TAKE 5 looking ahead: defining the terms of a sustainable architectural profession

edited by Paolo Tombesi, Blair Gardiner and Tony Mussen

A TRADE TO RETOOL? ARCHITECTURAL PRACTICE AND DIGITAL MODELLING

The expression 'building information modelling' , introduced by the software company Autodesk in 2002 and quickly adopted by the industry as a non-proprietary acronym BIM, describes an integrated approach to building design, construction and management that rests on the utilisation of CAD and parametric modelling technologies. The aim of this approach is to give its adopters the ability to control all the aspects of the building's life cycle, from design to disposal, by bringing the various threads of program and construction information, project management and facility management together into a single operating digital environment.

BIM combines the advantages of interconnectivity and 3D representation, linking drawings to sets of information that allows all the parties involved in a project—architects, engineers, project and construction managers, and even product manufacturers—to follow, monitor, and coordinate their work. BIM can be used for everything from generating construction documents to predicting building performance and energy consumption, from tracing how a design change impacts expenditure to functioning as a management tool for owners of the completed facility. A BIM model is currently being developed as a facility and asset management tool for the Sydney Opera House.

BIM has started to permeate in significant ways the design and construction industry. Since 2003, for example, the US General Services Administration (GSA) has established, through its Public Buildings Service Office of the Chief Architect, the National 3D-4D-BIM Program. Within this program, close to 50 buildings have so far been developed, assessed or planned, in the attempt to gauge the increase-in-productivity potential of digital coordination and to codify future protocols for the progressive adoption of BIM in public work procurement.[1]

In the United States, studies of BIM users have been undertaken to consider the impact of digital modelling on the structure of architectural firms, their

evolutionary paths in practice and their strategic positioning in the industry.[2] Meanwhile, selected materials and building component suppliers have been looking at the re-engineering of the supply chain in construction. 2007 will be the third year that the American Institute of Architects will be holding its annual Building Information Model Awards competition. Incidentally, one of the winners of the first edition of the award was the consortium headed by the Sydney office of Arup Architecture for the Beijing National Swimming Centre, in China.

While the information analysis-and-coordination potential of the technology available is beyond dispute, its impact on the socio-technical organisation of design and the role of the architect within its development process is harder to measure at this stage.

If one adopts the position famously taken by Sigfried Giedion in *Space, Time and Architecture* (1941), the technology is bound to redefine the position of the architect by altering the knowledge boundaries of the actors involved in the building process as well as the balance of collaboration between them.

Some see the adoption of BIM as an opportunity for a more effective, architect-coordinated dialogue between design and allied fields, as well as the recasting of the architect as a modern-day master builder in control of construction processes and fabrication methods. Others contend that the collaboration patterns envisaged through BIM underlie cultural rather than digital issues, and should not be muddled with deterministic views of technology.

Within the context of *TAKE 5*, both the open-endedness and the breadth of the debate resonate powerfully, since the architectural repercussions of BIM's adoption can be considered vis-à-vis the various testimonies presented in the volume, particularly in Parts 2 and 3.

High-profile proponents of parametric modelling have declared their ambition to exploit BIM to blur the distinction between design architects and technical architects.[3] But does this match the actual aspirations, or even simply the reality, of the industry? At least in Australia, the current mantra of architectural professionals is to limit responsibility to design, whereas the use of the virtual model requires not only expertise in construction systems and methods but it is also likely to push more of the liability for the finished product upon them. Moreover, the tendency in the industry to accept performance-based design and documentation falls counter to BIM-based

production, since this relies on the accuracy of the incorporated material, product, system and methodology earlier on in the process. BIM, that is, may sit well within design/build procurement methods, whereas its application to other, more traditional procurement arrangements could be up for debate. This is particularly the case where the benefits of the software are mainly to be found downstream, for the developer and end user.

