

# PhD Focus

Spring 2005

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## America's Hospitals Are Falling Short

Hospitals are stressful places to work, stressful to visit, dangerous for patients and expensive to run. According to the National Academies' Institute of Medicine, hospital stays are a leading cause of death in the US:

- As many as 98,000 Americans die each year during hospitalization due to preventable, medical errors.
- Up to 2 million U.S. hospital patients, 1 in 20 of all those admitted, contract dangerous infections every year during their stays.
- In 1995, hospital-acquired infections cost \$4.5 billion and contributed to more than 88,000 deaths. Hospital infections are a leading cause of death in the United States.

But hospitals need not be this way. Researchers in the PhD Program at Georgia Tech, are exploring evidence-based approaches on how to improve healthcare facility design and are collaborating with MCG Healthcare, Emory Health Sciences Center and SSM Healthcare in studying their current facilities and in planning new ones. Research Scientist Dr Mahbub Rashid and Dr Craig Zimring are conducting a Healthy Environments class where they are focusing on how information technology for computerized medical records can be incorporated into the architectural design of Emory's Hospitals to increase teamwork, improve patient-centeredness and reduce error.

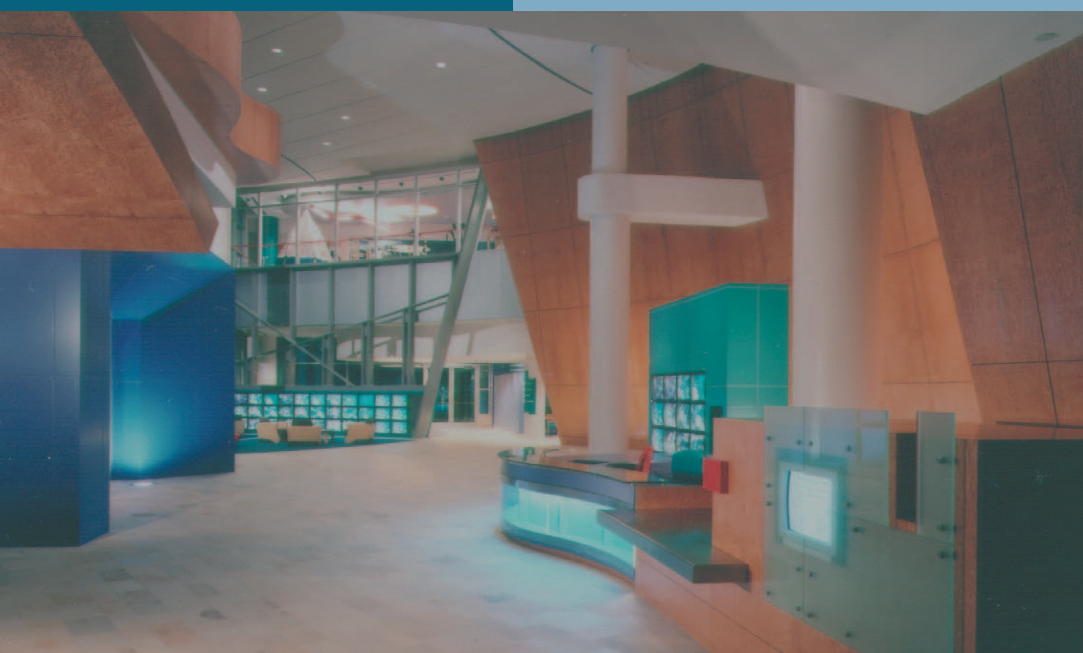
PhD faculty member Dr Ruchi Choudhary has conducted an indepth study of strategic decision-making for technical and mechanical systems in hospitals. She has developed a methodology that allows hospitals to make tradeoffs during renovation and construction among systems and requirements, such as lighting, HVAC, energy control and infection control.

