the academic environment more closely with the sustainability and technical performance issues increasingly faced by practitioners. In the United States, buildings account for ~70% of electricity consumption and ~40% of all carbon dioxide (CO_2) emissions. Architecture, engineering, and construction (AEC) professionals are increasingly championing the need for projects that are not only more resource efficient, but also better support occupant health and well-being (e.g. natural lighting, access to views, improved indoor air quality). Designers must also address the need for resilient buildings that can accommodate increasingly frequent and severe weather.

To meet these responsibilities, it is important for students entering the profession to have the ability to implement sustainable design principles and have the critical analysis skills to verify performance throughout their process of design. It is equally important to begin to identify and reward students whose design work effectively meets these responsibilities. Unfortunately, in

Digital Reconstructions and Ambiguity


Automation in Construction 13 (2004) 175–186

Fantastic reconstructions or reconstructions of the fantastic? Tracking and presenting ambiguity, alternatives, and documentation in virtual worlds

Karen M. Kensek, Lynn Swartz Dodd, Nicholas Cipolla*


DIGITAL RECONSTRUCTIONS: CONFIDENCE AND AMBIGUITY

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School of Architecture

Abstract

DIGITAL RECONSTRUCTION

Often, it is not possible to determine with certainly exactly what a building or environment looked like hundreds of throusand of eyars ago. Kensek is a pioneer in developing methods to express uncertainly in visual representation.

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These techniques are already well established, although the limitations in the real world are notable. Once an object is restored, there is considerable investment required to change the form to accommodate new data or to experiment. Such constraints are less relevant in a digital domain.

4. Reconstructions of architectural objects

One two-dimensional solution to revealing the relationship between extant remains (evidence of a material nature) and the reconstruction is well-known: books using transparent overlays. For example, in Israel Past and Present (Macmillan Travel, 1999), the temple of Solomon has been reconstructed on the Temple Mount in Jerusalem. This is an (at-present) unrealizable reconstruction because the area is contested, and the Haram es-Sharif, or Temple Mount area, is occupied by mosques and other buildings. Similar popular books exist for ancient Rome, Pompeii, and Greece.

Transparent overlays have been attempted at the site level, in full size. This excellent, unique example is situated in Ename, East Flanders, Belgium (Fig. 1). The resources to accomplish this are more substantial, but the relationship between remains and reconstruction is intuitively apparent. Still, the reasoning behind

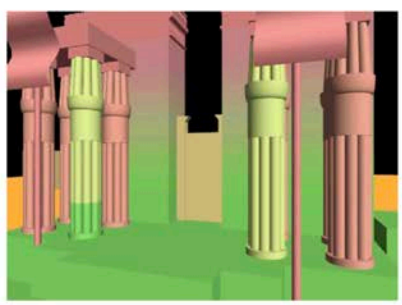


Fig. 2. A false color version that shows the level of confidence in various sections of the model. Green hues implies greater confidence, while red hues implies lesser confidence. Darker hues imply greater confidence than lighter hues.

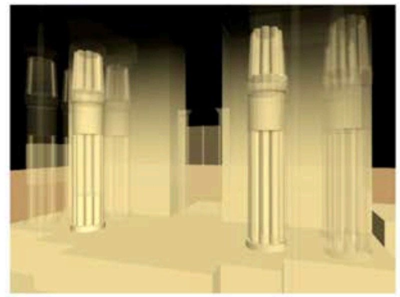


Fig. 3. A reconstruction using varying opacity values as a key for confidence levels. Greater opacity implies a higher level of confidence in the reconstruction.

the entire reconstruction, though it can be read or voiced, is not made transparent to the viewer, although this could be accomplished within the framework the creators have established.