The move into digital building may also prompt the need to re-evaluate employment patterns. The rise of BIM has created a new category of digital design specialists that are becoming crucial to firms, charged as they are with guiding architects and developers through the slow and uncertain transition into adopting complex new technology, and comprehending how it can enhance their design or development process. Yet, with the connection between model-based technology and information, a lot of tasks such as drafting, view coordination, document generation and schedule creation are automated. Drawings that represent different views of the same building object are automatically updated when modified. Does this mean that the technical workforce traditionally at work on these tasks will become less necessary in the office or more so? After all, the dozen or so major software firms involved with BIM are aggressively marketing their products all around the world, including low-cost labour countries, where documentation firms—as we read earlier—are getting trained to work in 3D. How will this reflect on the division of labour inside the traditional firm? Will salaries and wages be affected by the potential for further standardisation brought about by digital tools? Or will BIM trigger the relocation of technical digital workers towards builders' and contractors' structures? In other words, will BIM create further opportunities for the business of architecture or will it rather create a market that will no longer need the services an architect, at least for standard design production?

These questions are difficult to answer because, in spite of the favourable momentum, not everyone is ready or able to jump on the digital modelling wagon. Getting the system to work across multiple disciplines is a great leap that requires major capital investment and has in fact yet to be made. BIM could produce real advantages/savings for construction firms by generating accurate schedules and estimates, and by allowing clashes to be detected long before work begins on site. But the construction management industry as a whole is still a long way from integrating it into its practices.

In architectural practice, the dissemination of BIM could be hindered not only by the capital costs required to acquire the system and train the workforce but also by the current structure of professional training. A common criticism voiced at architecture schools is that graduates come out of them without the experience of how to build. If one of the consequences of digital modelling is entrusting the architect with the task of figuring it all out in a virtual environment, then the theoretical effect of the availability of BIM tools may be cancelled out by the lack of knowledge of actual construction techniques at university level, and thus amongst firms' younger staff. Furthermore, architectural education tends not to be geared towards team-based training, which is what BIM relies on. Hence, how should digital modelling be introduced within schools' curricula?

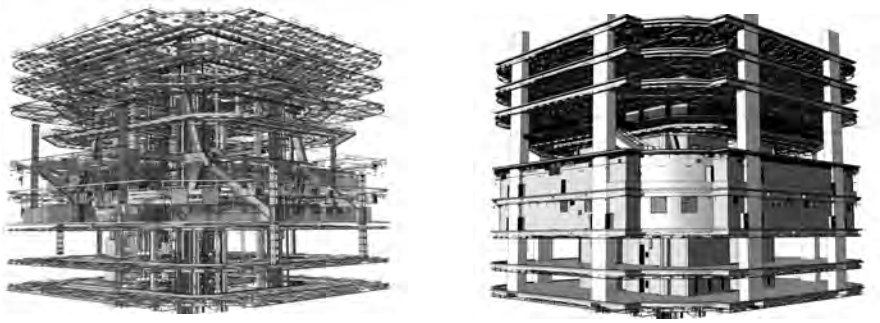
In either case, the rewards could be substantial for some of the very reasons articulated within *TAKE 5*. To start with, the ability of BIM systems to represent the building artefact and all its related processes in their detailed entirety could ease the response of the architectural profession to its new occupational health and safety responsibilities. Second, the simulative and computational abilities of digital modelling could facilitate energy consumption and environmental performance analyses whilst offering alternatives capable to penetrate and inform the entire supply chain. Last, the sheer representational power of such digital tools could allow the complexities of design not only to be pursued further but also to be explained better in less complicated ways. Broadly, the industry will require regearing to optimise BIM benefits, as end-of-line communication currently remains predominantly in a 2D format.

In the following interview, we asked Mark Burry and John Frazer, Australia's two international authorities on the application of parametric modelling to design, to clarify these issues for us while answering some additional questions. In doing so, Burry and Frazer lay out their separate arguments as to why BIM will change the face of overall building procurement, affecting, in the process, the connections between academia and practice.

[1] United States General Services Administration, 3D–4D Building Information Modeling, http://www.gsa.gov/bim.

