

TOWARDS ALGORITHMIC BIM NETWORKS: THE INTEGRATION OF BIM DATABASES WITH GENERATIVE DESIGN

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1 ABSTRACT

It seems that we can no longer think the future of digital technologies in architecture without rethinking the future of the profession. We argue that professional practice and architectural academia have developed two diverging stories about the present and future of the computerization in design. Architectural practice is using computer technology to “modernize” the profession more than truly revolutionize” it. Professional architects are integrating information technology with two narratives: first, computers are applied to streamline traditional manual processes, and second, computer are used to change the relationships among partners in the design-and-construction process, which in turn may drive new design-build documentation and bidding process, organizational culture, and structure.

While in academia many support this “modernizing” view, an increasing number of universities are becoming test beds for new visions of design imagination. This ground-breaking portion of academia is presenting a broader critique in which architectural materiality can be rethought in relation to generative form-finding, population thinking, and automated topological structures.

In this paper we will argue that a plausible merging of the ideas that are at the forefront of main stream practice and pioneering academia can yield one of the most novel themes for the future of architecture: generative modelers that contain specific topological intelligence could be fused to a worldwide network of procurement of products and services in the construction industry.

2 THE DISCOURSE OF COMPUTERS IN ARCHITECTURAL PRACTICE

Architectural practice has used computing with one main objective: to improve productivity. The notion of productivity has changed in the past 30 years. In a first period, “skills changes,” architectural practice attempted to use CAD systems to improve productivity mostly in the architectural office. In a second period, “business processes changes,” Architectural firms are using computers to improve the productivity of the whole design-build industry. During this decade we have

entered into this second period primarily with the implementation of Building Information Model (BIM) software and processes.

2.1 BIM

BIM has become one of the central themes in the computerization of Architectural practice today. BIM software and processes allow architects to construct virtual models that accurately replicate building systems and materials. The model is linked to a database that contains information such as construction estimates, schedules, fabrication details, and construction simulation. Any change in the 3D model automatically updates the database and other construction documents such as 2D plans, door schedules, and specifications. The basic premise is that by building the facility virtually in 3D one can test the potential problems during construction and simulate alternatives.

However, the majority of the stories about BIM today offer mostly a glossy and a seductive description of the benefits of the software. They said very little about how these changes are being implemented in practice. This article is based on a research of more than 30 architectural firms, construction companies, and universities that are implementing BIM technology in order to obtain a more precise understanding of the technology management issues. It is also based on a more than 18 years investigating the trends in computing in the Architecture, Engineering, and Construction Industry [ANDIA]. In this article we argue that the implementation of BIM has not been easy. Firms have to learn not only difficult software but also change their culture, team formation, and their fee structure.

BIM is typically understood as buying software and training staff, but is much more complex than that. BIM is ultimately about business processes and information management in one of the most fragmented and complex industries in the world. There is no right BIM solution but only BIM narratives that specifically respond to the particular work culture in which the design and construction teams are embedded. We have observed that there are clearly 3 major implementation strategies of BIM model in the cases we researched: (1) Collision detection BIM models, (2) Cost estimation and construction sequencing BIM model, (3) Integrated Design and Construction BIM models.

2.2 THREE CONTEMPORARY DISCOURSES ON BIM

The first wave of BIM processes is implemented primarily to transition from 2D CAD to 3D BIM. In this phase a significant number of BIM models are created after a considerable part of construction documentation is produced. Design-build teams

find difficult to convince clients to pay upfront for a BIM model or the teams are inexperienced with the technologies and associated business processes. These earlier models are mere 3D CAD representation of buildings that only control the geometry of the project and coordinate the potential “collisions” between the building structure and systems.

In a second phase Architectural offices began to coordinate the BIM model. Initially firms find benefits in the production of traditional construction documents and the management of the collision detection of systems. Soon firms in this stage began to discover also initial routines of cost estimation during the design process. Firms at this stage report that they began to experience changes in the allocation of staff. The hours of senior architects dedicated to a project increase while the hours of entry level architects decrease. Another layer of BIM benefits emerge when design and construction teams use BIM models to simulate and examine the phases of construction of a project. While 3D BIM models are accurate geometric representation of a building, 4D BIM models include time data which can trigger an analysis of construction sequencing, and project scheduling. It allows project teams to measure, quantify, and visualize time-lapsed construction sequence.

In the third phase firms that control the BIM database can control a significant part of the coordination of the process. BIM at this stage began to transform the structure of the traditional method for billing design fees. Firms that control the BIM model are able to charge more at the initial stages of design than during construction documents. This is done via contractual agreements with clients or by providing additional services that create supplementary fees. For example some firms are beginning to rent the BIM model for early cost estimation or for construction sequencing after the bid process. During this stage business processes are more integrated and efficiencies do not rely much on the production of drawings but on creating a more integrated process in which the cost of construction is controlled better during the whole process.