A recent review of the research literature—the most thorough of its kind—conducted by Dr Zimring, PhD student Anjali Joseph and Dr Choudhary, working with Dr Roger Ulrich and Xiaobo Quan from Texas A&M, carefully analyzed over 700 scientific studies, and concluded that the interior design of hospital environments contribute to the hospital illnesses previously listed, and can be a cost-effective tool for improvement. Through improved design, and particularly design of patient-care areas, hospitals can increase patient safety, reduce patient and family stress, increase staff effectiveness and improve overall system efficiency, effectiveness and financial performance. For example:

- There is compelling evidence that providing single patient rooms, as opposed to semi-private rooms or wards, reduces infection rates, patient falls and medical errors, and increases participation by family. While larger variable-acuity rooms and other amenities might increase the initial cost of construction by 5%, evidence suggests that the payback period is approximately one year.
- Controlled, randomized studies show that increased natural lighting and a reduction in noise can diminish drug use, decrease pain for patients and minimize hospital stays and lower stress levels for staff.
- Implementing improved filtering systems for air quality during construction, can reduce hospital-acquired infection.

- Using methods for analyzing networks of corridors and pathways in hospital layouts, like Space Syntax, can reduce poor wayfinding—which is a major source of stress for outpatients and visitors, and is costly in staff time.

The full text of the literature review, complete with all references, can be downloaded without charge at: <http://www.healthdesign.org/research/reports/>.



The credit for this photo is MCG Health System. "Photography: © Jonathan Hillyer" College of Architecture researchers are working with MCG Healthcare to explore the impacts of patient centered design, like this children's hospital.

## Studies in design formulation and critical interpretation of architectural work

A theme issue of the *Journal of Architecture* to be published this spring will feature four essays describing recent work at Georgia Tech at the interface of architectural morphology, critical interpretation, and cognitive studies of design. The lead essay by Dr John Peponis outlines an emerging theory of design formulation; papers by Dr. Aarati Kanekar (PhD, 2000, Assistant Professor, University of Cincinnati) and Weiling He (PhD, 2005) offer interpretive accounts of architectural works which draw their program from works in other media such as painting and poetry, and a paper by Dr Sonit Bafna extends the argument by drawing methodological conclusions related to historical understanding of buildings.

These essays are a part of a research program at Georgia Tech aimed at developing a structural theory of architectural design. The point of departure for the work is the observation that architectural works are able to engender meaning that may not be a part of the initial intention of the designer, and that such meaning is neither circumstantial, nor external to the design, but rather inherent to the design itself. The goal of the work is to develop a structural description of the manner in which such meaning is produced and to examine its consequences for morphological theories of the generation of designs, and for interpretive studies of architectural works. The work so far has progressed on several fronts. A series of graduate seminars on "The Spatial Construction of Meaning" led by Dr Peponis and Dr Ken

Knoespel (Chair, Department of Literature, Culture, and Cognition in the Ivan Allen College) have explored this issue through exercises in which the programmatic content of works in different media, such as poetry and painting, is translated into an architectural program. The point of these exercises is to develop cases through which specific structural characteristics of the meaningful architectural form can be explored. This work has been presented in several forums, including a special issue of the journal *Philosophica* (no. 70, guest edited by Dr Ken Knoespel).

On another front, the program of research has involved interpretive analysis of historical works. In a series of recent papers and conference presentations, Dr Bafna has been exploring design sketches and personal recollection of designs by prominent architects in order to analyze strategic moments at which the design falls into place, or at which crucial design decisions are taken. The premise here is that understanding the differences between successful and unsuccessful versions of designs gives important clues to structural understanding of designs. This work has the potential to offer contributions to the methodology of historical interpretation of buildings. It offers clarifications to long debated issues such as the role of authorial intention in interpretation and a methodical approach that puts the focus in interpretive studies back on the architectural object itself. Ongoing doctoral dissertations by Hazem Ziada on the Palace of the Soviets competition of 1926 and by Saleem Mokbel Dahabreh on Richard Meier's recent projects both continue this analytically descriptive approach to understanding architectural work.