[2] Philip Bernstein, BIM Adoption: Finding Patterns for a New Paradigm, *DesignIntelligence*, March 17, 2006, www.di.net/article.php?article_id=529.

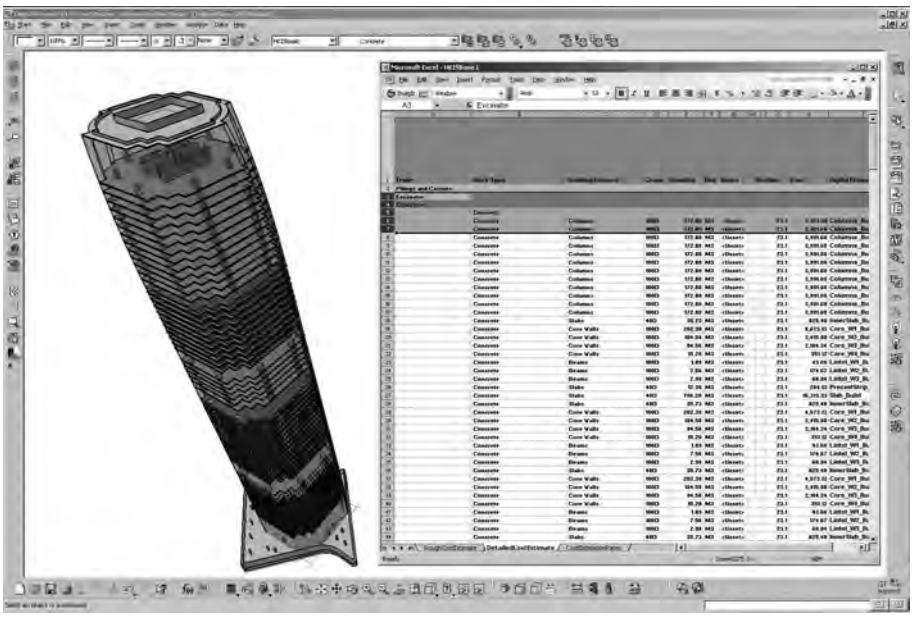
[3] Super Modeling, *The Architect's Newspaper*, 20, November 11, 2006, http://www.archpaper.com/features/2006_20_super_modeling.htm.

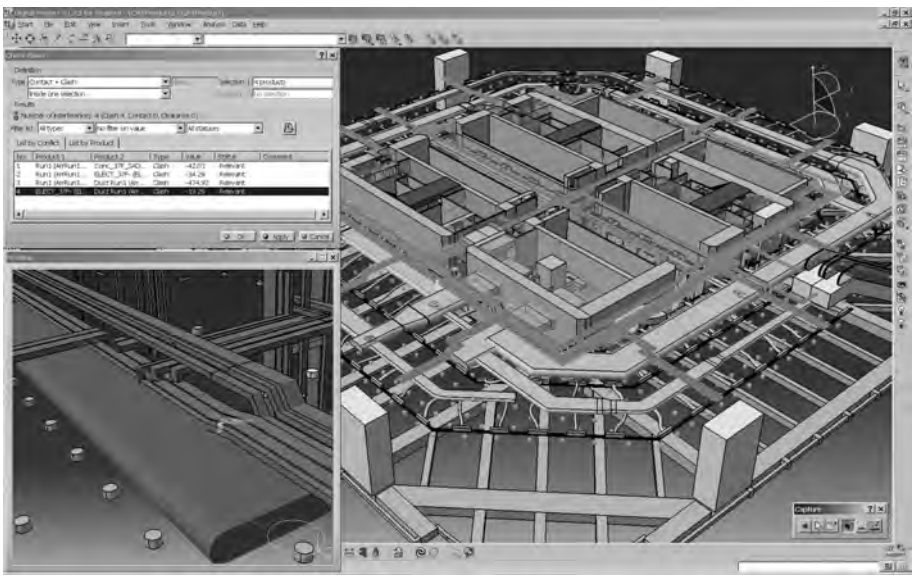


One Island East project, Hong Kong: 3D representations of building components and assemblies from the project's database (Courtesy of Swire Properties and Gehry Technologies). Gehry Technologies was the BIM consultant for One Island East. Their software, Digital Project, was utilised to create the virtual 3D model prior to construction, discovering close to 2,000 clashes that led to significant cost savings.

