

Connecting—Crossroads of Digital Discourse October 23.24.25.26
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Indianapolis Ball State University Kevin R. Klinger, Conference Chair

ACADIA KEYNOTE:
Doug Garofalo, Garofalo Architects, Inc.
Chris Sharples, ShoP/ Sharples, Holden, Pasquarelli

ACADIA Keynote Panel

Branko Kolarevic, *University of Pennsylvania*, - **moderator**
Doug Garofalo, *Garofalo Architects, Inc., Chicago, IL*
Chris Sharples, *ShoP, Sharples, Holden, Pasquarelli, New York, NY*

“org” Summit: Crossroads Panel

Kevin R. Klinger, *representing ACADIA, ACADIA President-elect 2004, Ball State University*, - **moderator**
Julio Bermudez, *representing SIGraDi, University of Utah*
Bob Martens, *representing eCAADe. CUMINCAD, Vienna University of Technology*
Brian Sinclair, *representing ARCC, Dean, Faculty of Environmental Design, University of Calgary*
Lisa Tilder, *representing ACSA, ACSA EC Director. the Ohio State University*
Beverly Willis, *representing ARI, Director, Architecture Research Institute, Inc.*
Nancy Cheng, *representing AIA, Technology in Architectural Practice(TAP), University of Oregon*

Digital Discourse Panel

Mahesh Senagala, *University of Texas San Antonio* - **moderator**
Alfredo Andia, *Florida International University*
Julie Flohr, *Garofalo Architects, Inc., Chicago, IL.*
Yu-Tung Liu (Aleppo), *National Chiao Tung University, Taiwan, President CAADRIA*
Cristiano Ceccato *Research & Development, Gehry Partners, LLP. - Gehry Technologies, LLC.*
Brian Lonsway, *Director, Informatics and Architecture, Rensselaer Polytechnic Institute*

Digital Pedagogy Panel

Nancy Cheng, *University of Oregon*
Gregory A. Luhan, *University of Kentucky;*
George Proctor, *California State Polytechnic University, Pomona*
Thomas Seebohm, *University of Waterloo;*
Aron Temkin, *Florida Atlantic University;*

Digital Press Panel

Mike Bordenaro, *Architectural Writer*
Chris Sullivan, *Editor-in-Chief, Architecture Magazine*
Kevin Matthews, *Editor-in-Chief, ArchitectureWeek.com, Artifice, Inc.*
Deborah Snoonian, *Senior Editor, Architectural Record*

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Peter Anders, MindSpace.net, CAiiA-STAR.

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21 Undo Reinterpreted Wilson Chang, Robert Woodbury, Simon Fraser University

The class of operations known as *undo* has proven to be a valuable addition to most professional work tools. In practice though, its use is frustrating: *undo* often undoes too much. Its essential informal semantics are that it returns the user to a prior state by recapitulating all intervening states. Why not give the user greater control over which aspects of a design to undo? An alternative is to seek to reuse prior work in any logically-coherent pattern—user input is a precious commodity. The area of generative systems provides insights in a search for alternatives to undo, in particular that prior user and system actions can be changed and reused in new contexts. We contingently introduce a concept we label as *design promotions* to describe system designs that demonstrate a tight coupling between interactive authorship and system-led generation, that treat past user actions as valuable intentional statements, and that treat alternative user choices as first-class objects of concern. In practice these three properties emphasize reuse. We briefly survey the current state of *undo*-like operations and potential candidates for implementing design promotions strategies. Through examples, we demonstrate approaches to realizing *undo*-like operations over specific representations, especially that of constructive solid geometry.

80 Process and Individuation: Designing for Controlled Indeterminacy R. Shane Williamson, University of Toronto

Through the presentation of the design of a memorial, this paper intends to introduce an iterative design process that incorporates particle-based animation, parametrically constrained operations, and a variety of rapid-prototyping techniques. This is a project rooted in the generation and interpretation of physical artifacts dependent upon both the generative potential of digital media and the subjective modifications associated with design authorship.

90 The Parametric Bridge: connecting digital design techniques in architecture and engineering Andrew Maher, Mark Burry, RMIT University

This paper describes a practice-led research project that investigates the application of digital modelling and communication technologies in urban and architectural design. The project is being carried out by our team with the collaboration of the architecture and planning departments at local borough council and local community participation. The main methodology for the project revolves around the evolution of an interactive three-dimensional digital urban model, which incorporates a variety of visual, graphic and numeric data. This digital model is utilised within a web site to help facilitate a participatory approach to the physical and social regeneration of an inner urban zone, in terms of both the built environment and the attempted creation of a virtual community.