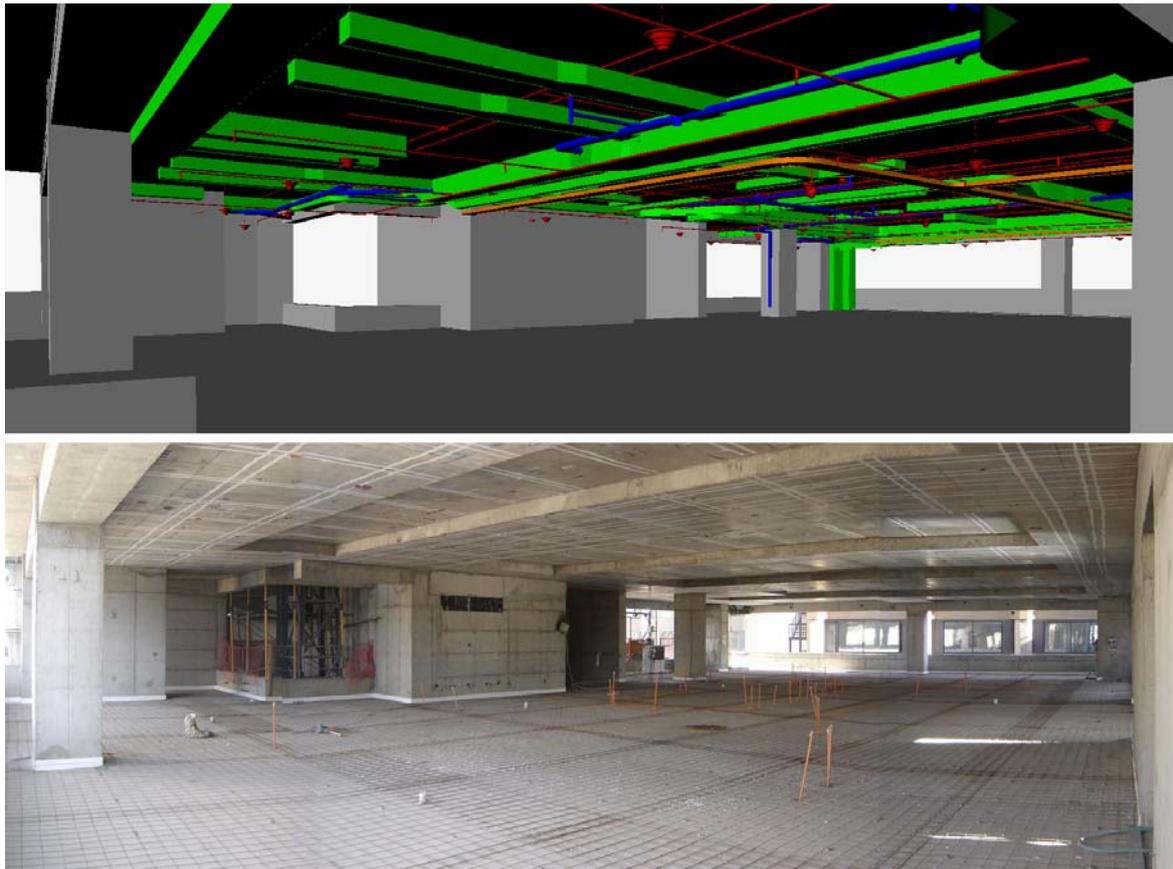


Figure 1: Job site image and coordinated BIM model developed by the firm Modelacion Digital from Chile (image courtesy of Modelacion Digital, Chile, 2008).

2.3 TOWARDS 3D BIM METADATAS

However, much of what is been advertised about BIM today is oversold. BIM remains a relatively manual process or at best partially automated. Architects and Engineers spend considerable time modeling and specifying objects that had already been manufactured but whose information still remains in analog, PDFs, or CAD catalogs. Currently there initial signs of a massive move to create digital catalogs populated with intelligent objects that could be embedded into BIM models. The metadata of those objects could be searched automatically like we search today for hotels and airplane tickets. Throughout the design and construction phase manufacturers, distributors, and even contractors could provide initial bids improving significantly tasks such as cost estimation, procurement, and order fulfillment. Also a pricing engine could make the BIM model an internet portal: a 3D BIM metadata engine fully integrated to a global distribution system. The model could provide real-time pricing from multiple brands which can be connected automatically to all interested parties such as constructors, sub-constructors, and distributors.

3 THE DISCOURSE OF COMPUTERS IN ACADEMIA

While practice has been using computing technology mostly to control cost and optimize coordination, in academia advanced digital software has been used primarily in form finding and generating complex environments. In particular the field loosely named genetic, generative, or morphogenetic architecture has produced design processes in which the geometry of the projects is dictated by programming specific spatial conditions and not by directly modeling a shape. By programming or coding the conditions of an architectural case designers can test multiple scenarios of much more complex spatial thinking. Architectural models are no longer frozen they became parametric and manageable if one changes specific parameters.