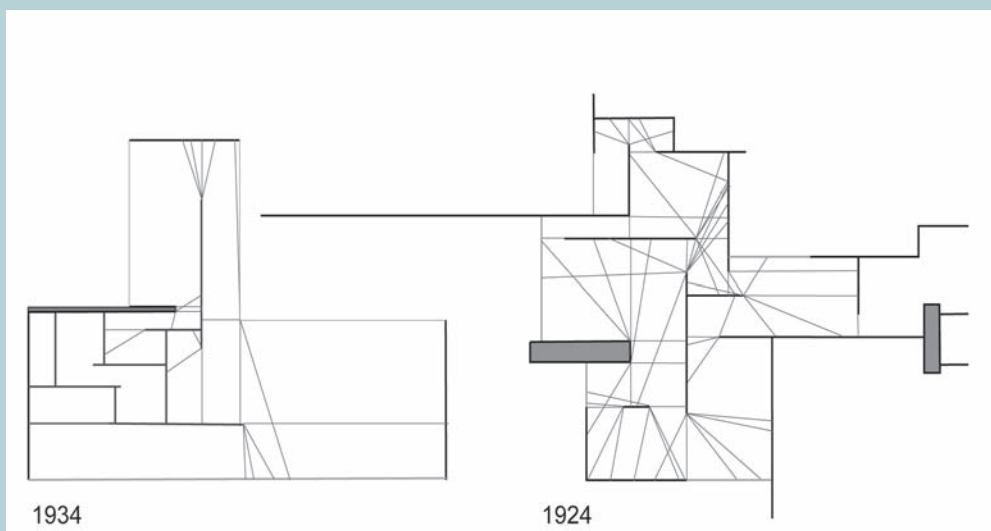


Research shows that regular stair use can help in weight loss and improve health. COA researchers are exploring how stair design and placement can encourage people to use stairs rather than elevators.

## Predicting and managing the risk of mold growth in buildings

Microbial growth is a major cause of Indoor Air Quality (IAQ) problems. In a study of 695 buildings, microbial growth accounted for 35% of the IAQ problems encountered. The implications of mold growth range from unacceptable musty smells and defacement of interior finishes, to structural damage and health effects, not to mention lengthy litigation processes. Mold is likely to occur when a favorable combination of humidity, temperature, and substrate nutrient are maintained long enough. As many modern buildings use products that increase the likelihood of molds, such as paper and wood based products, drywall, and foam ceiling tile, reported cases have increased in recent years. Especially hotels, residential buildings, and courthouses are in the center of the public eye, due to recent high profile litigation cases and increasingly voiced occupant complaints.

Despite decades of intensive research efforts to prevent mold, modern buildings and residences continue to suffer from mold infestation. The main reason is that current prescriptive regulations focus on the control of relative humidity only. However, recent research has shown that mold occurrences are influenced by a multitude of parameters with complex physical interactions. The set of relevant building parameters includes physical properties of building components, aspects of building usage, certain materials,



Two plans by Mies van der Rohe showing fragmentation into convex spaces based on the configuration of visible occluding edges. The 1924 plan shows a much higher degree of fragmentation as compared to the 1934 one, illustrating very different qualities of the internal space in what are otherwise seen as comparable examples of free-plans.



## Physical Activity by Design

The US is facing an epidemic of diseases related to obesity and physical activity. According to the National Centers for Disease Control and Prevention over 200,000 Americans die each year because we do not achieve at least 30 minutes of moderate exercise most days of the week. Faculty and students in the PhD Program have recently initiated several research programs exploring how the design of building sites, buildings and building elements can encourage physical activity. All of these are funded by the Robert Wood Johnson Foundation (RWJF).