57 VIRTUREALITY: Digital Urban Modeling as a Community Design Form Adrian Dobson, Peter Lancaric, University of Luton

This paper describes a practice-led research project that investigates the application of digital modelling and communication technologies in urban and architectural design. The project is being carried out by our team with the collaboration of the architecture and planning departments at local borough council and local community participation. The main methodology for the project revolves around the evolution of an interactive three-dimensional digital urban model, which incorporates a variety of visual, graphic and numeric data. This digital model is utilised within a web site to help facilitate a participatory approach to the physical and social regeneration of an inner urban zone, in terms of both the built environment and the attempted creation of a virtual community.

digitalfabrication

13 Function Follows Form: 10 Sticks (and a Bench) Mark Cabrinha, California Polytechnic State University, San Luis Obispo

While the introduction of digital media in the design studio often emphasizes virtual realms, the affect of new fabrication technology on the architect brings the architect back to the realm of master-builder rather than distancing the architect from reality. While purely digital projects have pushed the development of form, they have also placed an emphasis on form over material. However, with the intention to physically build a project, the connections between process, form, and material become intertwined. The inception of this project also served as a clear reminder that the tools we use affect the way we think. This project began as a simple idea: how a column becomes animated to form an arch over time. The digitization of this idea took literally minutes in Maya, was exported and further modeled in AutoCAD, and then rendered and reanimated in 3d Studio-Viz. This project was a very brief, two-week introductory project, on a class on drafting and wood light frame construction. It served to make a greater connection between digital media, the design process, analog drawing, and the role of craft and material.

24 Digital architecture - What would 6000 points turn out to be? Naai-Jung Shih, National Taiwan University of Science and Technology

This paper presents students' fulfillment of an assignment that explored the concepts of digital architecture using rapid prototyping (RP) process. A point cloud was given to students and different representational data were substantiated as real 3D physical models. The presence of RP models and the sequential illustration of working steps in their reports revealed that the control of shapes often differed from what students perceived in VR worlds. The results thus confirm that physical models are useful for visualization as well as in design pedagogy.

81 Fabrication of partially double-curved surfaces out of flat sheet material through a 3d puzzle approach Axel Kilian, Massachusetts Institute of Technology

The topic of this paper is connection of digital modeling with generative programming and rapid prototyping, to produce physical sketch surface models. The physical surface models are assembled out of developable strips connected through a puzzle-like detail. The use of programming as a design approach allows the generation of connection details that corresponds to the rules of flat sheet rapid prototyping techniques of laser cutting and water jet cutting. With numerically controlled cutting there is no need to keep the joint detail related to manually achievable forms or to apply a standardized dimension. This paper demonstrates the possibilities of programming to generate cutting geometries that adapt to the local surface properties. The larger perspective of the research approach is the question of how to formulate and capture design intention through programming. What influence does the use of generative modeling in combination with rapid prototyping have on the design language of physical objects?

39 Using Actuated Tensegrity Structures to Produce a Responsive Architecture Tristan d'Estrée Sterk, The School of The Art Institute Of Chicago

The major theoretical roots of responsive architecture lie within the work of Nicholas Negroponte, and its most inspiring realization, to date, is found in the work of dECOi Architects, while the work of NOX, and Diller & Scofidio provide two other built examples of responsive architectures. Each of these works is impressive within its own right. However, all of them have their shortcomings, suggesting that several possibilities for alternative visions still exist. While Negroponte's work identifies the characteristics of a responsive architecture, it does not propose a model that is suitable for implementation. On the other hand, the work of dECOi architects does not address the technical needs of a building envelope designed for real world conditions of weather and structural load. Diller & Scofidio's work also does not have a functional envelope, and NOX's work lacks physical responsiveness, favoring a palate of virtual responses instead. This paper, after examining the four specific precedents of Negroponte, dECOi, Diller & Scofidio, and NOX, will examine how a fifth precedent—that of Buckminster Fuller's model of tensegrity structures—may be applied. The paper will propose that by actuating a tensegrity structure a responsive architectural envelope that addresses real world weather and structural loading conditions becomes feasible.

digitalpedagogy *Digital Curriculums: Effective Integration of Digital Courses*

19 Collaborative Design Process Simulation Game Yehuda E. Kalay and Yongwook Jeong, University of California, Berkeley

Collaboration is an important aspect of the architect's education. However, it is not amenable to the traditional project-based learning pedagogy that works so well for developing form-making skills. Being a process, rather than a product, it cannot be revealed by judging the results alone, which is often how form-making skills are taught and judged. Rather, the process of collaboration is only evident when the number of the participants exceeds a certain threshold, and when actions taken by other participants affect an individual's on-going design decisions. The advent of on-line, multi-player simulation games provides an analogy and an opportunity to explore interactive collaborative design pedagogies. Their abstract nature helps focus attention on the core issues of the simulated phenomenon, while the playful nature of a game, as opposed to 'work,' encourages immersion and role playing that contribute to the learning process. This paper describes an on-line game for simulating the design collaboration process. It espouses to simulate, exercise, and provide a feel for the social dimension of collaboration, by embedding mutual dependencies that encourage players to engage each other—in adversarial or collaborative manners—to accomplish their goals. Specifically, it is intended to help students understand what

collaboration is, why it is necessary, and how it is done. The game is modeled after popular board games like Scrabble and Monopoly: players build 'houses' made of colored cubes on a site shared with other players. Actions taken by one player immediately affect his/her neighbors. A carefully constructed set of rules awards or deducts points for every action taken by a player and by his/her neighbors. The rules were constructed in such a manner that players who collaborate (in a variety of ways) stand to gain more points than those who do not. The player with the most points 'wins.'

