

DIGITAL TECHNOLOGY & ARCHITECTURE - White Paper

Julio Bermudez & Kevin Klinger (editors)

Submitted to the NAAB by ACADIA [□]

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00: Introduction

We, in ACADIA (the Association for Computer Aided Design in Architecture) believe that the consideration of digital technology in architecture is necessary and unavoidable, given its ubiquity and widespread effects on architectural practice, teaching and research. Hence, we respectfully submit this white paper to the NAAB Validation Conference in the hope that by sharing our insights, NAAB authorities will gain valued information to enlighten their discussions aimed at improving accreditation standards.

Healthy disciplines remain tolerant of a state of flux by constantly questioning the inclusion/exclusion, import/export, and collaboration/isolation to/from new ideas, new techniques, new disciplines, and new technology. At the perimeter of this nebulous exchange, an innovative **digital discourse** is emerging that offers some unexpected new conduits to an attentive discipline of architecture. **Topic nodes** within this discourse are evolving with a particular set of important distinctions from one another. Thus, we contend that the digital discourse is augmented by further specificity such as: *Digital Pedagogy, Digital Tools, Digital Production/ Fabrication, Digital Visualization, Digital Projects, Digital Design, Digital Representation, Digital Thinking, and Digital Practice*. While many points of view are represented with these position writings, all stress the immediacy of acting with strong and proactive consideration of digital technology. We urge NAAB to color the rhetoric of its discussions with the immediate issues of digital technology and its impact on architecture. We hope that this white paper will serve as a useful guide for that discussion.

This white paper is organized into 9 brief position writings. Each section covers a different aspect of digital technology and the present state-of-the-art issues as seen by leading experts. A brief biography has been included at the end of this report.

[□] **ACADIA** (Association for Computer Aided Design in Architecture) was formed in 1981 for the purpose of facilitating communication and critical thinking regarding the use of computers in architecture, planning and building science. A particular focus is education and the software, hardware, and pedagogy involved in education. **ACADIA** is also committed to the research and development of computer aides that enhance design creativity, rather than simply production, and that aim at contributing to the construction of humane physical environments. **ACADIA** is the oldest organization of its kind in the world and its activities include an annual national conference, publications, competitions, and exchange with international sister organizations. For more information, visit www.acadia.org

01: Digital Pedagogy :: A- Digital Foundations: Building a Base for Digital Futures

George Proctor

Has “the digital” been absorbed by the discipline or has “the digital” absorbed the discipline? Depending on your perspective, Architecture either continues to disintegrate or has reformed around a new definition of “the master builder”. Digital technology has opened a variety of new career opportunities for the graduates of a digitally advanced architectural education. Some depictions of this trend have the discipline of architecture continuing to fragment into specialties. However, software has established platforms from which the activity surrounding a design project can be directed, managed, and built. But, does the capacity of software to re-center what is required to make a built environment mean that the design and making of such will fall to the historic notion of “master builder” or “the architect”?

Much of what applies to the general education of an architect can also be said for the digital portion of architectural curricula. Some students come to the university with digital media skills, some are autodidactic, a large number are waiting to be taught and some either struggle to absorb digital skills or probably do not fit a life in architecture. In the midst of this new landscape, sketching and drawing freehand has become more important and necessary. Ironically, less time is provided to build these “old” skills because more time goes to learning a variety of digital skills. Synthesizing digital media training and tool use into an already demanding professional curriculum along with the financial demands of upgrading and absorbing changes in this technology is, overwhelming for students, faculty, pedagogy, and the institution. NAAB requirements may need to be reorganized to accommodate this paradigm shift.

01: Digital Pedagogy :: B- Connected Courses: Methods of Network Communications

Thomas Seeborn

A recent computer survey sent by the NJIT School of Architecture to thirty-one, mostly American design schools, including twenty-nine architecture schools, indicated that all but one had networked design studios. This is clear evidence that digital methods are becoming routine in architecture schools. In addition, the Internet and web have resulted in new methods of working.

Since the first virtual distance studios, where students collaborated over the internet with students in other physically remote studios, in 1994 by Wojtowicz and colleagues, such studios have to relied on web-based databases to store shared design information. This has led to some very sophisticated connected studios where students exchange and develop each other's designs. A model for this kind of exchange, and perhaps the most advanced web-based infrastructure for studio teaching, is the Arc-Line project at ETH in Zurich, part of a university-wide web infrastructure project called “ETH World.” Here, up to 170 first year architecture students have a collaborative environment allowing project submission, viewing and reviewing of design projects, and access to design resources.

