

The Ten Bytes of Architecture? Some Thoughts on Architectural Culture in the Age of Simulation

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"... the current architectural production methodology (and all associated deliverables) is about to be completely turned on its head... architects will now have to adjust their understanding of collaboration as one occurring synchronously (in real time) within a team creating and assembling an interrelated set of building components, versus occurring asynchronously (at staggered times) with a team creating and assembling a loosely interrelated set of drawings... This is a radically different notion of collaboration as understood and commonly played out in professional practice and academia..." Paul Seletsky, *Digital Design and the Age of Building Simulation*, Oct 2005, [AECbytes Viewpoint #19](#)

In the excellent article quoted above, Paul Seletsky spells out the changes that are about to transform not only the practice of architecture but the entire construction industry as a result of the advent of what he calls "digital design." In his use of the term, digital design is based on building information modeling, the web, and other related technologies and will transform the role architects play in building production as well as the way we work with our consultants, clients and contractors. Seletsky foresees a realignment of the division of labor on which our present system of building production is based, blurring the distinction between design and construction.

Many architects familiar with the current state of the technologies at the heart of digital design may be inclined to dismiss such predictions. It is true that BIM applications do not presently perform as advertised nor do they reliably exchange information with other necessary applications. In addition to such technical problems, there are systemic cultural obstacles including resistance to changing established work methods and the deeply engrained separation between design and construction. Nevertheless, I believe that the profound changes Seletsky envisions will come to pass. The technical problems will be solved and the cultural obstacles will eventually yield to the economic imperatives to increase productivity and reduce costs. The questions that most intrigue me concern the impacts these changes will have on *what it means to be an architect*. As an educator as well as a practitioner, I also wonder what changes should be made in architecture curricula to prepare future architects for their new roles. This article is an attempt to look into the future that Seletsky describes and ask what changes may come about in the fundamental role and daily work of architects.

These questions go to the larger issue of our architectural culture. By this I mean the (often tacit) values we promote in our work that both inform and result from how we understand our role in the building industry and in society as a whole. Architectural culture, like that of any profession, is partly embodied in institutions that change slowly, such as the laws that govern our activity. However it also exists in more ephemeral ways that are expressed in the stories or myths we tell ourselves to place ourselves in a social context. One such myth is that of the "hero architect"—the form-giver whose unique vision guides building and allows it to transcend mere utility to become art. Most working architects know that this is indeed a myth, yet I would suggest we never really free ourselves from this vision. As a teacher, I see it transmitted to our students in many subtle ways: the fact that students most often do projects alone, the value placed on originality, the emphasis on buildings as isolated aesthetic objects, the absence of interdisciplinary courses or contact with students in related fields, and the way history is taught as a sequence of iconic objects associated with individual architects. Most American architects working today are the products of this kind of training, so it is hardly surprising that we struggle to overcome its effects even when it contradicts the evidence of our own experience.

If myths like that of the hero architect are contradicted by our experience, we still somehow manage to operate with them. The persistence of such a myth may even help us provide something society wants—buildings that express cultural values and aspirations. The market has difficulty valuing such an intangible good, so it must find its way into the building process by other means—the values architects bring to their work, i.e., architectural culture. This culture, then, serves an important social role.

A full account of the sources and history of our architectural culture is far beyond the scope of this article, but we can get an initial idea by referring to our training and the texts we were asked to study. Much of our culture can be traced to the influence of Leon Battista Alberti's famous *Ten Books on Architecture (De Re Edificatoria)* originally published in 1450. Alberti gave the architect a dual character as both scholar and builder (See A. Grafton's *Leon Battista Alberti, Master Builder of the Renaissance*, Hill and Wang, 2000). Although Alberti deeply admired Brunelleschi and aspired to the status of master builder, his book had the effect of placing scholarly (abstract) knowledge at least on par with practical experience, laying the groundwork for the tension between design and construction that has been a feature of Western architecture ever since.