49 Exploring Playful and Effective Digital Design Process with Games: A Framework for Digital Design Studio Teaching and Learning Pei-Ling Wu, National Chiao Tung University

The idea of developing a framework, which integrates design studios and computer graphics, is derived from the nature of architectural design, which has always combined creativity and technology. Furthermore, as computers are being increasingly used in design studios, a systematic digital pedagogy, which can take advantage of the strengths of computers in all stages of design, should be developed simultaneously to facilitate learning. This paper attempts to propose a playful and effective digital design process that can be flexibly applied to computer-based design studios and design-based computer graphics courses. The pedagogical framework is based on a set of digital design games that follows a general design process presented by the author. First, the components of digital design games will be defined and the relations of those game components will be clearly depicted. Then, a framework will be proposed, followed by the use of an example demonstrating applications of the framework. Continual advancements in digital technology have created generation gaps amongst teachers of architectural schools. A structured digital design process can help teachers, with varying levels of computer-capabilities, know how, when and what needs to be adjusted in order to achieve the goal of digital design education.

60 An Inductive Approach to Digital Modeling Instruction Kyle Talbott, University of Wisconsin - Milwaukee

An argument is presented for respecting the student's process of inductive reasoning in introductory digital modeling instruction. The inductive education methods of Montessori and VanDamme are reviewed and relevant portions are applied to the problem of digital modeling instruction. Two primary concerns are presented – 1) the need to systematically reorient the student from the physical world to the digital world and 2) the need to sequence the presentation of introductory concepts according to logical dependencies inherent in these concepts. Five principles of inductive digital modeling instruction are established, which could act as the basis for a teaching method that reduces alienation among apprehensive students, eases the transition from traditional media for veteran designers, and speeds comprehension of core concepts of digital making.

digitalpedagogy Connected Courses: Methods of Network Communications

84 Requirements for an Effective Distributed Design Review Wassim Jabi, Brian Johnson, Glenn Goldman, New Jersey Institute of Technology

With the wider availability of high-bandwidth communication networks and the maturity of commercial collaboration software, schools of architecture are experimenting with computer-aided distributed design reviews. A distributed design review enables geographically-distant participants to discuss a common design project using computer-supported collaborative technologies such as videoconferencing, voice over IP, and shared applications. While potentially beneficial to students, and attractive to teachers, there are a number of challenges facing the integration of synchronous distributed design reviews into the design studio by technically inexperienced faculty without significant technical support. This paper seeks to make it easier for faculty to make routine utilization of such reviews by examining our own experiences with a number of such reviews, in a variety of contexts, distilling out a set of guidelines for future reviews.

92 Case Study of Tacit Knowledge Sharing In a Distributed Design Studio Jeong-Han Woo, Mark Clayton, Robert Johnson, and Benito Flores, Texas A&M University

This paper demonstrates the effects of experts' tacit knowledge on improving architectural students' design artifacts in a distributed design studio. In geographically distributed design environments, the Internet is an important medium by which architects can share tacit knowledge in the form of dialogue via online communication technologies, such as online chat and Instant Messaging (IM). In spring 2003, the National Aeronautics and Space Administration (NASA) and 8 schools conducted a collaborative design studio to develop a crew restraint system for space flights. Online chat software was used as a primary communication channel. Throughout the entire design studio, NASA professionals served as knowledge holders while undergraduate students participated as knowledge seekers. An interpretive content analysis and case study methodology were used in this study. We qualitatively observed the interactions between NASA and the students based upon two aspects: knowledge reflection and design improvement. Data were collected using document analysis of all knowledge sources and students' design artifacts. The findings of this study indicate that the online chat system is useful in sharing tacit knowledge for the early part of design processes in a distributed design environment. Experts' tacit knowledge appears to not only influence how students understand problems, but how they initiate conceptual design. This study provides empirical evidence regarding tacit knowledge sharing, and strengthens Schon's (1983) claim about knowledge reflection in design studio. Furthermore, this study introduces architectural practitioners to the practical necessity of tacit knowledge sharing. This study is significant, because its findings indicate the appropriate knowledge management strategy for architectural practitioners.

105 Appropriate Levels of Access: An Empirical Study on the Availability of Computers in Studio Matthew Bernhardt and Beth Blostein, The Ohio State University

One of the most significant technological challenges facing architecture schools today is how to provide an appropriate level of access

to computing resources. As the computer has become a significant tool in the study and practice of architecture, students need to have access to that tool in order to further their studies. But in facing this question of access, what is “appropriate”? Is there such a thing as too much access? Is 1:1 access—a computer for every student—the minimum level of access that schools and students should accept? Or is there a point beyond which more resources just means more waste; computers sitting idle and unused, or students using the computer for unproductive ends? These questions were the subject of an experimental series of studios in the spring of 2002, wherein three studios were given varying numbers of computers for a term. The use of these computers was then tracked, and compared with previous terms. In tandem, the quality of work produced by these three studios was compared. While additional experiments are most likely needed to draw firm conclusions, the results of this experiment seem to support defining “an appropriate level of access” at less than 1:1.

digitalpractices

33 Towards Comprehensive Space: A context for the programming/design of cybrids Peter Anders, CAiiA-STAR, University of Plymouth

Cybrids have been presented as mixed realities: spatial, architectural compositions comprised of physical and cyberspaces (Anders 1997). In order to create a rigorous approach to the design of architectural cybrids this paper offers a model for programming their spaces. Other than accepting cyberspaces as part of architecture’s domain this approach is not radical. Indeed, many parts of program development resemble those of conventional practice. However, the proposition that cyberspaces should be integrated with material structures requires that their relationship be developed from the outset of a project. Hence, this paper provides a method for their integration from the project’s earliest stages, the establishment of its program. This study for an actual project, the Planetary Collegium, describes a distributed campus comprising buildings and cyberspaces in various locales across the globe. The programming for these cybrids merges them within a *comprehensive space* consisting not only of the physical and cyberspaces, but also in the cognitive spaces of its designers and users.