Digital design requires digital presentations of which distributed design reviews are an extension. Here, a physically remote critic, connected to the same display over the Internet by some collaborative software (such as Microsoft Windows Messenger and NetMeeting) participates in the critique over the web. In architectural practice, the office of Norman Foster (Foster and Partners) has pioneered the use of “extranets” (a restricted portion of the internet) to enable collaboration with consultants and distant branch offices.

Clearly, a major issue that all architecture schools face is the provision of an adequate computing infrastructure. Clearly, schools must provide networking and output devices such as printers, plotters and projectors and training on their use. Opinions are divided, however, on the provision of computers. Some schools recommend or even require that students provide their own computers *and* software.

01: Digital Pedagogy :: C - Digital Curriculums: Effective Integration of Digital Courses

Nancy Yen-wen Cheng

An Approach to Digital Design Teaching

Students need to use digital techniques throughout the curriculum to understand how computing can support architecture's diverse endeavors and thinking modes. In particular, students must be able to explore and communicate design ideas fluidly using digital and traditional media suitable to specific queries.

Schools should provide exposure to a palette of current and emerging techniques and foster development of a personalized set of media skills. Along with basic design and drawing, most beginners need a guided introduction to digital media. As in language learning, basic skills need to be immediately applied to problems of increasing complexity. Technical concepts will be most easily absorbed when they are introduced in support of design tasks on a need to know basis, with help available on demand. Baseline competency in 2D and 3D expression should be confirmed by portfolio screening, with remedial support available. Once fluency is reached, designers are empowered to experiment with media that supports their goals.

To reach fruition, a digital design sensibility must pervade the school culture. Faculty, staff and students need access to internal knowledge sharing as well as external educational opportunities. Students need to understand conceptual frameworks and strategies for approaching new technology, so faculty with broad knowledge are needed as well as instructors experienced in specific software applications. Peer tutors and small student-teacher rations can make training exercises work for individuals of differing abilities. A positive learning community is crucial to making computers effective in architectural education.

02 - Digital Tools

Ganapathy Mahalingam

In the early stages of their engagement of computer technology, architects approached the technology as an assistive technology that would enhance the practice of architecture. The scope of the engagement was captured in the phrase 'computer-aided architectural design.' In the four decades since, the role of computer technology in architecture has gained a marked significance. The scope has now been extended for architects to contemplate 'totally computer-mediated architectural design.'

The key in the development of digital tools to enhance the practice of architecture has been the facility with which the various tasks involved in the practice of architecture have been represented, enabled or enhanced using computer technology. The digital representation of architectural entities and the digital manipulation of those entities have provided alternate means to produce architecture. Drawing, modeling, performance simulation, design collaboration, construction management and building fabrication are now routinely performed using computer-based technology. This success has revealed the untapped potential of the computational representation of architecture.

Advances in computing based on the study of natural processes such as neural processing, genetic evolution and emergence now suggest that the elusive nature of creative architectural thought can be articulated enough to be applied in a technologically-mediated environment. Digital tools may finally reveal what other architectural tools have hitherto concealed – the architectonics of architecture. Therein lays promise. The future of digital tools rests on the extent to which architects can accept that exemplary architectural designs can be created in a computer-mediated environment and that digital thinking is indeed architectural thinking.

03 – Digital Production/Fabrication

Branko Kolarevic

The digital age has radically reconfigured the relationship between conception and production, creating a direct digital link between what can be conceived and what can be built through “file-to-factory” processes of computer numerically controlled (CNC) fabrication.

It was the complexity of “blobby” forms that drew architects, out of sheer necessity, back into being closely involved with the production of buildings. In the process, they discovered they have the digital information that could be used in fabrication and construction to directly drive the computer-controlled machinery, making the time-consuming production of drawings unnecessary. The introduction of digital fabrication also enabled architects to produce scale models of their designs using processes and techniques identical to those used in the industry. Thus, a valuable feedback mechanism between conception and production was established.

This newfound ability to generate construction information directly from design information is what defines the most profound aspect of contemporary architecture. The close relationship that once existed between architecture and construction (what was once the very nature of architectural practice) could potentially reemerge as an unintended but fortunate outcome of the new digital processes of production. The digital generation of information to manufacture and construct buildings can render the present inefficient hierarchies of intermediation unnecessary. As constructability becomes a direct function of computability, the question is what new instruments of practice are needed to take advantage of the opportunities opened up by the digital modes of production.

04 – Digital Visualization

Julio Bermudez

Digital Visualization addresses representational challenges from within and without Architecture.