Craig Zimring and PhD students Anjali Joseph, Gayle Nicoll and Sharon Tsepas co-authored a paper in a February 2005 supplement to the American Journal of Preventive Medicine, entitled "Influences of Building Design and Site Design on Physical Activity: Research and Intervention Opportunities." The authors found that most active living research has focused on how city and urban design impacts physical activity; relatively little has focused on how the design of buildings and sites impact physical activity. This is an important area for future research. Craig Zimring and PhD student Sharon Tsepas have recently completed a white paper for RWJF exploring how

public buildings can increase physical activity, and are proposing further research and policy intervention. Zimring and Tsepas reviewed the literature and concluded that public agencies can impact physical activity, by such measures as choosing walkable sites and providing comfortable and useable stairs within buildings.

Zimring and Tsepas surveyed several high-level state and federal officials, and found considerable interest in active living and a desire for case studies and best practice examples.

The importance of encouraging physical activity through design has also resulted in four additional research projects to the PhD Program from RWJF. Ruth Dalton (now a faculty member at the University College London), Craig Zimring, and Anjali Joseph completed a research project in spring 2005, focusing on the role of design and layout in encouraging physical activity for older adults. Working with Lauren Harris-Kojetin and Kristen Kiefer of the American Association of Housing and Services for the Aged's Institute for the Future of Aging Services, the researchers surveyed some 800 continuing care retirement communities in 42 states in the US. They have found that having covered sidewalks and

providing attractive walking destination, can help encourage older residents to be active. Joseph is following up on this work with a RWJF dissertation grant where she will conduct case studies of retirement communities.

Stairs in buildings provide a good opportunity for everyday physical activity. Gayle Nicoll is conducting her own RWJF dissertation grant where she is exploring what design features of stairs, and features of building design and layout, affect users' willingness to use stairs voluntarily. Craig Zimring and PhD student Keith Jundanian are working with CDC epidemiologist Dr Bill Kohl, and California building planner and programmer Cheryl Fuller, to conduct a case study of an innovative state office building in Los Angeles. The building, designed by noted architect Thom Mayne of Morphsis, is the first major office building in the US to use "skip stop" elevators where the main elevator only stop at floors 1, 4, 8 and 12. Able-bodied users are expected to walk up or down to their offices, on an innovative stair that allows views into the building and encounters with others. The research team will do Post Occupancy Evaluations (POEs) on use of the stairs, as well as how this new, and innovative design of stairs, is received by staff and management.

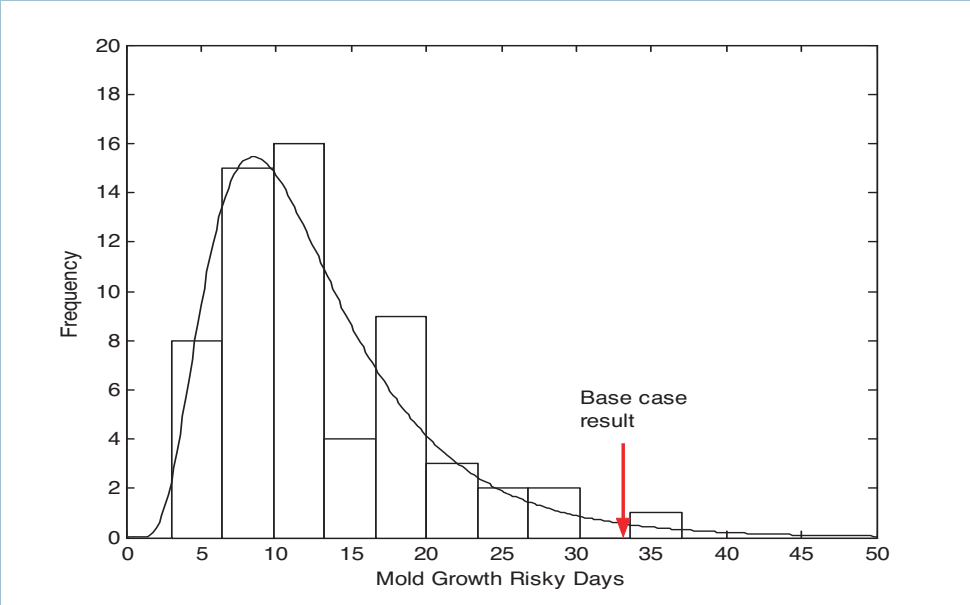
occupant behavior, cleaning regime, HVAC system components and their operation, the local climate conditions, and others. Mold happens mostly as the unexpected result of an unforeseen combination of deviating properties, bad workmanship, uneducated operation of the HVAC to name just a few.