51 The Level of Knowledge of CAD Objects within the Building Information Model Magdy Ibrahim, Robert Krawczyk, Illinois Institute of Technology

The first generation of CAD software depended on entity objects that were manipulated and interpreted by the user as meaningful graphics symbols. These entities only represented the geometrical properties of the architectural elements. With the present emerging generation of CAD systems, a new concept shifts a drawing based model into a Building Information Model with the potential of modeling true architectural objects. These CAD objects will theoretically, provide all related data to the designer describing the geometry, as well as, any related data associated with how the object is actually used. The knowledge required to support an object should have structure to it. Different levels of knowledge need to be included, such as the geometrical information, which should be flexible enough to accommodate any type of shape and modification to it while keeping the integrity of the object as a unit and maintaining its relations to other objects. The CAD object concept, as remarkable as it is, might also have potential problems. It has some implications over the design process, as well as the architectural profession itself.

54 Digital Innovation and Organizational Change in Design Practice Robert E. Johnson, Eberhard S. Laepple, Texas A&M University

The real estate and construction industry is among the largest industries in the world. It also is one of the most fragmented industries, with few economies of scale and historically low productivity. Recent technological advances in the use of information and communication technology have the potential for dramatically improving construction productivity. But substantial organizational barriers exist that inhibit the effective adoption of these technologies. This research project (in progress) examines the practices of selected, innovative firms in order to develop an in-depth understanding of the factors that have influenced the effective adoption of information and communications technology in the design and construction industry, and, potentially, provide examples that may provide prototype models for an alternative, future organization of the AEC industry.

69 FORM FOLLOWS SOFTWARE Pierluigi Serriano, University of California, Berkeley

Software selection affects design outcome. Computer applications externalize in their graphical interface and in their internal logic a set of assumptions about how objects are constructed and space is represented. Accessibility of tools is in direct correlation with their rate of use. Depending on how user-friendly particular functions are, their use will appear with higher frequency than those foreign to the technological frames of the user groups for which software is designed. As each software is geared towards the needs of specific communities, it replicates in digital fashion those disciplinary practices already present in the analog world. However modeling results are bracketed at its inception the very moment a particular 3D package is chosen from a diverse array of digital offerings. If the application adopted is designed to appeal to the computer animation industry, the modeling results will bear the imprint of those organic qualities: buildings will appear character-like. Since computer programs have built-in slant meant to aid disciplinary specific users, they yield families of designs with formal commonalities. Unquestionably, proficiency of software use also broadens inventiveness of design. Nevertheless some applications make particular transformations harder to achieve, and as a result will be likely to exclude those modeling options from architects’ imaginary world.

12 Development of a Knowledge-Rich CAD System for the North American Precast Concrete Industry Charles Eastman, Ghang Lee, Georgia Institute of Technology; Rafael Sacks, Israel Institute of Technology

The downstream production sectors of the construction industry are developing powerful parametric modeling design and engineering tools for fabrication modeling. This paper reports an effort by the North American precast concrete industry toward developing such

tools. Some implications for architectural design and practice are outlined.

digitalrepresentation

22 To proceed analysis of dynamic virtual environment by using physical model as a protagonist Chien-Hung Shih, National Chao-Tung University, Taiwan

This paper intends to combine architecture with state-of-the-art software technologies and operational methods of other domains to free architectural rendering from the restrictions of cold, still graphics or unrealistic computer picture. The author transforms physical models into digital models through industrial design software, and synthesizes these digital models into motion pictures of the environment via film production software. This way, a designer can effectively turn the ideas of his mind into rough handmade models, instead of spending enormous amounts of time building computer models, and viewers will be able to quickly grasp the conditions of the site through the motion pictures.

62 Seeing Architecture with a Filmmaker's Eyes Aron Temkin, Florida Atlantic University

Where do the methods of architectural communication cross over to other disciplines? As digital tools provide greater opportunities to communicate pre-built design in both space and time, in motion and in video, how should our methods of presentation (and therefore our method of seeing) evolve to meet this need? While filmmaking is a much younger art form than architecture, it is already much wiser with regard to motion-based presentation. If we are to evolve beyond the unsophisticated motion of the average fly-through animation, we need to develop a process of seeing and composing in time that better relates to the way we perceive temporal space. A well-edited film detaches us from the confines of the medium: we do not think about how many cameras are used in a scene if it is filmed (and edited) in a manner that is natural to the way we see and perceive. Where can the filmmaker's art inform an architecture student's processes of presentation and design? This paper will discuss ways that filmmaking can be used to inform the process of architectural design and animation with specific examples from the work of our advanced digital media course.