3.1 ESTHETIC EXHAUSTION

Algorithmic techniques substitute the sculptural or figurative designer. Designers, when using programming, are forced to make explicit the design process and environmental conditions to which they want their design to respond. In these new circumstances the generative software no longer mimics the traditional environment in which the architect has to model everything. Initially, architects using these new types of software seem to get infatuated with the shape generation process. But after a while one can clearly observe very precise families of forms that move across the oceans between academic venues and bounce in blogs that share the software tricks. The apparent aesthetic exhaustion of this first generation of algorithmic techniques is the result of the obsession architecture has had almost exclusively with complex geometry, shapes, and form since 1988. But what is form?

3.2 DELEUZIAN SPACE

Deleuze and Guattari crack the topic of form in a chapter named "10,000 B.C.: The geology of Morals (Who the earth think it is?)" in their book "A Thousand Plateaus." Deleuze and Guattari here enter into the discourse of form purposely by not looking at human space. The whole section is dedicated to look at natural form. The authors move loosely from the formation of molecular populations to flora and fauna milieus to demonstrate that form in natural structures depends of autonomous codes. But the codes are the result of clear population thinking that evolves over time. Deleuze and Guattari write that "first, if we assume the presence of an elementary or even molecular population in a given milieu, forms do not preexist the population" ...yes forms do not preexist the population...forms "are more like statistic results. The more a population assumes divergent forms,

the more its multiplicity divides into multiplicities of different nature, the more its elements form distinct compounds or matters" [DELEUZE, GUATTARI, 1987: 53].

3.3 TOPOLOGICAL THINKING VS. ALGORITHMIC CAD

Form as a result of population thinking, as declared by Deleuze & Guattari, is very different than algorithmic CAD as it is practiced in some trendy schools today. Critical to population thinking for Deleuze is the topological diagram. Topological transformation allows natural forms to adapt, progress, and respond to their environments as the populations develop and mutate. For Deleuze natural space is always in a process of becoming, thus, it is always emergent. But underneath this turbulent process of transformation there are constant topologies that maintain populations' identity. For example Mammals or vertebrate species have the same topological modes of ordering the structure of their bodies but intelligently adapt their form to the different environments species inhabit.

Deleuzian space is not about the form of the smooth, the striated, or the fold. It is not geometrical space at all. It is evolutionary space. The radical contribution of Deleuze is that it is the final point of departure from Cartesian space. An exit from what was considered human space until the 1960s. Deleuzian space based on topological models draws a sharp contrast with many algorithmic CAD efforts we find today and that are deeply based on aesthetic searches in the latest Cartesian software.

3.4 WHO IS THE DESIGNER?

At this level computing and human thinking can develop a more deep conversation about who is the designer: humans, computers, or an accumulative process of coding design over long periods of time, as put forward by Deleuze. These arguments have a long tradition that has come and gone since the 1960s between architectural design theory with computer systems theory, cybernetics, and biology. Among the most celebrated in architecture at the time were Christopher Alexander's "misfit variables" [ALEXANDER 1964], Nicolas Negroponte's "architectural machine" [NEGROPONTE 1973], Morris Asimow's "morphology of design" and "design elements" [ASIMOW 1962], Christopher Jones' "factors" [JONES 1963], Bruce Archer's "sub-problems" [ARCHER] and Nigel Cross "automated architect" [CROSS 1977]. Specifically influential were the ideas of Nobel Prize laureate Herbert Simon that stated that human problem solving behavior could be simulated and programmed [NEWELL, SIMON, 1972]. Although Simons universally known thoughts seem to have been rejected or forgotten in appearance they are still in the DNA of computer software designers.

3.5 PROBLEM SOLVING VS CREATIVE DESTRUCTION

However, narratives that suppose that the design professions navigate only in problem-solving realms are incomplete and do not truly understand the political and poetic challenges that design disciplines confront in late capitalism. If Simon ideas on rule-based problem solving are truly computed then we would tend to solve our human-space-needs based on a very restricted framework. We would only accept the factors we consider important in a particular time and would be developing solutions to a stationary framework. This would dangerously freeze architecture which would be unable to critically respond to innovative challenges. Simon's models do not consider that capitalism is not based in creating industries that freeze over time. On the contrary, capitalism is based on what Economist Joseph Schumpeter called processes of "creative destruction" [SCHUMPETER, 1942]. He described capitalism as the story of continuous transformation - a process that can never be stationary. This economist-historian argued that the most important driving force in capitalistic economies does not come from industrial conditions, revolutions, wars, or even capital, but from the ability to generate innovation. Schumpeter would argue that the design of a new pen, a new car, or a new building, becomes the item to be destroyed by creative capitalism as soon as it is successful. And "innovation" does not occur by defining a framework of the old pen but by precisely destroying that framework and creating an original, more spectacular and desired pen. As we will argue at the end of this paper it will be the need to "innovate," not the theory of problem-solving or design thinking, which will be the driving force of the discourse of computing and BIM in the AEC industry.