In light of this, the most significant aspect of the future of architecture envisioned by Seletsky might appear to be the blurring of design and construction. Some see in this the possibility of a return to the notion of the architect as master builder, but this view fails to take into account the complexity of modern building projects and the enormous range of knowledge needed to complete them. The amount of specialized expertise that goes into a modern building expands constantly. No one person can possess all the knowledge needed to design and construct a modern building, making it unlikely that we will have a 21st century Brunelleschi. In fact, the most significant aspect of the future of architecture is best understood as a revolution in the nature of collaboration in our industry. These profound changes in how we work with the other participants in the building process are bringing about a shift in architectural culture as profound as that initiated by Alberti. In homage (or with apologies) to Alberti, we might base our new practice on a ten-part treatise, as Alberti followed Vitruvius. The following is a sketch of the first three of a possible ten "bytes" of architecture.

Byte 1: Lineaments

Alberti's first book is devoted to the basic elements of architecture. He begins by defining what he means by an architect:

"Him I consider an architect, who by sure and wonderful reason and method, knows both how to devise through his own mind and energy, and to realize by construction, whatever can be most beautifully fitted out for the noble needs of man... to do this he must have an understanding and knowledge of all the highest and most noble disciplines." L.B. Alberti. *On the Art of Building in Ten Books* (translated by J. Rykwert, N. Leach and R. Tavernor), The MIT Press, 1988.

What should an architect know? Emerging technology and the resultant work processes demand that architects become versed in new areas of expertise. Many of the skills involved in creating, using and maintaining a building information model are outside the experience and training of most architects. A major question posed by the rise of this technology concerns the extent to which architects will acquire the knowledge to expand their activity into areas of model creation and management or if these skills will become the domain of other professions (construction management, for example) or even call an entirely new profession into existence (see the white paper, [New Heroes of the Building Industry](#), by D. Gallello and C. Freeman, in Graphisoft's Envisions Newsletter). At present, university programs in construction management are far more advanced in their use of BIM than architecture schools. The challenges to architectural education are profound: while current architectural training remains focused on form (as it has been for centuries), digital design demands that architects simultaneously think about materials, bidding, construction and project management. BIM makes all of these things aspects of design. Bringing BIM into the architecture curriculum entails introducing whole topic areas that are presently ignored or not integrated with the design curriculum.

The culture of the architect's office will also change with the addition of information technology staff. With IT playing a central role in their practices, architects will work with network engineers and programmers on a daily basis. In addition to keeping all the technology working and updated, these people are needed to customize BIM applications to suit the needs of an individual firm or project. Some architects, at least, will need to learn some of the language of this new culture, and will need to understand enough about its capabilities and constraints to incorporate it creatively into the practice. In ways difficult to foresee, incorporating people from a different professional culture (IT) will inevitably affect architectural culture.

The very ways in which we conceptualize our projects will ultimately have to change. Much of our shared architectural culture is based on two-dimensional representation. We employ plane geometry developed by the ancient Greeks. Our drawings use the system of linear perspective rediscovered during the Renaissance. We base designs on the idea of plan parti from the 19th century Ecole des Beaux-Arts. In addition, the meanings we ascribe to built form are heavily colored by historical association.

Our thought processes as designers are deeply reliant on two-dimensional representations. The ability to "see" our designs in three dimensions using modeling software has not changed this. A few architects like Frank Gehry use design processes that do not rely on two-dimensional representation, but with the new tools we will all be able to conduct the entire design and documentation process in three dimensions with no reference at all to two-dimensional representations. The possibilities for new forms and new uses of materials are fascinating. But to take advantage of these new opportunities, we will need to think in what might be called radically three-dimensional terms.

Although we can visualize objects in three dimensions, we rely on an orthogonal mental image of space that is better for imagining planar forms than curvilinear ones. Simple Platonic forms (spheres, cones, etc.) are also easy for us to visualize. But our image of space is inadequate to think about an arbitrary three-dimensional form. Our tools can help us describe and visualize forms, but how can we *think* about three-dimensional form without our orthogonal concept of space?

Byte 2: Materials

Here Alberti dealt with the physical materials used in building. Our materials include a much larger repertoire of these, but must also include aspects of our working methods. Our present forms of collaboration involve the exchange of design data. The architect, in principle, controls the flow of this information to ensure (again, in principle) that all parties have the same current information at important junctures of the project. This information control function is critical because information is generated by many people in different forms. Ultimately it must be manipulated and coordinated so that it forms a coherent totality. This requires an experienced architect who knows how to interpret and coordinate the welter of information he or she receives from his client, consultants, contractor and subcontractors. This architect performs complex operations of interpretation, comparison and compilation.