95 Digital Exploration of Unbuilt Architecture: A Non-Photorealistic Approach Daniela Sirbu, University of Lethbridge

This paper presents a new approach to the digital investigation of unbuilt architecture. A navigable world, emulating the architect's graphic style, is built as a 3D non-photorealistic reconstruction of the unbuilt project. A cinematic journey through this world intermediates the exploration of the architect's possible mental visualizations during the creative stages. The goals of the proposed approach are: to open new avenues for investigating the conception of architecture, to help architectural students visualize and experience important unbuilt projects that have shaped the practice of architecture, and to popularize less-known architects to the general public. The approach stems from the idea that architectural drawings are the artifacts reflecting most accurately the architect's creative and thinking processes. Anchored in the concept of multi-dimensional space developed by the author, the proposed method uses the original drawing of the artist as the main artifact on which the reconstruction process is based. The present paper concentrates on those aspects related to extracting information from the architect's drawing and embedding historic knowledge in the 3D reconstruction of the unbuilt project. It calls to attention the idea that technological progress creates tools that the Architect uses to operate with the fundamental concepts of place, space, and time.

56 Architectural design and digital paradigm (from Renaissance models to Digital Architecture) Paolo Fiamma, Università di Pisa

The means of expression have always affected our ways of thinking. Designers, who have to interpret signs, languages, and evolution in order to translate into an organised "form" the recurring problems and values of mankind, have left thoughts, projects and wishes to the study of representational techniques. In this way, they have also disclosed a unique view of reality and at the same time a "way of being" towards the meaning of design itself. In the relationship between architecture and representational techniques, Brunelleschi said that "perspicere" was no longer just the science of optics, but also the science that contained the lines of research on geometry and shape that he was the first to exploit in design. Centuries later, in the axonometric representation advocated by De Stijl and intended for factories and industries, the object, shown in all its parts, easy to reconstruct even in the space to which it referred, revealed with extreme clarity the mass-production building and assembly materials and systems. Digital representational media make a great entrance in the heuristic process, invalidate all signs, and promote its quality. The result is an ever-changing, computerised architecture, dominated by curvilinear, wavy shapes that flow from a generative process made of the deformations, additions, and interference of different volumes.

digitalthinking

85 Deep-Time Probe Investigations in Light Architecture Gregory A. Luhan, Dr. Suketu Bhavsar, Dr. Bruce L. Walcott, University of Kentucky

This paper presentation presents an interdisciplinary research project conducted by a design team comprised of faculty from the Colleges of Architecture, Engineering, and Astrophysics. The title of the project, Deep-Time Probe, Investigations in Light-Architecture, explores the use of an optically active-SETI experiment that centers on the thematic of time, vision, and movement through space. The realm of architecture was the digital glue that united the varied disciplines. The core of the project is broken down into three intrinsically

linked components—data representation—collection, storage, and modulation; the Project Mission Wall; and the resultant Light Architecture or Deep-Time Probe. A small team of architecture students under the direction of one architecture faculty member designed the Mission Wall while the Robotics Department provided CNC machinery to digitally mill and fabricate its components. This same team assembled the 40'x60'x15' structure in one day. The site of the launch created an adequate interface for the public art structure at the scale of an urban park. The scale of the Mission Wall addressed a variety of places, paces, and scales that mediated between the laser, the context of the surrounding plaza, and pedestrian and vehicular circulation, all while concealing the laser from direct view. The Mission Wall served three functions. It provided a housing for the Deep-Time Probe laser. It created windows and scaffolding for lighting. Moreover, it established a series of "View Corridors" that provided the onlooker with multiple vantage points and thus multiple-readings of information as architecture. Nearly fifty "Time Probe Reporters" gathered information through oral interviews. In addition to messages linked to the interviews, the Deep-Time Probe contained verbal and graphic information, images depicting the design and fabrication processes. At the time of the launch, the design team digitized, specially formatted, converted, and modulated the data into a special high-powered laser that was "launched" into space. An advanced civilization in the universe could theoretically receive and decode this information. The Deep-Time Probe project visualized the strengths of each profession, fostered the creative aspects of each team member, and resulted in a unique and dynamic experience. The deep time probe is right now passing through the Oort Cloud, the debris left over from the formation of our Sun and planets, present as a halo surrounding our solar system . . . a distance of nearly 1.5 trillion miles.

4 Representing Architectural Design Using a Connections-based Paradigm Ganapathy Mahalingam, North Dakota State University

Any *making*, including a work of architecture, is synthetic in nature and is made by making connections. To base the core of a computational representation of architectural design on *connections* is to base it on the very core of making. The articulation of the core of architecture, its architectonics, should be based on articulating its connections. This paper probes how connections can serve to represent architectural design. A paradigm consists of a core cluster of concepts that, for a time period, provides a framework to articulate the issues and problems facing a field and to generate solutions. This paper offers a connections-based paradigm to represent architectural design computationally. A number of connections-based strategies for the representation of architectural design have emerged. Modeling frameworks that have been identified include dendograms, bipartite graphs, adjacency graphs, plan graphs, planar graphs, Hasse diagrams, Boolean lattices, and Bayesian networks. These modeling frameworks have enabled the representation of many aspects of architectural design. Is it possible to extract a uniform modeling framework from all these frameworks that enables the computation of architectural design in all its aspects? Using biological analogies, will an integration of these modeling frameworks provide the 'molecular' structure of a 'DNA' that makes up the architectural 'genome'? This paper will attempt to answer these questions.