Ongoing PhD thesis research at GA Tech, conducted by Hyeun Jun Moon under supervision of Professor Godfried Augenbroe, has revealed that standard, deterministic mold assessment studies fail to give conclusive results. These simulations are based on "idealizations" of the building and its use, and therefore fail to capture the effect of the random, situational, and sometimes idiosyncratic nature of building use and operation.

The GA Tech team has therefore opted for a radically different approach, based on the assessment of the uncertainties of all parameters and their propagation through a dynamic mold assessment model. This approach generates a mold risk distribution that reveals the probability of mold occur

rence in selected trouble spots in a building. The approach has been tested on the highly contested Hawaii Hilton case, an office building in Miami, the MLK office building in downtown Atlanta and a student dorm at the campus. The figures below show examples of the results using the developed mold risk indicator (MRI) in

the case studies. In all cases the new approach was able to show the circumstances under which mold risk could indeed occur, leading to a set of clear specifications for remediation and, for new designs, to A/E procurement methods that will significantly reduce the mold risk.



An example of the results of the mold risk indicator: Cumulative density functions of the office case and the dormitory case with normalized mold growth risky days



The Building Futures Conference brought senior leaders of the construction industry together with Ph.D. student researchers. Here is Moderator Derish Wolff, Cindy Menches from University of Wisconsin, Dabajyoti Pati and Elif Yagmur of GA Tech and Yoko Saito from University of Michigan.

## The Building Futures Council's First Conference on The Future of the AEC Industry: Engaging the New Generation of Doctoral Students in U.S. Universities

Academic researchers too often attend conferences that only involve other academics. There is a important need to link researchers with people who understand the context of the problems they are working on. On March 16-17, 2005, such a conference was initiated in Las Vegas, Nevada, by the Building Futures Council.

Its purpose was to connect industry with doctoral education in the built environment. Its aim was to explore new ideas, opportunities, directions, and innovations that will impact the practices and technology used by those designing, constructing and managing the built environment. A goal was to create an intellectual pipeline addressing the future of the Architecture, Engineering and Construction (AEC) industry with researchers addressing its problems. The conference was organized by Dean Thomas Galloway, and chaired by Chuck Eastman, Roozbeh Kangari and Linda Thomas-Mobely of the College of Architecture. The Conference Coordinators were Ghang Lee, Research Scientist, and Tarang Taunk, PhD. student and Amy Fields, AGC staff person. The Call for Papers generated fifty-five abstracts from seventeen

universities in the US. Through the blind peer review process, thirty-three abstracts were invited to submit full papers. Twenty-two full papers were received that were reviewed again through the blind peer review process with sixteen selected for presentation.

Two thirds of the reviewers were from the academia and one third were domain experts from industry with many years of experience. Among the papers accepted were four papers by Georgia Tech Ph.D. students, Hans Verheij, Shariar Makarechi, Elif Yagmur and Debajyoti Pati.

Travel expenses for students with accepted papers were paid by the conference. The conference lasted two half days, with a conference dinner and lots of discussion time. In addition, eight of the presented papers were selected for publication in the special issue of the journal *Automation in Construction*. During the conference, three of the presented papers were selected for the Best Paper awards; one was awarded to Hans Verheij, for his paper, "Collaborative Project Planning in Owner-Architect Partnerships". The goal of this event was to facilitate the interaction between the authors and the BFC/AGC members, and eventually between academia and industry. BFC members served as mentors, providing insightful comments or possible sources for data or funding. This was the first for what is hoped to become an annual affair.