‘Disciplinary’ Digital Visualization is used to explore, understand and communicate architectural information associated with the production of buildings. 3D modeling, rendering, animation and VR as well as the power of digital media to permit the seamless integration of various data types are unleashing completely new ways to display architecture. As digital power continues to increase and get cheaper, portability and wi-fi networks take root, and visualization work becomes even more main stream, we can expect growing changes in the way the design process is conducted, buildings are presented and documented, and the public and 3rd party’s demands from professional services. This demands a more conscious research/pedagogies aimed at developing new representation conventions.

‘Interdisciplinary’ Digital Visualization is a rapidly expanding area of expertise with competency ranging from artificial environments (e.g., video game worlds, cinematographic stage sets, web and other cyber environments) to abstract data representation constructs (i.e., information architecture). This type of work has already generated quite a number of new jobs, educational programs and research projects in many industries, schools and universities. Whether or not this type of knowledge implies a different type of architect (e.g., information architect) is subject to debate. What is beyond argument is the fact that the need for this kind of expertise will only grow in the coming years. Therefore, it is imperative that architecture programs pay serious teaching and research attention to the areas of digital visualization.

05 – Digital Projects: Defining Digital Architecture

Kevin R. Klinger

Architecture is presently engaged in an impatient search for solutions to critical questions about the nature and the identity of the discipline, and digital technology is a key agent for prevailing innovations in architecture. Although, this is really nothing new, as new technology *has always been* a catalyst for **new ideas** in architecture. A positive digital future in architecture requires a clearer definition of principles and skills necessary to maintain a rigor in emerging digital projects

What is digital architecture? Architectural ideas have found new forms of digital representations, as information reconfigures into digital visualizations, and projects evolve further as digital fabrications. However, using digital technology doesn't necessarily constitute creating digital architecture. Ideas are still scrutinized by the author(s). Thus, a responsibility for a **critical dimension** still falls upon the author(s). Any new categorizations of architecture must connect equally with the critical as well as the technological skill base of the authors. Just as there is a difference between building and architecture, there is also a distinct difference between digitally generated projects and digital architecture.

digital principles+rigor: Does the tool path limit the density of the ripple? Did I choose a suitable algorithm for that surface? ...A clear and critical definition of **new principles** has yet to materialize in the wake of these new tool driven terminologies. I submit that digital architecture projects still come to life through the lens of a familiar architectural process—as a critical problem solving activity that results in projects represented with a rigor and depth of idea and intention, albeit with a highly sophisticated digital tool skill set. Without new principles, many projects remain impenetrable and thus intimidating, or merely “interesting.” Without a rigor and critical dimension, the projects will remain only exercises in software.

digital skills: Digital architecture requires proficiency with a specific foundation set of **digital skills** such as: *2D composition, vector graphics, image manipulation, 3D modeling: surface modeling, solid modeling, video editing, motion graphics, rendering, animation, parametrics, drafting, communications, layout, printing, presentation, database operations, web interface, CAM-based fabrication, performance analysis: lighting, structures, systems, etc.* However, innovative digital projects will not sacrifice the development of this skill set at the expense of a critical problem-solving dimension. Thus, we must carefully consider the guidelines for what truly constitutes a digital “architecture” project.

06 – Digital Design

Peter Anders & Wassim Jabi

Describing design as a sequence of steps cannot convey the complexity of social interactions that it embodies. Design is not merely a process, but a co-evolution of efforts and events in various places and times —both synchronous and asynchronous. Designers share their values, effort and expertise within design settings via artifacts that further the design process. Increasingly, these design settings in academia, research, and professional practice combine physical and virtual modalities such as immersion, projection, and a range of interaction technologies. Peter Anders has described such spaces as cybrids: hybrids that integrate virtual and physical space. In these settings, designers use overlapping physical and virtual artifacts and tools to arrive at a co-operative design resolution. Within collaborative design, these artifacts take on an additional role. As embodiments of design ideas and actions, they become media for communication.

Donald Schon asserts that design should be considered a form of making, rather than primarily a form of problem solving, information processing or research. Indeed the line separating creation from design is becoming increasingly blurred. For the design artifact itself may become a part of the design proposal — its virtual presence incorporated within a cybrid structure or object. We may in the future see a proliferation of cybrid settings that support collaborative, digital design. The technologies for this already exist in collaborative tools, networked computing, scanning and immersive media. However, it will take a creative vision to see how these disparate tools and devices can integrate within the ideal design setting.