4 MARRYING GENERATIVE DESIGN AND BIM METADATA

Although computing will have several roles in the design industry a major scenario for "innovation" could be merging of the generative design promoted today in academia and BIM metadata engine paradigms that practice is adopting. Firms that do very specific typologies such as hospitals, hotels, condominiums, may develop reusable parametric BIM models that can be connected to worldwide systems of pricing. These reusable parametric models could be open platforms that can interact with all types of data such as excel spreadsheets, CAD, energy analysis software, and even automated 3D zoning code routine checks developed by local ordinances. It can quickly adjust the model to different conditions such as zoning, financial scenarios, structure, and can provide a clear audit trail of the entire design build process for potential liability disputes.

4.1 SOFTWARE STRUCTURE

Possibly the biggest obstacle to arrive to the scenario painted above are: (1) The cost structure of the CAD/BIM software industry which requires users to pay a heavy fee to access software licenses and (2) Universal software exchange standards. In 2005 the expenditures on Information Technology accounted an average of \$36,000 per firm or 2 to 3 % of the firms' gross billings. Firms of 100+ employees reported having spent an average of \$5,000 per employee per year while firms 5-19 spent \$2,400 [AIArchitect, 2007]. Fees segment the software market and do not encourage the adoption of a ubiquitous usage of an integrated technology. Just imagine if today we would have to pay separately for software such as email, internet browsing, access to news sites, and other services on the Internet. Certainly the ubiquity and the growth of the system would not be experience today. The vendor wars and the fragmented nature of the Architecture, Engineering, and Architecture, Engineering, and Construction (AEC) industry makes it very difficult to create one system or standard that can accommodate the diverse professional requirements. In the 1990s the IAI (International Alliance for Interoperability) brought together the major software companies to develop a universal standard for digital models in the AEC industry. The IFC (Industry Foundation Classes) standard followed the STEP standard which was developed for other industries as they were described above. But after more than a decade of work the IFC standards is still in progress.

4.2 OPEN AND INTEGRATED BIM METADATA NETWORKS

A better model for software access in the design and construction industry would be an open system model like the Internet where software usability is practically free and the economy is based on advertising or commissions per click. The AEC industry, at \$4-plus trillion per year, is one of the largest industries in the world. A large number of manufacturers, distributors, subcontractors, would be willing to a fee-structure that will allow that their products are sold in secure and openly integrated 3D BIM networks - just at the time when architects and engineers are making their decisions. These 3D BIM metadata networks will be connected to secure business-to-business e-marketplaces such as the one found in other industries: Sabre, Worldspan, and Pegasus in travel, Chemconnect in the Chemical trade, or PartsBase in aerospace. A first generation of transaction platforms based on e-commerce principles, such as BuildNet which went bankrupt in 2001 after an investment of \$140 million dollars, emerged in the construction industry almost a decade ago. A more robust business-to-business marketplace may emerge if more automated open system could be integrated to emerging 3D data processes. But

still the funding model, software segmentation, and interoperability have become very difficult issues to solve in a much fragmented industry [POST, 2008]. And although all this may be possible, a question still lingers: what is the reason for all this? Are we being bought by oversold ideas?

4.3 INTELLIGENT BIMs

In an AEC world that has resolved its interoperability issues BIM will move from 3D representation to intelligent prototyping. Fully integrated BIM prototypes will become construction rehearsal. Powered by algorithmic thinking these BIM models can collectively contribute to a knowledge base that has been very difficult to achieve in the history of the construction industry. Although computing will have several roles in the design industry a plausible scenario could be the merging of the generative design and BIM metadata engine paradigms. Firms that do very specific typologies such as hospitals, hotels, condominiums, may develop reusable parametric BIM models that can be connected to worldwide systems of pricing. These reusable parametric models will be open platforms that can interact with all types of data such as excel spreadsheets, CAD, energy analysis software, and even automated 3D zoning code routine checks developed by local ordinances. It can quickly adjust the model to different conditions such as zoning, financial scenarios, structure, and can provide a clear audit trail of the entire design build process for potential liability disputes.

4.4 THE SHADOWS OF DRACONIAN TECHNOLOGIES

Of course, this scenario has also an enormous dark shadow. It can make everything efficient and horrific at the same time. It can be so proficient that it could eliminate a large number of redundant architectural and engineering jobs, as it has occurred in industries such as agriculture and manufacturing in the past century. Without the ideological resistance of architecture, clients that only look at the bottom line could advance us further into a hopeless generic city. But are not we already living in the unpromising generic city?