TAKE 5: There is a lot of talk about building information modelling (BIM) and its simulative powers. Can you explain very briefly what BIM is and what BIM can do, even in relation to how we work today? How can its use contribute to enhance the performance of the design or the building?

BURRY: Building information modelling is just a fancy way to describe the tie-up between the visual representation of a building via our computer monitors and the data that is the factual representation of the building via the digital database (FIGURES 1, 2). When we use a conventional CAD package, what looks like a door on the computer monitor, for instance, is more than just a visual impression of a building element in a BIM environment. What it is made from, how many hinges it is hung from and where they are placed, what it costs, who will supply it, how long it will take to deliver, how long it will take to hang, how many operatives are involved in hanging it, how it is finished, its maintenance cycles and how long it will last and, ultimately, how it will be disposed of, are all information tags that could be called up from the various databases associated with the BIM visual representation. What is more, all this information can be reinterpreted in 4D through the use of time and animation. Not only can the building's use be simulated realistically with a lot of 'what ifs…?' applied to the BIM environment – 'how will people enter the building?', 'how would they evacuate the building in a fire?' et cetera, but also all the construction sequences including clash detection of elements can be realistically considered.





FIGURES 1, 2: One Island East project, Hong Kong: Computer monitor screens with structural files and clash checks. (Courtesy of Swire Properties and Gehry Technologies)

Of course, this is still utopian at this point. I am not aware of a single package that will handle all the various possibilities that BIM purports to offer despite the promotional rhetoric. The more successful products all seem to operate on the lowest common denominator approach. For instance, whereas a building made from standard industrial components and tilt-up panels might be relatively successfully adapted to conform with current BIM structures, a typical award winning architectural gem will probably not be able to take full advantage yet. In any event, architects preternaturally will work beyond any software's natural limits, so I expect that BIM will take hold of the innovation centre stage for the time being, especially for construction companies, whereas I am sure architects will complain about the various products' limitations. I know I do, but I also recognise that the 'master of BIM' might end up being the 'project overlord', so architects need to take it very seriously, I believe.

TAKE 5: Is this type of technology going to change professional practice and building design? To what extent will it be able to modify the structure of the architectural office or the building procurement process?

FRAZER: I think everything is poised to change. We can foresee the changes in the building procurement process because digital modelling will affect the relationship between contractors and subcontractors in very predictable ways. The subcontractors will be able to get more, and more accurate, information directly from the designers. Thus, the whole hierarchy will inevitably change. In terms of the design providers, it is less clear. There are several options open, but the ability to take advantage of the opportunities offered by digital modelling depends on the structure of the design team.

BURRY: I think digital modelling will change both the practice and the process, and I think we will see challenges to the traditional leadership of the architect. Digital modelling will enfranchise a whole lot of that which was previously presented to be specific to professional expertise. It provides an opportunity to level the playing field for design procurement.

TAKE 5: Are you referring to the field in which professional architects and non-professional architects operate?

BURRY: Yes.

TAKE 5: So, you can see an expansion of the market for building designers and 'space' designers, not necessarily for architects.

BURRY: Yes.

TAKE 5: To an extent, though, this already happens. Architects occupy a small portion of the market for design services to construction. Are you saying that digital modelling will reduce their position even further?

BURRY: I can't predict what will happen. What I am saying is that new digital technology will challenge the social, physical forces that have allowed architects to maintain their position up until now.

The first challenge concerns the status of the 'concept', and its resolution through a design development process leading to building procurement. As long as the idea, that is the basis for the building, is held in great reverence by the client body, those people who are most practiced at ideation and resolution will sustain their role; and that would typically be the architect. But if we, as a society, start placing less importance on those attributes, then there will be other actors more adept at using the technology *per se*—a technology that allows, among other things, integrated workflow—who will take advantage of the windows of opportunity provided by the digital world.