07 – Digital Representation: Architecture, Technology, and Representation

Frederick Stacy Norman and Lisa Tilder

As digital technologies and connective systems begin to redefine traditional notions of place, space and time, how might Architecture itself transform? Over the past century, extreme

conceptual and spatial transformations have come about in relation to the introduction of mechanical reproduction, computer graphics and redundant systems, however Architecture and representation have remained somewhat constant. This is evident in the continuity of traditional architectural representation methods that draw primarily from Renaissance models - though the original impetus from which such projection methods evolved no longer bear the same significance to culture. How do contemporary models of communication, mass production, distribution and imaging influence the conception and production of Architecture? How might hybrid models influence architectural production, from pre-manufactured housing to consumer products, brand identity to mass-market advertising? Below are three aspects of contemporary representation that explore emerging connections between architecture, media, representation and culture.

Drawing: Whether handcrafted, computer-translated or computer-generated, drawing provides us with abstraction capable of communicating architectural design ideas. With the increase in digital media and availability of computer graphics applications and hardware, the medium of the drawing is changing. With a change in mediums analog to digital, should that impose a change in how we draw, what we draw, and the intended use of a drawing? Will the two-dimensional flattened image give way to intelligent three-dimensional digital models for construction?

Modeling + fabrication: Digital media is providing an opportunity to return a sense of materiality to an immaterial realm. The relationship between architectural design and production are brought closer together given the fluidity and accuracy of digital tools. Computer-aided design and computer-aided fabrication processes provide the means to create new forms of architectural practice and challenge traditional methods of project delivery.

Presentation graphics + new media: As computing technologies have begun to be absorbed into the popular realm, the general public has become acclimated to an inundation of media. Relationships between architect/client may be facilitated by the use of popular or experimental media such as television, computer games, and the web. Architects might look to popular media for techniques of communication to the general public.

As methods of representation change, Architecture's definitive boundaries transform. Relationships between disciplines may join more readily, forging collaborative partnerships. Students now enter architectural education and the profession from a technologized generation more facile and familiar with digital tools and environments, and they begin to effect representational changes in both education and the profession from the bottom up.

08 – Digital Thinking

Mahesh Senagala

The computer has gone from being an isolated box to become part of a gigantic digital network of networks, which shapes our collective future. The way and pace at which we connect, communicate, memorize, imagine and control the flows of valuable information have changed forever. There are at least six digital phenomena that directly affect the architectural world: *miniaturization* (of all that can be shrunk), *ubiquity* (being everywhere, global), *realtime* (communing globally in realtime, which is 1/10th of a second), *noospherization* (networking everything), *virtuality* (all that is solid melts into knowledge), and *anamnesia* (inability to forget). Temporal contiguity and temporal connectivity have taken precedence over spatial and geographical contiguity. The strands that animate our life today emanate from spatially distant but temporally contiguous/connected places. These phenomena have squeezed, stretched, restructured, reconfigured, and redistributed most major human institutions. Consequently, the built world's role, importance and nature have changed. Architecture as traditionally understood has become more marginalized than before. Many practices, however, have been repositioning themselves to take advantage of the new opportunities beyond the bounds of traditional architectural practice. Design, practice, fabrication and construction are increasingly becoming networked affairs. The new measures of architecture are *connectivity* and *speed*. The architecture of a new world needs to recognize these transformations and think differently.

09 – Digital Practices

Raffi Tomassian & John Marx

Technical competence in computer technology has become a *conditio sine qua non* of landing a job at a respectable architectural practice. By itself, though, this does not imply that all architectural practices are now doing their work in a revolutionary way. In their overwhelming majority they have been forced into the digital domain by the ubiquity of technology itself. The digital file has replaced the drawing as the information backbone in building profession. However, the common convertible currency of this information down the construction process is still lines on paper, albeit physically produced by incredibly sophisticated devices.

A few practices are looking beyond the drafting and visualization solutions offered by digital technology and finding themselves reshaped in the course of this interaction. The problems that those practices solve today are less related to design than to organization and project management. This reflects the uniqueness of practice among the other architecturally related endeavors, such as theory or education.

Technology has a revolutionary potential in architectural practice, but an ingrained psychological stigma needs to be abolished first. A torrent of energy will be unleashed when the legal framework of the industry stretches to accommodate the digital model as a legitimate appendix to or replacement of the traditional bid documents. Until the profession finds a non-mediated route between digital design and digital fabrication, the changes in the practice will be more cosmetic than internal.

Short Bios of Contributors

Peter Anders is an architect, educator, information design theorist and author of *Envisioning Cyberspace*. He is currently a fellow of the University of Plymouth CAiA-STAR Ph.D. program. Anders is director of MindSpace.net, an architectural practice specializing in media/information environments and has presented his research and projects in a variety of international venues.