5 ARCHITECTURAL INTELLIGENCE

The emerging “software metaphor” of Generative BIM metadata could allow Architects to not only automate current designs but challenge traditional typologies and include data that today is not available for architects. Most building typologies today are frozen because design and construction teams have enormous limits to experiment with ‘what-if’ scenarios. The data and uncertainties they have to deal with are enormous and the time to tackle them is

usually extremely restricted. Under these circumstances the designs of most family of projects such as hospitals, prisons, malls, suburban houses, hotels, etc., fit into a homogenized set of program rules and materials selections which are very difficult to break. The homogenization and repetition of solutions makes creative design in Architecture almost irrelevant.

Critical to understanding how the intelligence of Generative BIM metadata will consolidate it is important to consider the contemporary conditions of Architectural astuteness or brainpower and how that could be altered. The 1970s was a critical decade for Architecture. The world population as a whole began to grow at an unprecedented level around that decade, adding 1 billion people every 12-15 years. Architecture after that decade no longer had universal answers such as: CIAM modernity or international style. While population growth has been minimal or stagnant in the developed world, its cities began to swell as never before in history. Consolidating a suburban and exurban style of living. Walmart, Walgreens, McDonald urbanism retracted the act of building to a default condition, in which Architectural discourse could no longer imagine but just have speechless drafting contractual obligations. Under the cloud of litigation Architecture has been unable to consolidate a professional intelligence that could tackle the generic calls for proposals and the ultimate spreadsheets of investors.

5.1 CAD INTELLIGENCE IN POST-INDUSTRIAL CITIES

Despite all its revolutionary promises, Architects in the past twenty years have used CAD mainly to improve drafting efficiencies. But in the same period Architects have lost the control of the delivery process in most developed countries. In the US twenty years ago nearly 85% of projects were delivered via the design-bid-build method - with the Architect taking a central role in the coordination process. By 2005 design-bid-build projects were only 45% of all projects. With rest delivered via design-build (45%) or via construction management method (10%). CAD has not added much to the intelligence of the Architectural profession or the efficiency of the Construction Industry. In fact, in the US the AEC industry has gradually declined its productivity at an average of -0.57% per year from 1964 to 2001, while all other non-farm industries have increased productivity at an average rate of +1.77% per year throughout the same period.

Also in the last twenty years CAD has been used by the Architectural vanguard to merely generate more and more complex forms. This addictive practice has kidnapped the forefront of Architectural thinking into a worldwide competition for the formally spectacular. High-end architecture has become the race for the novel

geometry. Promoted by a network of intellectual pimps and enlightened socialites, Star-architecture turned into the ultimate trophy of the Cultural, Olympic, CEOs, and Petroleum Sheiks. The formal twists, bends, and splits are a hit in the world of media but their scale is minute and it has barely touched our post-industrial cities. The prime-time influence of star-architecture is intensely limited. It allows for only a few super-stars buildings per city. Its powers are comparable to a breast-augmentation procedure. It gets a lot of eyeballs, but does little to change our own biological condition. Definitely, today's avant-garde architecture can only show microscopic cosmetic victories. But it has not touched anything essential about the generic cities that surround us.

5.2 CAD VS. PARAMETRIC MODELING SOFTWARE METAPHOR IN OTHER INDUSTRIES

A different software metaphor than CAD was used by the aerospace, manufacturing, and electronic industries in the late 1980s. During that period most large companies abandoned their own software endeavors and began to massively buy commercially available 3D parametric software. Companies such as Boeing began to reinvent their business processes and organizational structures around these parametric systems [ANDIA 1995]. The foundation of parametric models is its associative geometry. Associative geometry allows the manipulation of the 3D parametric model by changing variables and linking it to efficient manufacturing. Parametric software routines can trigger automatic form-finding. Designer can script particular design constraints and consider similar or unusual 'what-if' scenarios. For example in aerospace the initial design of the wing of an airplane can be parametrically coded to fit a precise variation sheet metal panels, patterns of hole markings, and tools used for fabrication and assembly. Later, the associative software allows companies to integrate 3D models, knowledge and best practices without the need to do extensive coding. Once the best practices are captured they can be used by the company as pseudo-applications that automate the repetitive parts of the design and engineering tasks.

Over time large repositories of parametric models, processes, and knowledge bases began to surface. These models were attached to networked databases which are also associated with an increase number of lean practices that began to transform the design intelligence of these industries. The intelligence of the design, fabrication, and assembly process slowly began to be coded, transformed, synthesized, and rationalized - creating a new astuteness.