But what if these functions were automated? What if a technology existed that could accept information in whatever form, combine it with any other kind of information, and construct a consistent product from it (or send up a flag if there were inconsistencies)? In that case, each participant would submit information to the project and draw information from it via this technology. The architect would no longer be like a spider at the center of her web, but one of many participants sitting around a virtual table. What is the architect's role if information control is automated? This is perhaps the most important question posed for architects by BIM and related technologies.

This question implies a challenge to the existing architectural culture. As much as collaboration is central to our work, our instincts as "hero architects" lead us to see the other project participants as providing us with information we need to accomplish our design goals. The form and the language of our contracts affirm this. Usually the rest of the design team is "our consultants." The "design intent" and our ability to ensure its integrity in the construction are prominent in the standard AIA owner-architect agreements. The fact that the input of "consultants" (particularly structural engineers) is at times critical in forming the design intent does not alter that fact that in the end, we come to view this intent as ours to claim and defend.

We rely on our ability to control the flow of information to implement our design intentions. Since all information passes through our hands, we can review it and request changes from our consultants before the document set is finalized. Moreover, we use our knowledge of how information flows through a project in framing our design intentions. Effective strategies for implementing a design intention must take into account the pragmatics of our industry. Information management is a part of these pragmatics over which we have control. This control thus becomes the key to the kinds of intentions that we can adopt as well as the strategies we use to implement them. What would happen if we lost control over information management? I would suggest that our ability to function as architects, i.e., as the project participants who define and defend the design intent, would be seriously and perhaps fatally compromised.

How will architects formulate and implement design intentions without controlling the flow of information? To answer this question, a more detailed look at a BIM-based building production process is needed. The ultimate implementation of BIM will be a single central virtual building model residing on a server from which the entire team will get the information on which they base their work. They will update the model with their own work which will then become available for the rest of the team. This process will be mediated by software that controls access to the model based on each team member's role. The model itself will be the construction document; contractors will use on-site computers to generate views and other information from the model that they need for various tasks. This system creates three principal roles for architects.

First, the initial project will have to be conceived just as it is today. The owner's requirements will still have to be combined with a knowledge of codes, construction systems, and other information to create a building solution. While some individual tasks within this process may be automated (expert systems that apply code constraints to design solutions, for example), the same complex problem-solving skills that architects now bring to the process will still be needed.

Second, collaboration among members of the project team will require facilitation. Interactions among collaborators will take place largely online as geographically dispersed teams become common. Methods and technologies for online collaboration are the subject of much current research (see the paper, *Advances in Collaborative CAD: The State-of-the-Art*, by J.Y.H. Fu and W.D. Lee in the journal, *Computer-Aided Design*, Volume 37, pages 571-581, published in 2005). It has been shown that collaborations are most productive with a combination of group support systems technology and a skilled facilitator (see the paper, *Improving the accuracy of group judgment: a process intervention combining group facilitation, social judgment analysis and information technology*, by P. Reagan-Cirincione in the journal, *Organizational Behavior and Human Decision Processes*, Volume 58, pages 246-270, published in 1994). Architects are best suited among the members of a project team to assume the role of facilitator, given their comprehensive view of the project. Here, some of our cultural baggage will have to be jettisoned. A facilitator must be perceived by the parties as neutral. Effective facilitation requires framing issues so they can be discussed and resolved, enabling all points of view to be heard and ensuring that each viewpoint is understood by all. In other words, the facilitator must appear unbiased. The role of facilitator will still allow the architect to guide the development of a project, but his or her touch will have to be light and the attitude one of being among equals rather than being the final authority. The hero-architect myth must finally be put to rest. We will have to learn to live with the loss of a certain amount of control and learn strategies of organizing collaborative teams and structuring interactions to produce the results we seek.

Third, architects will need to manage and maintain the central BIM model. This is already a controversial topic with owners demanding ownership of the model. However, the model has considerable economic value beyond its use for construction. It may incorporate organizational strategies, templates, custom library parts, customized code and other intellectual property of the architect. Keeping the model current with all modifications made during construction will save time and expense in coordinating the work of subcontractors, resolving spatial conflicts before they become critical, optimizing the schedule, and tracking overall progress. It will also be extremely useful for facilities operation after completion. The BIM model will be the architect's main work product and will embody value that is not exhausted when the building is finished. Architects need to maintain control over the model to realize these benefits and protect themselves from intellectual property theft and misuse of their work.