Julio Bermúdez (March & PhD Minnesota) is an Associate Professor at the University of Utah College of Architecture & Planning. His research and pedagogic work focuses on the interaction between design process and digital media as well as the application of architectural concepts to data environments. His work has been widely published, exhibited and/or performed in the U.S. and abroad. In addition to being a member of the ACADIA and SIGRADI steering committees, Bermudez is in the advisory board of Leonardo.

Nancy Yen-wen Cheng (B.A. Yale, M.Arch. Harvard) researches how digital media can enrich the architectural design process at the University of Oregon. She currently investigates mobile tools for capturing places. She is active in the AIA Technology in Architectural Practice group, the International Journal of Architectural Computing and ACADIA.

Wassim Jabi is an Assistant Professor of Architecture at the New Jersey Institute of Technology. Jabi is a Ph.D. candidate and holds an M.Arch. with distinction from The University of Michigan. Jabi is currently the coordinator of the third year undergraduate design studios at NJIT and teaches electives on computer-aided design. He has published several articles on computer-supported collaborative design. Jabi is a long-time member of the Association for Computer-Aided Design In Architecture (ACADIA). He is also a member of the editorial board of the International Journal of Architectural Computing (IJAC).

Kevin Klinger is presently the Conference Chair for the ACADIA22 Conference 2003 in Indianapolis hosted by Ball State University: <http://www.bsu.edu/acadia>. He is an Assistant Professor of Architecture at Ball State University. Kevin's teaching and research interests revolve around the social, cultural, and formal transformations of architecture and urban environments resulting from the influences of new technologies and the subsequent emerging digital discourse(s) in architecture.

Branko Kolarevic (DDes, MdesS-Harvard, Dipl.Ing.Arh.-Belgrade) teaches design and digital media courses. Prior to joining Penn in 1999, he taught at several universities in North America and Asia. He has lectured worldwide on digital media in design, and has authored and edited several books. He is a former president of ACADIA.

Ganapathy Mahalingam is currently an Associate Professor of Architecture and Architecture Program Director in the Department of Architecture and Landscape Architecture at North Dakota State University. He holds a Ph.D. in Architecture from the University of Florida. Professor Mahalingam has firsthand experience in the creation of digital tools for architecture, having created software for the preliminary design of proscenium-type auditoriums. The creation of the software involved the definition of an algorithmic process for auditorium design based on acoustical, functional and programmatic performance parameters

John Marx, AIA is a Design Principal and Partner at, San Francisco based, Form4 Architecture. He has designed over 150 buildings in 11 different countries. Mr. Marx has lectured around the world on "Digital Practice", including Kyonggi University, Seoul, the Technion, Israel, UC Berkeley, and the University of Sydney.

Frederick Stacy Norman is an Assistant Professor of Architecture at Ball State University. He is also the Site Chair for the ACADIA22 Conference 2003 held in Indianapolis. Frederick was also co-Chair of the 2002 Digital Design Exhibition: <http://www.bsu.edu/dde>. Frederick is the recipient of the 2003/4 Paul Rudolph Visiting Assistant Professor, Auburn University, School of Architecture

Prof. George Proctor directs the digital media curriculum at Cal Poly, Pomona. He has taught digital media courses and design studios in digital design methods since 1993. His writings are in the area of digital tool use in studio and design education. Proctor Chaired the 2002 ACADIA Conference at Cal Poly Pomona.

Thomas Seebom is registered architect and an Associate Professor of Architecture in the School of Architecture of the University of Waterloo, in Waterloo, Ontario, Canada. He specializes in digital design technologies and is currently focusing on these areas: digital design pedagogy; rule-based generative design and expert systems; double shell tensegrity structures, digital lighting design; and interactive, real-time, 3D architectural and urban modeling in stereo

Mahesh Senagala is an assistant professor of architecture at the University of Texas, San Antonio and runs an international practice. His areas of expertise include systems theory, cybernetics, sustainability and design computing. He has written and lectured extensively about digital culture, thinking and architecture.

Lisa Tilder is an Assistant Professor of Architecture at The Ohio State University Knowlton School of Architecture, where she teaches architectural design, computer graphics and seminars that address the relationship of technology, design and representation. As an educator and architect, Tilder's work pursues the critical relationship of technology to architecture and culture through various means: web-based projects, interactive constructions and installations, competitions and building projects.

Raffi Tomassian, UBA, is an Architectural Designer at Cincinnati based Glaserworks. He has won awards at two international competitions. His work on the Cincinnati Zoo Kids' Shop received the local AIA chapter Honor Design Award and has been featured in several publications. He is a frequently invited critic of academic assignments.