5.3 ASSOCIATIVE GEOMETRY IN ARCHITECTURE.

The utilization of the parametric, topological, and associative nature of BIM technology is still in its infancy. As it is discovered, it will allow architects to reuse old BIM models and practices in new projects by changing specific parameters. Scripting performance conditions will allow architects to not only gradually eliminate manual drafting processes but also to envision many more automated techniques. These could significantly inform design with themes such as land cost, construction cost, codes, sunlight, just to name a few. Several programs have emerged in the generative domain but have not yet been clearly linked with BIM. Among the most powerful today, amid the large AEC CAD vendors, is "Generative Components" from Bentley. Its founder, Robert Aish, was also one of key members of RUCAPS in the 1970s - one of the pioneering BIM software from which SONATA, Reflex, and Revit emerged. According to a coauthored paper by Aish: "Generative design methods are capable of generating concepts and stimulating solutions based on robust and rigorous models of design conditions, design languages, and design performance...integrated performance-driven design tools are aimed at creating new design processes and exploiting computing capabilities for stimulating novel yet achievable solutions" [SHEA, AISH, & GOURTOVAIA 2003]. These observations are similar to the conclusions we found in the implementation parametric 3D software in aerospace, manufacturing, and electronic industry. Shea, Aish, and Gourtovaia contend that the additional capabilities of associative modeling allow designers to "experiment with many different design scenarios and dynamically assess the structural impact of alternative global forms." Aish, who held the post of Head of Research at Bentley, moved to AutoDesk in late 2007.

5.4 INNOVATIVE INTELLIGENCE IN DESIGN AT THE BEGINNING OF THE 21ST CENTURY

As theoretician Michael Speaks points out, at the beginning of the 21st Century, Knowledge can no longer be contained in philosophy and theory but in intelligence. By intelligence he means "innovative intelligence" in the tradition of "creative destruction" paradigm put forward by Josef Schumpeter as we discussed above. Speaks follows the writings of management thinker Peter Drucker to argument that "Intelligence-based practices are more entrepreneurial in seeking opportunities for innovation that cannot be predicted...the most innovative of these practices are thus more concerned with the 'plausible truths' generated through prototyping than with the received 'truths' of theory or philosophy. Plausible truths offer a way to quickly test thinking or ideas by doing, by making them, are thus the engines for innovation rather than the final product" [SPEAKS 2007]. We can argue that there are two distinct design intelligences that have began to "innovate" with associative geometry, parametric technologies, and BIM in Architecture. The first

one is mainly interested in developing “efficiencies” in form making or building coordination. The computer software can offer some intelligence and automate some tasks but is usually feature specific: 3D form-finding, coordination, cost estimation and scheduling, etc. The second type of design intelligence searches to innovate in the “domain of architecture.” The applications integrate progressively more holistic knowledge bases and best practices. Although the first one is easier to visualize as it has momentum today, the second one is the one that has more potential to transform the AEC industry. Each one of these two types of approaches has a particular culture and vision for the profession we will discuss below.

5.5 COMPUTING EFFICIENCIES

For the first group parametric scripting and BIM software allows them to generate unimagined shapes and to efficiently control construction. Most avant-garde designers and professional offices fall in this camp. Although parametric systems offer extraordinary possibilities to “innovate” the appearance of buildings, they seldom have another level of intelligence than just geometry manipulation and very basic analysis. Something similar occurs with BIM systems used in large practices today, they only aid in improving the accuracy of coordination and construction. In both cases the “innovative intelligence” has been geared to make more efficient what the firms already do today. But computing is not used to truly “innovative” and transform the industry in a Schumpeterian sense. These efforts maintain the status quo and the figure of the architect as a shape-maker and coordinator. The domain of architecture continues to be restricted to form. Its kingdom continues to be only the character of buildings. And the design ideas still emerge with no much more help than the genius of a master architect that produces in a cloud of darkness, mystery, and as part of the magical process of the firm.