7 On the Limitations of Shape Grammars: Comments on Aaron Fleisher's Article "Grammatical Architecture?"

J. Michael Gerzso, Boulder, Colorado

Shape grammars were introduced by Gips and Stiny in 1972. Since then, there have been many articles and books written by them and their associates. In 1992, Aaron Fleisher, a professor at the School of Planning, MIT, wrote a critique of their work in an article titled "Grammatical Architecture?" published in the journal *Environment and Planning B*. According to him, Gips, Stiny and later Mitchell, propose a hypothesis that states that shape grammars are presumed to represent knowledge of architectural form, that grammars are "formable," and that there is a visual correspondence to verbal grammar. The strong version of "the hypothesis requires that an architectural form be equivalent to a grammar." Fleisher considers these hypotheses unsustainable, and argues his case by analyzing the differences between language, and architecture, and by dealing with the concepts of lexicons, syntax and semantics. He concludes by stating that architectural design is negotiated in two modalities: the verbal and the visual, and that equivalences are not at issue; they do not exist. If there is such thing as a language for design, it would provide the means to maintain a discussion of the consequences in one mode, of the state and conditions of the other. Fleisher's observations serve as the basis of this paper, a tribute to him, and also an opportunity to present an outline to an alternate approach or hypothesis to shape grammars, which is "nonlinguistic" but "generative," in the sense that it uses production rules. A basic aspect of this hypothesis is that the only similarity between syntactic rules in language and some rules in architecture is that they are recursive.

32 Cynergies: Technologies that Hybridize Physical and Cyberspaces Peter Anders, CAiiA-STAR, MindSpace.net

This paper presents ways in which cybrids depend for their technology upon three existing models of architectural hybrid: display space, environmental computing, and augmented/mixed reality. Cybrids bring these techniques together into a synergistic whole that depends as much on the observer for its consistency as it does on its comprising technologies. This synergy is a product of corroborative behavior between different modes, which provide cybrid users with a coherent social/spatial experience. The paper notes cybrids' similarity to theater, not only for their technological dependency, but also for the tacit yet vital role of the observer in their effect.

digitaltools

27 A Parametric Approach to the Design of a Tensegrity Vaulted Dome for an Ephemeral Structure for the 2004 Olympics

Katherine A. Liapi and Jinman Kim, The University of Texas, Austin

Tensegrity, defined as "tensional integrity," is central to the design of a semi-open exhibition space that was submitted as an entry to the international competition for the design of "Ephemeral Structures for the City of Athens," in the context of the 2004 Olympic Games.

The main feature of the proposed exhibition space is a vaulted dome composed of interconnected detachable and deployable tensegrity units. The most challenging aspect in the design of the tensegrity vault was the generation of alternative spatial configurations for form exploration and study. For this purpose a mathematical code has been developed that links all the parameters that affect the design of tensegrity vaults. The code also allows for the parametric graphical generation of the vault by displaying geometric information in a 3D environment. This paper discusses the geometric basis of the code and its usefulness in the morphological study of the tensegrity vaulted dome for the proposed ephemeral structure. The mathematical code has been shown to significantly facilitate the study of various preliminary configurations of tensegrity vaulted structures.

48 SpaceMaker - Creating Space by Sketching It Ming-Chun Lee and Ellen Yi-Luen Do, University of Washington
Creating space is the essence of architectural design. Architects actually work with three-dimensional (3-D) space, although two-dimensional (2-D) drawings are perhaps the most commonly used design medium. It is thus valuable to help architects truly see 3-D space while making drawings in 2-D. In addition, architects usually use symbols in their drawings to identify architectural concepts. By recognizing the symbols, it is possible to identify architectural configurations of the design. This paper introduces a symbol-based modeling tool—SpaceMaker—that allows architects to make freehand floor plans and apply symbols to identify different functional spaces. SpaceMaker then converts those floor plans into 3-D models according to the symbols.

50 Architectural Applications of Complex Adaptive Systems Phillip Anzalone, Pratt Institute and Cory Clarke, Columbia University
This paper presents methods and case studies of approaching architectural design and fabrication utilizing Complex Adaptive Systems (CASs). The case studies and observations described here are findings from a continuing body of research investigating applications of computational systems to architectural practice. CASs are computational mechanisms from the computer science field of Artificial Life that provide frameworks for managing large numbers of elements and their inter-relationships. The ability of the CAS to handle complexity at a scale unavailable through non-digital means provides new ways of approaching architectural design, fabrication, and practice.