Byte 3: Construction

In Alberti's time, the limited variety of construction materials allowed architects to be experts in construction. This has, of course, changed. As mentioned above, the specialized expertise required by modern construction is rapidly expanding and has long since surpassed the ability of a single person to master. However, BIM will return architects to a more direct involvement in construction via digital fabrication. There is a growing number of buildings today for which components are fabricated "directly" from digital files created by the architect. The reality behind most of these projects is a good deal messier and more interesting than the glossy articles lead one to believe. Some of the difficulties encountered by these early experiments in direct fabrication are due to the immature state of the technology. Others have a more interesting origin in the fact that the process still requires two different types of knowledge: the designer's intention and the fabricator's experience with materials and tools. The new situation is that the proper point of transfer between the two is now harder to determine. There is inherent uncertainty about when it makes sense to hand a system or component from the designer to the fabricator that must be resolved on a case-by-case basis. The fabricator must take part in the design process, informing the designer about the capabilities and limitations of materials and tools. The designer has much greater ability to control the fabrication process but the final product still requires the intervention of the fabricator on the shop floor. The ongoing development of new materials and techniques ensures that this situation will not change. An architect will never be able to absorb all the information at the command of the enormous array of specialized fabricators. No matter how automated shops become, skilled people will be needed to operate and maintain the machinery and adapt it to new uses.

Nevertheless, the architect's role in fabrication and construction has expanded and will continue to do so. Emerging technologies foster a closer relationship between designer and fabricator, demanding a greater awareness on the part of the former of the properties of materials and the capabilities of machinery. This development will cause a major shift in our architectural culture. While we will not become master builders again, we will acquire a more intimate knowledge of making, a closer familiarity with the physical reality of building and a greater ability to experiment with new materials, techniques and forms.

When the technology is mature, a BIM model will be not merely a representation of a building, but its virtual analog. All of the building's salient properties will be incorporated into the model, permitting its use for a wide variety of simulations (as Seletsky envisioned in [AECbytes Viewpoint #19](#)). We will be in the domain of "performative" architecture: the design itself will be able to be tested to see if the building will perform to specified standards (see the Autodesk white paper, [Building Information Modeling: A Key to Performance-Based Design](#), published in 2003). Architects will be able, and perhaps expected, to test their designs and assume responsibility for their performance. The idea of taking this kind of responsibility for our work now evokes a chill of fear in most architects, with visions of lawsuits dancing before their eyes. We shun this responsibility because our current work methods (and the legal environment based on them) don't give us the necessary degree of control over the actual construction process. I, for one, would like to see this change. I believe the decline in our profession's standing in the construction industry and the relatively low fees we command are due largely to the fact that we avoid responsibility instead of embracing it. In the present circumstances, it would be foolhardy to take more responsibility than we customarily do. The emergence of BIM and related technologies will give us the tools to assert more control over the building process, but an equally revolutionary development will be needed on the cultural plane.

As long as our culture is based on a sharp division between design and construction, an adversarial environment is inevitable. A culture of collaboration must arise in which project teams are motivated to work together to meet the owner's goals. This change in attitude among architects, contractors and others has been called for many times in the past. What has been missing are the tools to enable such collaboration. With the tools in hand, we will need to forge a new set of relationships between designers and constructors: more flexible, designed to be negotiated as the project develops, and based on joint responsibility for the finished project. Architectural culture will have to change to embrace a greater involvement in and responsibility for the construction of our projects. This cultural shift will depend to some extent on the expanded awareness of materials and techniques mentioned above, but it will also require new conceptions of architectural design. This will give greater importance to thinking about processes of fabrication and construction and their impact on overall form and how functional needs are met.

Conclusion: Architectural principles in the age of simulation

In every time and place, an architectural culture arises as the product of social, technical, economic and political conditions as they affect building. Yet, while these factors shape the culture, they do not determine it. The members of our profession and our industry can take an active role in deciding the direction of emerging technology. We have a unique opportunity to rethink where we want to go and what we want our work to be. We need new thinking about architecture, building, and society that takes account of the challenges and possibilities implicit in technology—the architectural principles for the age of simulation.