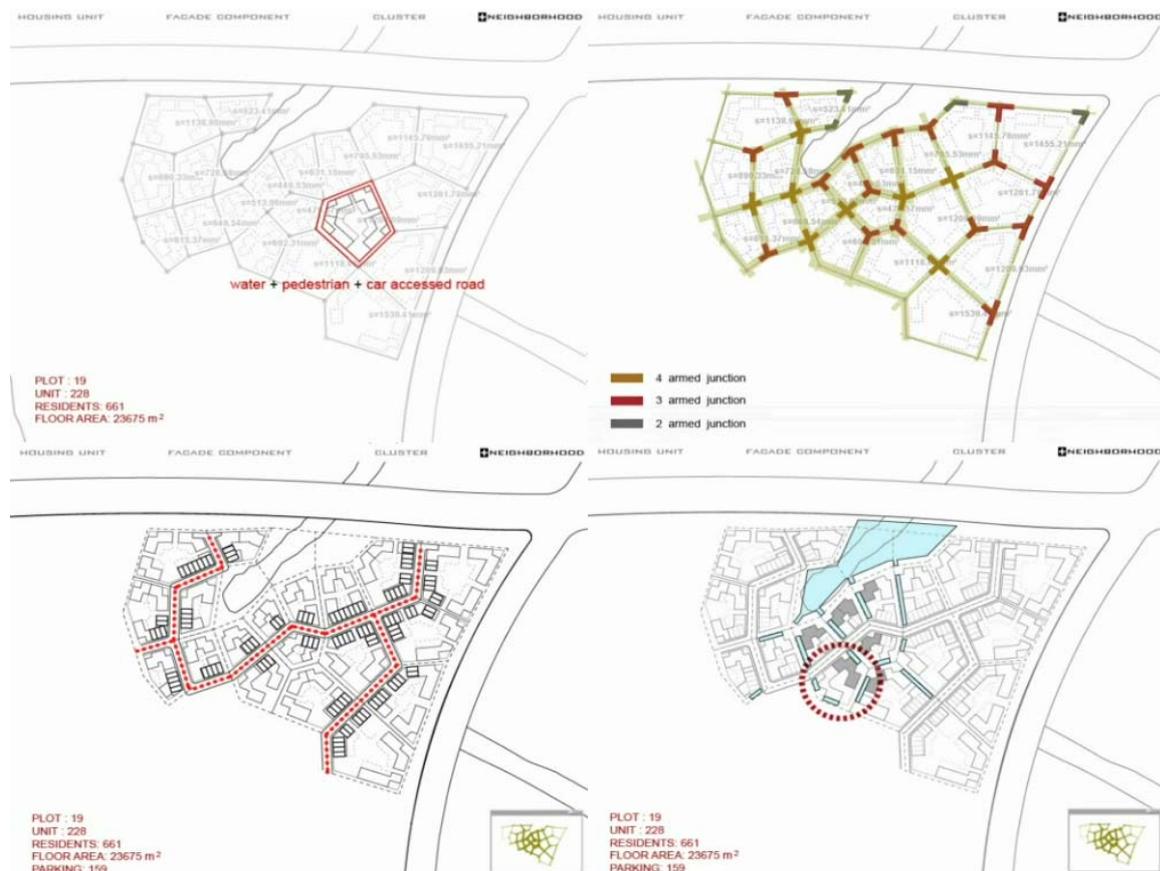


Figure 2: Images from the generative planning layout at the Berlage Institute. The model automatically configures the plots, streets, parking, corners and public areas based on national regulations and mixed use zoning evaluations. (Enclosure 2007).

5.6 COMPUTING THE DOMAIN OF ARCHITECTURE

A small cluster of Architects have observed that the scripting of parametric models will inevitably led designers to enter into programming the design thinking part. This does not mean to program the formal thinking of architects or replace the architect of its role, as formulated by problem-solving paradigm in the 1960s. It means to develop computing frameworks that have certain levels of intelligence in areas the architect cannot usually include while designing. These are intelligent computing scripts that contain other parametric factors such as: land cost, density, codes, regulations, structural parameters, acoustics, automated parking layouts, sunlight, heat evaluations, etc. We are not taking here about generic software, but scripts that are very particular to unique design thinking develop by the architect. The architect in this context becomes a topological operator. And the 3D design model turns into a dynamic mock-up full of parallel intelligent scaffolds that can test multiple scenarios. This software metaphor is relatively difficult to explain to architects who are so accustomed to the Personal Computer metaphor that has guided computing in the profession.

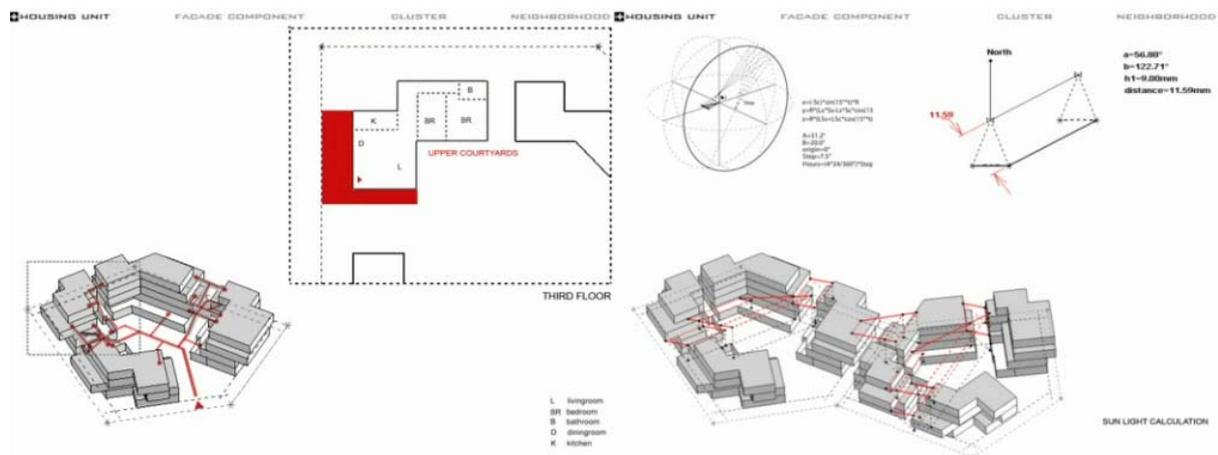


Figure 3: The generative 3D routine automatically develops the internal layout of each apartment (Enclosure 2007).