What would happen, for instance, if buildings were delimited by technology rather than formed through technology? What if we decided not to preoccupy ourselves, beforehand, with the physical appearance of the building, and accept the physical translation of the technology selected?

One of my PhD. students is working with glass that has light embedded in it, and the light is fired through invisible gas conduits in the glass. It is extraordinary - you are looking at a piece of glass studded with light that you can see through, but you can't see little wires, or anything else to do with the technology for that matter (FIGURE 3).

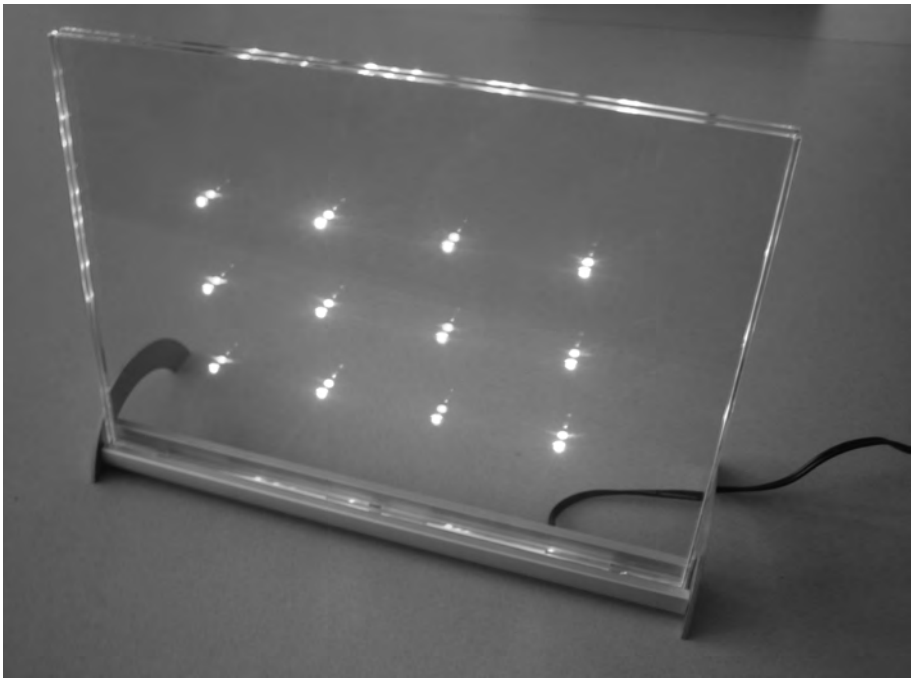


FIGURE 3: M. Hank Haeusler, LED glass by LIF Germany with LEDs embedded in two glass panels wired with conductive layers. (Courtesy of M.H. Haeusler)

TAKE 5: And you can imagine that, when the price point comes down, you can have a building that is classical today and Gothic tomorrow. The example may be banal, but there are going to be challenges to the traditional attributes of form and light.

You are saying that digital technology allows you to work deep into the future of things. And those industry actors who don't have as much cultural baggage as the architect but enough technology to carry out and implement their ideas, particularly at a commercial level, will win.

BURRY: Yes. And this is also related to how we teach and research at graduate and post-graduate level. Design flexible modelling, for instance, is a difficult technique to acquire; and if you look at the profile of the typical architecture student, you realise that very few of them are interested in becoming involved at that level and in that type of work. So it might mean that another kind of designer, interested in these generative techniques, might come through from an allied field and take control of the role.

TAKE 5: Will the adoption of digital modelling technology be associated to particular types of market or particular firm sizes? Can you see it percolate throughout the entire industry?