## PhD News

### Publications

#### Books

Craig R, Bernard Maybeck at Principia College: The Art and Craft of Building, Gibbs Smith Publisher, Salt Lake City, Utah, 2004.

Malkawi A and Augenbroe G (eds). Advanced Building Simulation, SPON Press, Taylor and Francis Group, 2004.

#### Chapters of Book

Augenbroe G, "A Framework for Rational Building Performance Dialogues," Editors: Kolarevic B and Malkawi A. Performative Architecture, Taylor and Francis, 2004. (Chapter 7, pp. 97-109).

#### Journal Papers

Bafna S, (2005), "Symbolic Content in the Emergence of Miesian Free-plan," *Journal of Architecture*, 10: 181-199.

Butterfield T and Ramseur JH, (2004) "Research and Case Study Findings in the Area of Workplace Accommodations Including Provisions for Assistive Technology: A literature review," *Technology and Disability*, 16(4): 201-210.

Eastman C, Wang F, You S-J, Yang D, (2005) Deployment of An AEC Industry Sector Product Model, *Computer-Aided Design* (in press)

Gharipour M, (2005), "Pure House in Japan and Iran/ A Comparative Study on the Influences of Climate, Social Context and Cultural Behaviour in the Design of Sukiya and Safavid houses," *Architecture Asia*, 4: 71-75.

He W, (2005), "When does a sentiment become an architectural concept? Otherness in Hejduk's Wall House 2," *Journal of Architecture*, 10: 161-180.

Kanekar A, (2005), "From building to poem and back: The Danteum as a study in the projection of meaning across symbolic forms," *Journal of Architecture*, 10: 135-159.

Lee S and Leigh NG, "The Role of Inner-Ring Suburbs in Metropolitan Smart Growth Strategies," *Journal of Planning Literature*, 19(3): 330-46.

Leigh, NG and Lee S, (2004), "Philadelphia's Space in Between: Inner-Ring Suburbs Evolution," *Opolis: An International Journal of Suburban and Metropolitan Studies*, 1(1): 13-32.

Moon H and Augenbroe G, (2004) "Towards a Practical Mold Growth Risk Indicator," *Building Services Engineering Research & Technology*, 25(4): 317-326.



Peponis J, (2005), "Formulation," *Journal of Architecture*, 10: 119-133.

Riecke V, (2004) "Public Construction Contracting: Choosing the Right Project Delivery Method," *Popular Government*, 70(1): 22-32.

Zimring C, Dogan F, Fuller C, Dunne D and Kampschroer, (2005), "The Facilities Performance Evaluation Working Group," W. Preiser & J Vischer (eds.) *Building Performance Evaluation*, New York: Wiley

## Conference Proceedings

Eastman CM, "New Methods of Architecture and Building," *Proceeding of Fabrication: ACADIA 2004 Conference*, Toronto, Canada, February 2005.

Eastman C, Wang F, and Yang D, "Multi-Model User Interface for STEP Model Repositories," *Proceeding of PDES, Inc. Offsite Meeting*, Asheville, March 2005.

Makarechi S, "Real Time Decision Making Techniques for Optimization of Building Performance," *Proceedings of CIB W92*, Las Vegas, February 2005.

Pati D, Park CS, and Augenbroe G, "Roles of building performance assessment in stakeholders dialog in AEC," *Proceeding of the Future of the AEC Industry Conference*, Las Vegas, March 2005.

Rashid M and Zimring C, "On Psycho-social Constructs and Office Settings: A Review of the Empirical Literature" *Proceeding of the Environmental Design Research Association (EDRA) 35 Conference*, Vancouver, Canada, April 2005.

Riecke V, "Public Construction Contracting: Choosing the Right Project Delivery Method," *Proceeding of CIB W92*, Las Vegas, February 2005.

Zhang Y, Augenbroe G, and Vidakovic B, "Uncertainty Analysis in Using a Markov Chain Model to Predict Roof Life Cycle Performance," *Proceeding of 10th International Conference on Durability of Building Materials and Components*, Lyon, France, April 2005.