72 LiQuID: Lighting Quality for Design James Peng, Ben Liao, Daniel Glaser, John Canny, University of California, Berkeley; Ellen Yi-Luen Do, University of Washington, Seattle
In this paper, we present LiQuID, a tool for seeing lighting quality in design. Photographs are useful vehicles for both describing and making assessments of architectural lighting systems. A significant barrier to using photographs during the design process relates to the sheer volume of renderings that needs to be analyzed. Although there have been efforts to produce novel visualization systems to manage large sets of photographs, this research aims to reduce the complexity by classifying data into representative prototypes. A hypothetical case study is discussed.

digitaldata

52 Enhancing Architectural Communication with Gaming Engines Michael Hoon, Michael Kehoe, New Jersey School of Architecture
This paper makes a case for exploring the feasibility of utilizing the advanced graphics and sound systems of contemporary gaming engines to promote architecturally relevant work. Gaming engines, while developed largely for the PC entertainment industry, have vast potential for application in architecture. This paper will explore the depth of this potential and will outline work demonstrating the advantages and the limitations of this technology. The supporting research and observations examine the technology and reveal its potential usefulness as an instructional or depictive authoring tool. Game engines were selected that had appropriate graphical prowess, but were customizable as to allow the removal of game-specific features (to create a “professional” user interface). Projects were authored that expressed complex building details using the engine for visual depiction. The details, which included constructional components, structural assemblies, or simple design nuances, were modeled with 3D geometry and realistically textured and lighted. The game engine allowed one user or many remote simultaneous users in the virtual environment to interactively explore the presentation in real time. Scripts were developed to encourage end-users to interactively disassemble or reassemble building components as desired. Audible and/or text-based information regarding the assembly sequence were provided by exploiting the game interface features. Furthermore, interactive object scaling was provided to facilitate analysis of component relationships.

65 Fluid (in)form: Influencing design through dynamic particle simulation John Maze, Mark McGlothlin, Kim Tanzer, University of Florida
The early work of Christopher Alexander and Nicholas Negroponte marked the beginning of architects’ selective flirtation with computational technologies. In recent years work developed in the context of Columbia’s Paperless Studio and its spin-offs has embraced the fluid form-making potential of programs such as Maya in an effort to subvert the strictures of Cartesian space. This group has also challenged the authorial will of the individual architect by assigning spatial and temporal properties to abstract concepts and setting these now-spatialized concepts in motion. The resulting interaction produces a collision of amorphous forms, currently described colloquially as “blobs.” Our project takes the same issues—the quest for an appropriate fit between computational promise and form-making and a fascination with shaping complex flows—in a different direction. We pose this architectural question: How does architecture shape and redirect one of the earth’s physical “flows”—water—as it falls in the form of rain? Can we model rainfall digitally, and then shape surfaces such as roofs, terraces or landscapes to design the flow of water? Can this flow be conceived as a design opportunity, contributing to the phenomenal experience of a project as it is simultaneously shed more responsibly to the larger landscape? Can the poetic exploration of fluids prevalent within the academy be transformed into equally poetic tangible applications?

These are some of the questions we set out to explore, working in collaboration with colleagues in the University of Florida Global Information Systems Center and Digital Worlds Institute (DW). Fifteen students and three faculty members culled from our senior architecture studio met over a period of several weeks with faculty and graduate students with expertise in urban planning, engineering and fine arts. First our architecture students were required to develop a rudimentary understand of GIS regional mapping capacity, with a particular emphasis on the study of hydrology and watersheds across our watery state of Florida. Following this regional analysis we developed a method to demonstrate the water shed by individual student's projects set within this larger landscape. Students first translated their physical models of modest (1000 sf) projects into three-dimensional digital models, then into animations to which rain could be "applied." Students' representations moved from chalk pastel to GIS to basswood to AutoCAD to 3D Studio Max and finally to Maya. Difficulties in translation and changes in material behaviors occurred at each state, and form the primary focus of this paper.

6 Automated Classification of CAAD-related Publications: Conditions for Setting-Up a Keywording System Bob

Martens, Vienna University of Technology; Andre Brown, University of Liverpool; Ziga Turk, University of Ljubljana
This paper deals with the CUMINCAD-repository (Cumulative Index on CAD), which was set up in 1998 and has served the CAAD-community since then as an important source of archived domain related information. CUMINCAD contains over 5,000 entries in the form of publications in the field of Computer Aided Architectural Design. The number has been growing steadily over the years. To date only advanced search mechanisms have been provided to access these works. This may work out well for a just-in-time location of a reference, but is inadequate for just in case browsing through the history of CAAD. For such applications, a hierarchical browsing interface, like one in Yahoo or DMOZ.org is envisioned. This paper describes how the keyword categories were defined and how a moderate, distributed effort in defining the categories will allow machine-identified classification of the entire data set. The aim of the paper is to contribute to building up a wide spread consensus on what the appropriate keyword categories in CAAD are and what sub-topics should sit below the main keyword categories.

82 Online Database for Structural Details – DeTra Robert Pahle, Arizona State University; Friedhelm Stein, University of Siegen

DeTra is a research project that arose from the question: "How is it possible to assist students and professionals in architecture, dealing with structural details?" Our solution is a structural detail database, which assists by presenting example solutions of similar designs. This research was conducted in two overlapping parts. The first part of the research included the definition of a structure and a language to describe structural details—flexible enough to enable complex computer based queries, simple enough to be understandable. Major problems were the inclusion of vague terms, different meanings for the same word, and different words for the same fact. The second part was to create internet-based computer software, which utilizes the developed concepts and allows their evaluation. Thereby the system can be used with different access methods to the same data collection.