FRAZER: I am convinced it will, and one of the things I am interested in is to help make it happen. Since I operate from within a university, I can be instrumental in making these technologies available to small practice. In fact, I have been talking to a lot of small firms recently about how we can provide access to skills and technology so that they don't have to invest, upfront, a great deal of resources in equipment or retraining programs. Yet firms are still nervous about training their people up, because there is a feeling that aggressive poaching will soon start occurring in this area. This means that, in spite of my best intentions, the larger firms will be the first ones to move onto it, and on larger projects. But I see no reason why digital modelling shouldn't percolate right down the system very quickly once its benefits are realised; also because, as Mark Burry was saying, unless architects seize the potential advantage now, digital modelling poses a very real threat to them. At the moment is a fantastic opportunity for the profession to rethink its own role in terms of offering an integrated and professional service. If it doesn't take it up, I don't see how it will have anything to offer in the future.

TAKE 5: How long do you expect the diffusion curve to be?

FRAZER: Five years? I don't know, I am only guessing. There was an interesting article in the United States, recently, where the authors seemed to think that anybody who hasn't adopted this technology will be out of office in ten years. But, of course, they are guessing too. Personally, I don't see the issue in such a threatening manner at all; there will obviously be a long, long tail of buildings being constructed by the traditional trades and through the skill set available. Digital modelling, that is, is not going to remove the architectural profession and its established modes of operation overnight. But I still think that the next five years will be crucial if architects really wish to establish, or re-establish what they think their role ought to be. And those who wish to maintain the role of the architect as one in control of the whole process must demonstrate that they are able to do that through technology.

TAKE 5: You mentioned the United States, where the debate around BIM is very strong, and where also the construction industry has taken a proactive, inquisitive position in relation to the possible extended use of digital modelling. Is the situation in Australia different from that of other countries in this respect?

FRAZER: Architects in Australia are taking quite a lead in addressing some of these issues. The RAIA has a working party looking at integrated practice as a way of working with building information modelling. The construction industry could be seen as being comparatively less interested than some of its foreign counterparts, even though the experience of 'alliancing' provides a model platform for integrated practice that makes use of building information modelling. Not unlike alliancing, in fact, if there is only one integrated building information model the different parties can't sue one another over any error in the model.

Moreover, there are certain aspects that are quite progressive, particularly within those groups in property development that are exporting their skills to the Asian market. Last, there is a very strong sustainability agenda in Australia at the moment, and there are companies that are quite open to using these technologies constructively. This is the reason I'm here.

TAKE 5: Are there any specific factors that are likely to produce obstacles to the introduction or takeoff of integrated modelling and need to be taken into account? For example, copyright, liability, fee structure, etc. If so, do you think they can be overcome?

FRAZER: The model that is coming out of Asia is that the building client takes on the intellectual property of the design and then requires all the contributing parties to work as an integrated team. This means, essentially, that the design may be cloned. While this could give rise to an interesting phenomenon to watch right across China, it also raises questions about the impact that the concentration of intellectual property could have on the quality of the built environment; and this gives me considerable concern.

The fee structures are a problem also in relation to this. First, because the use of a fully integrated building information model requires an architect to attach a great deal more information to make an Information Foundation Class (IFC) link to a structural engineer. And yet there are no extra fees for this. So,

why bother? Second, because the person who benefits the most from using new building information technology is the client. Clients are likely to make significant savings in construction time, significant savings in contract cost and significant improvements in actual building performance. If they get a model that will remain useful for the whole lifetime of the building, and can be used for maintenance and ongoing management, should they be paying more for this? The integration of design information into one model and the shift in intellectual property rights should really imply quite radical changes in the fee structure.

TAKE 5: Will the cost of the system be reduced down to a level where acquisition, development and replacement will not be matters of concern for the office?

FRAZER: This may be contingent on the question and answer above. I would say that the costs involved with the acquisition of the system and required training are nothing compared with the total building cost savings that can be made as a result. The problem for architectural firms, as I see it and have already stressed, is really about training the personnel and preventing it from being poached. But, since the benefits are enormous, I would think that most practices cannot afford not to be seen to be involved. And, if most practices get involved, the problem about poaching will lessen in time.