One of the most remarkable prototypes of coding design intelligence can be found in the “Associative Design” Studios led by Peter Trummer and assisted by Martin Sobota at the Berlage Institute, in the Netherlands - please see a 40 minute video of the work at Dystrub.net [ENCLOSURE 2007] and at the blog of one of the projects [QIAN 2007]. In essence, the studio uses software devised for manufacturing industry and adapts it to generate complex parametric models for large planning projects. The images 2,3,4 depict some of the results of the 2007 studio which planned a new solution for contemporary Chinese housing. Most efficient mass housing solutions today in China are large mid or high-rise blocks because it has been very difficult for architects and developers to conceptualize the problem in a different manner. The studio was divided into research teams that studied issues such FAR, internal room organization, land value strategies, sun trajectories, Chinese national code, and the traditional vernacular Chinese housing. These elements had clear morphogenetic systems and several routines were coded into the manufacturing software. The generative 3D routine automatically develops the internal layout of each apartment. The routine calculates the spaces based on the studies of traditional use of courtyard, national sunlight regulations, population densities, family structures, circulation requirements and different configuration for diverse income groups (images 2 and 3). The associative model allows the designer to consider many domains which are impossible to consider in a manual drawing process or a traditional CAD system. This is reflected in the final project. Each interior space, wall, interior space, and public spaces is treated differently based on the performance criteria set in the parametric system (image 4).

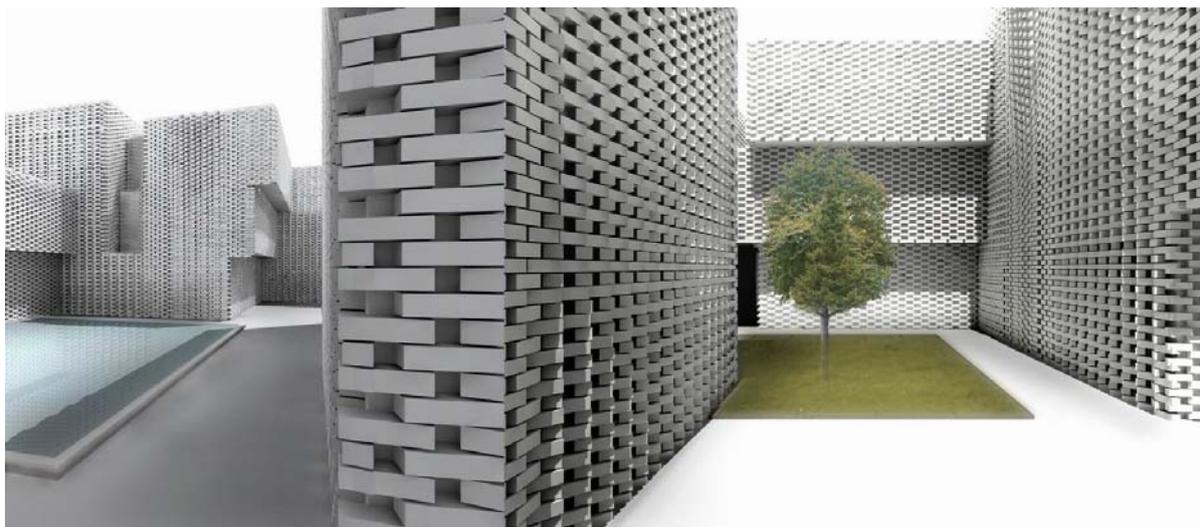


Figure 4: Each exterior wall is designed differently based on the environmental criteria programmed in the parametric system (Qian 2007)

6 CONCLUSION: NEW ARCHITECTURAL BRAIN POWER

For all of those who have followed the discourse of computation of the AEC industry in the past 40 years BIM is not a fresh concept but “*déjà vu.*” A significant number of pioneering 3D parametric software from the 1970s such as SSHA, CEDAR, HARNESS, and OXSYS were initially designed as specialized systems to serve particular organizations [MCCULLOUGH & MITCHELL, 1990]. These systems had a common vision: to construct virtually a 3D building by modeling all their building elements and assemblies. They allowed multi-users to manipulate a single parametric 3D model. Graphic reports and 2D drawings were mere derivatives created automatically from the main model.

BIM, as it is been sold today, it is just the beginning of a bigger discussion that will transport us back to the methodological debate about computation that was present in the 1960s and 1970s. The market will began to sort the interoperability, practical, and network issues but for us architects the main theme will revolve around the framework of our design practices. Today’s generative programming and BIM “software metaphors” still revolve around architects designing manually or with some automated help. A more powerful “software metaphor” it will be systems that will allow architects to expand their design powers so they can enter into design realms that previously were impossible to tackle.

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8 KEYWORDS

CAD, BIM, Generative Architecture, Algorithmic Architecture, Topological Model, Building Information Modeling