## Presentations

Ballal T, "Space, Family and Gender in the M'zabite Home," presented at Georgia Tech, March 2005.

Craig R, "Maybeck and Nineteenth-Century Theories of Empathy," presented at Southeastern College Art Conference (SECAC), Jacksonville, FL, October 2004.

Craig R, "Maybeck and the Tradition of Reptons Red Books: Painting with Plants in the Creation of a Picturesque Architecture," presented at Southeastern Society of Architectural Historians (SESAH), Knoxville, October 2004.

Craig R, "Bernard Maybeck: From Arts and Crafts to Pioneer Brutalism," presented at Georgia Institute of Technology, February 2005.

Craig R, "Maybeck's Principia: From Arts and Crafts to Pioneer Brutalism," presented at Savannah College of Art and Design (SCAD), September 2005.

Fernandez-Solis JL, "Building Construction Challenges and Capacity for Change," the 5th International Postgraduate Research Conference of the University of Salford, UK, April 2005.

Ho CH, Eastman C, "How Strategies and Representations Influence Design Spatial Problem Solving," AAAI 2005 Spring Symposium--Reasoning with Mental and External Diagrams: Computational Modeling and Spatial Assistance, California, March 2005.

Hobson DD, "1705/6: The Dwellings of the English Colony of St. Christopher's Island (St. Kitts, Leewards, West Indies)," presented at the SESA Conference, Knoxville, Tennessee, October 2004.

Keel TM, "Life Cycle Costing and R.O.I. for the Commercial Building Owner," *BuilConn Americas, Building Systems Conference*, Dallas, March 2005.

Joseph A, "Where People Walk: Assessing the Relationship Between Physical Environmental Factors and Walking Behavior of Residents in Retirement Communities," *Active Living Research Conference*, San Diego, April 2005.

Lee G, Eastman C, "Standards Development in the Architecture/Engineering/Construction Domain," *PDES, Inc. Offsite Meeting*, Asheville, March 2005.

Makarechi S, "Building Simulation Assisted (BSA) Global Optimization Systems (GOS) Using Real Time Information (RTI) and Predictive Feed Forward Control (FFC) Strategy," *The First BFC Conference on The Future of the AEC Industry*, Las Vegas, March 2005.

Pati D, Park CS, and Augenbroe G, "Roles of Building Performance Assessment in Stakeholders Dialog in AEC," *The First BFC Conference on The Future of the AEC Industry*, Las Vegas, March 2005.

Pati D and Zimring C, "Interfacing E-B Research and Building Design: Revisiting POEs through a Conceptual Modeling Approach within the Performance Framework," *EDRA 35 Conference*, Vancouver, Canada, April 2005.

Pati D, Invited speaker in the Courts Technology Track at Delivering Design Excellence in Justice Architecture, Organized by the American Institute of Architects, Chicago, October 2004.

Pati D, Invited speaker in the PBS Capital Construction Conference, Organized by the Office of Chief Architect, GSA-PBS, Miami, March 2005.

Peponis J, Invited keynote speaker at the First International Conference on E-Design organized by the Arab Society for Computer Aided Architectural Design in the King Fahd University of Petroleum and Minerals, Saudi Arabia, March 2005.

Peponis J, Invited to lecture at the Taubman College of Architecture and Urban Planning, University of Michigan.

Rashid M, Zimring C, "A Comparative Analysis of the Effects of Spatial Layouts on Behaviors in Cellular and Landscape Type Open-Plan Offices: Movement, Visible Co-presence and Face-to-face Interaction Considered," presented at the Environmental Design Research Association (EDRA) 35 Conference, Vancouver, Canada, April 2005.

Rashid M, Craig D, and Zimring C, "Integrating Linear and Point-Based Behavioral Observation Techniques to Study Complex Behavioral Settings," presented at the Environmental Design Research Association (EDRA) 35 Conference, Vancouver, Canada, April 2005.