This approach intends to present both standard detail examples and project-related detail examples. For that reason the structural connections will be presented including all available project data. The information includes texts, sketches, drawings, photos, animations, and the database description. Our implementation handles this content. According to the holistic presentation of the search results a strong tool for evaluation is given to the user.

digitalwork-in-progress

37 An insight into the freedom of using a pen: pen-based system and pen-and-paper Chor-Kheng Lim, National Chiao Tung University

In earlier researches on freehand sketch, the cognitive behavior of designers was studied. In recent years, some researchers began to look into this area from the design media aspect. The pen-based system, developed by Gross, Landay and other researchers, used the pen as an input device, allowing sketches to be freely drawn in a computer environment. The importance of the freehand sketch lies in its ability to freely represent various drawing projections using ambiguous sketches. However, as far as the various drawing projections, such as diagrams, symbols, plans, elevations, sections, perspectives, etc., how are they related to a designer's thinking process and cognitive behavior? Different media have different abilities to represent different projections. Would they affect the designer's design thinking as well? Targeting different media, i.e., conventional freehand sketches versus the computer pen-based system, this research uses case studies and think-aloud protocol analysis to present an analysis and discussion. Research results show that there is a relationship of gradual embodiment, which is mutually complementary, going from the whole perspective to the dissected sections between the different projections. In addition, these projections restrict the designer's various design thinking processes, while the use of different media may somewhat change the actual design thinking of the designer.

26 Physical Simulation in a VR Tool for Urban Design Frieder Schubert, Philipp Lurz, Constantin Boytscheff, University of Stuttgart

Physical influences on a city, such as noise, light, air flow and solar energy quantities can already be simulated on computers, however, these simulations are usually not embedded into the urban planning process. Regarding a broad field of these influences and their correlations will improve the quality of the design. The use of simulations in the sketching stage provides the possibility of reacting accordingly for the urban planner which is essential for sustainable design. This paper describes the development of a virtual reality tool for the early urban design process, in which we realized a network connection between a software package calculating noise propagation in urban spaces and a virtual reality design environment. In this dynamic VR design tool it is possible to experiment with simple geometric forms and objects (these objects can be added to constructions, removed and transformed). Interactively, with each action of the planner, simulations are generated and visualized in the VR environment in real-time. The last part of the paper describes our concept, how this VR design tool should be integrated in the study of urban planning and how we want the students to get a sense for the impact of their design on physical phenomena in an urban scale.

35 G Pen: An Intelligent Designer's Playmate Chor-Kheng Lim, National Chiao Tung University

In the field of design the pen-based system is a newly developed computer interface that provides the designer with the convenience of a pen in freehand sketches. But these pen-based systems only focus on an interface familiar to the designers and the application of the hardware and software that go with it, treating the pen only as a mouse-like input device. As pen and pad are devices for the pen-based system, the hope is that they can be endowed with more intelligent characteristics to let them interact with designer's gestures and become a creative source for the designers, while simultaneously preventing the design fixation encountered by designers during design process. This research utilizes the unintentional hand gestures made by designers, such as the designer's grip of the pen or movement involved in playing with the pen, putting it down, knocking it, twisting it or shaking it, during the thinking process or when running into a design fixation. From the interaction between the pen and the pad, certain actions may be generated to stimulate the designer's thinking process. This research uses a neural network as the main learning mechanism for the eventual development of a prototype of a pen-based drawing system that provides timely visual stimulation: a G Pen system.

38 SolCAD: 3D Spatial Design to Generate Solar Envelope Manu Juyal, Arizona State University, Karen Kensek, Ralph Knowles, University of Southern California

In this research the concept of Solar Envelope has been used to develop a 3D spatial design tool, SolCAD, for generating an envelope over a given site based on various design parameters. The solar envelope can be imagined as a container, whose boundaries are derived from the sun's relative motion. Buildings within this container will not overshadow their surroundings during critical periods of solar access for passive and low-energy architecture. The solar envelope is a space-time construct. Its spatial limits are defined by the parameters of land parcel size, shape, orientation, topography and latitude. It also depends on the time or the period of the time for which it is designed. Its time limits are defined by the hours of each day and the season for which solar access is provided to the land parcel (Knowles 1981). This tool intends to generate an envelope over a site of any shape, size and orientation and for different boundary and height conditions of shadow lines. It is suitable for initial stages of building design process to determine the shape of the building even before the design has been conceptualized.

44 Multidimensional Presentation Environments with Integrated Intelligent Agents Gregory More (SIAL), Lin Padgham (CSIT), Ian Mathieson (CSIT), Mark Burry (SIAL), RMIT University, Melbourne, Australia

A Multidimensional Presentation Environment (MPE) is defined here as a digital environment containing spatially located data that can be navigated by a presenter. Given an array of data types and the potential infinity of the associated datascapes, there is an opportunity to develop systems that assist the presenter in the navigation and analysis of complex information scenarios. This research reports on the utilization of intelligent agent based software for a better understanding of spatial information representation within the MPE. This is achieved by utilizing intelligent agent software to aid the presenter in the searching, retrieving, and articulation of datasets, and the application of such technologies in the generation of time based 3D graphical and audio presentations.