There are also already several easily accomplished, two-dimensional, computer-based reconstruction techniques available. These include mouseovers, false color (Fig. 2), mixed opacity values (Fig. 3), hybrid systems (in this case false color and different opacity values, see Fig. 4), and rendering types (wireframe, shading, rendered, see Fig. 5). All these methods offer the viewer a recon-

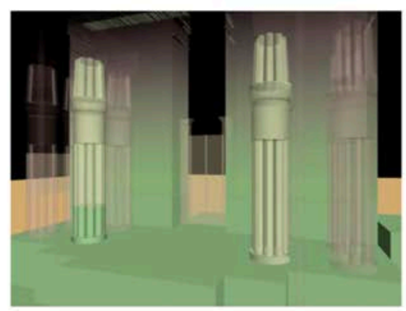
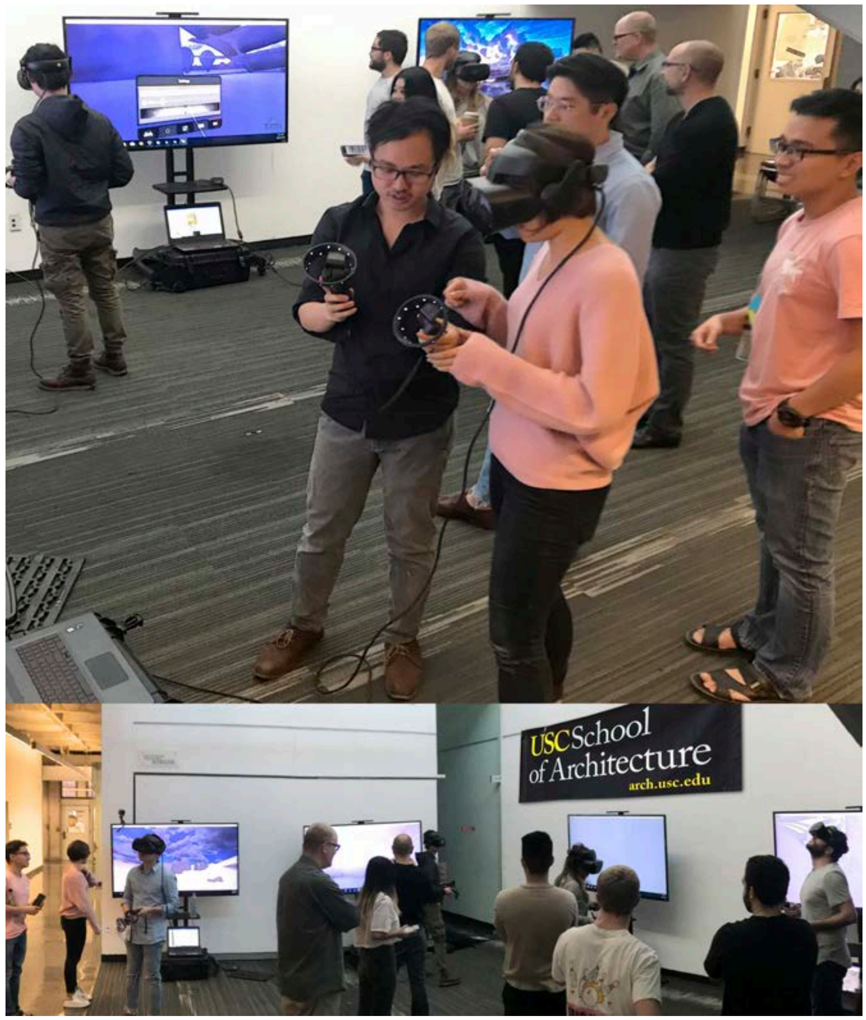


Fig. 4. A hybrid system using both false color and varying opacity levels.

Augmented Reality

PIONEERING AR and VR in the studio
Kensek has been using computer-supported visualization techniques such as virtual reality and augmented reality from the early days of her career more than 35 years ago.



Service

COMMITMENT TO EDUCATION

With Douglas Noble, Kensek has presented, organized, and managed hundreds of free licensing support classes, workshops, and lectures to help the next generation of architects through the licensing process.