Rashid M, Zimring C, "Individual Work Styles, Intra-Organization Networks, and Perceived Work Place Satisfaction," Invited presentation at the Workplace Intensive Session, Environmental Design Research Association (EDRA) 35 Conference, Vancouver, Canada, April 2005.

Riecke V, Panelist for State Public Policy, The 2005 Midwest Political Science Association National Conference, Chicago, April 2005.

Verheij H, Augenbroe G, "Collaborative Project Planning in Owner-Architect Partnerships," *The First BFC Conference on The Future of the AEC Industry*, Las Vegas, March 2005.

Yagmur E, Eastman C, "Automated Construction Scheduling & Cost Estimation for Designers," *The First BFC Conference on The Future of the AEC Industry*, Las Vegas, March 2005.

Zimring C, Seminars on architectural research, Ph.D. Program, North Carolina State University School of Architecture, Raleigh, November, 2004.

Zimring C, Invited Plenary Speaker, Health Design 2004, Houston, November 2004.

Zimring C, Featured Speaker, American Society of Health-System Pharmacists Midyear Clinical Meeting, Orlando, December 2004.

Zimring C, Featured Speaker, Second International Conference on Patient- and Family-Centered Care, San Francisco, February 2005.

### Honors and Awards

Augenbroe G and Hensen J, Guest Editorship Special Issue, Journal: Building and Environment, 39(8), August 2004.

Fernandez-Solis JL, Awarded the Presentation in the 5th International Postgraduate Research Conference of the University of Salford, Salford, UK, April 2005.

Hensen J and Augenbroe G, Guest Editorship Special Issue, Journal: Energy and Buildings, 36(8), August 2004.

He W, AIA Research Fellowship to extend the work documented in her thesis: "Flatness Transformed and Otherness Embodied: A study of John Hejduk's Diamond Museum and Wall House 2," March 2005.

Keel TM, Chairman of the CABA Intelligent & Integrated Building Council (IIBC), Task Force studying the Life Cycle Cost of Intelligent and Integrated Buildings, the CABA IIBC Roundtable Event, Orlando, January 2005.

Rashid M, Awarded for Research integration for his work in applying Space Syntax to the study of work environments under funding from the General Services Administration, The College of Architecture, April 2005.

Shakourian A, Urban Land Institute Atlanta Fellowship, March 2005.

Sundquist E, Awarded the American Planning Association Transportation Planning Division Student Paper, APA Annual Meeting, San Francisco, March 2005.

Riecke V, Awarded Best Presentation in the CIB W92 International Symposium on Procurement, Las Vegas, 2005.

### Other News

Eduardo Lyon, work was published in "Go Direct to Fabrication and Cut-out the Middleman" in Architecture Magazine, December 2004: 101. Eduardo Lyon's research is focused on design for manufacturing (DFM) in architecture.

Eric Sundquist, has been appointed to the Planning Commission in the City of Decatur. In February, he began a three-year term as one of seven members on the commission. The Planning Commission reviews projects that require variances of the city's zoning and design regulations. This year, it is also supervising the revision of Decatur's comprehensive plan.

Sugie Lee, got a tenure-track assistant faculty position at the Maxine Goodman Levin College of Urban Affairs at Cleveland State University in August 2005.

Weiling He, got a tenure-track assistant faculty position at the College of Architecture, Texas A&M University in August 2005.

Ermal Shpuza, got a tenure-track assistant faculty position at the College of Architecture, Texas A&M University in August 2005.

## Alumni News:

Manu Sobti defended his Doctoral Dissertation in Sept. 2004. He is currently Assistant Prof. at the School of Architecture, Southern Polytechnic State University and Instructor, College of Architecture in Georgia Tech. His ongoing projects include the research and development of an Urban Design Curriculum (comprising of design studios and seminar courses) for the School of Architecture, Universidad de Especialidades Espiritu Santo in Guayaquil, Ecuador, and the editing of a forthcoming publication on the Nomadic Architecture of Asia.

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