TAKE 5: Yet what sort of training challenges digital modelling will create is actually important in the context of the question you just answered…

FRAZER: You need to have everything: levels of training at the bottom end, through middle management, and all the way to the senior architects who really understand how some of these advanced techniques can be used to the benefit of their work. It is only then that they will be able to generate ideas in a different way, and take advantage of the parametric world. The ability to plug into the power of these systems does require quite different conceptual thinking, as well as ability to think generically at times. Then there is a need to train the middle-tier—that is, the mid-career professionally educated type, to make them understand what the implications are in terms of the whole way the tendering process is going to work, their legal role within it, and so forth. There is a raft of challenges here that have to be met, but the first requirement is educative.

TAKE 5: But isn't there a generational gap in technological awareness and proficiency that makes this proposition difficult to sustain in practice, at least in the medium term? The median age of employed architects in Australia is 41 years. This means that the technical training they received in academia concerned, at most, the first versions of AutoCAD. Besides, a lot of Australia's successful practitioners are significantly older. Wouldn't age be a factor to consider in the success, or the rate of introduction and dissemination, of these technologies amid the profession?

FRAZER: To be honest, I don't know. But that's because, ever since I arrived in Australia last year, I have been talking to people right across the spectrum —very small, very young practices, right through to some quite elderly figures. With the latter group it is the usual story: there are some who are very dynamic and open, and can see where things are going to change. They are going to be the leaders without having to learn themselves how to do these things. What's required is an understanding of the need for such techniques to be brought into the office. Similarly, there are younger people who have been through particular kinds of architectural training and are absolutely dogmatic about it, entrenched in their positions already. I worry about them quite a lot more. More than an age gap, it is a vision gap, an enthusiasm gap, and a kind of confidence gap.

TAKE 5: Do you see the working structure of architectural firms changing as a result of this change in professional labour skills and technological tools? Will BIM force established hierarchies to be rethought or will it rather reinforce the polarisation of labour brought in with CAD, chastised under the CAD-monkey business label?

To clarify: until now, architectural practice has remained labour-intensive regardless of the technology. Today, wages and salaries account for over 50 per cent of the office budget. Will BIM reduce the weight of the labour component by increasing the productivity of the architectural structure? Are we going to need fewer technical staff to accomplish the same amount of work, if not more?

FRAZER: The question about the hierarchies depends on the model of practice. And the model of practice determines and is determined by who is in charge. Whoever is in charge of the data model in the future is going to be

king or queen of the system; and then there will be the master builder model, the digital craftsperson model, et cetera. We don't know. It could be that the investor and the developer decide to take over everything, and that architects resign to the idea of being nothing more than CAD monkeys.

For this reason, we need to consider these developments carefully.

Dennis Shelden, one of the directors at Gehry Technologies, gave a very good lecture recently around Australia. He put up a whole lot of different scenario diagrams of different practices and different groups who are trying to push this agenda to their own advantage and vision. He showed slides comparing different models of future practice based on experiments at various companies, from Arup to Gehry, and then stressed the implications on the whole office.

And yes, the question about office productivity is relevant. The problem, here, is that with the introduction of BIMs the architects will need two different sets of skills. One set is needed to add extra—that is non-traditional—information into the model, and its application implies huge extra labour costs. The other set is required to be able to design the overall model, something that, as Mark Burry was intimating, is not yet being taught as a skill. There will be a huge pressure to design architecture generically, so that the elements that are parametrically adaptable can vary. In fact, once the design loop closes, and the feedback from the performance optimisation functions starts arriving, the architecture conceived must be able to respond to that feedback. This suits certain kinds of architects, perhaps not all. It could also be that, in the short term, these needs will themselves produce a particular type of office, geared towards bringing the various extra skills together efficiently.

In the end, I think the profession has the ability to ride the wave, particularly because it thinks spatially. Without this ability, it becomes much more difficult to understand a model. One of the things that have alarmed me the most since I've been in Australia is hearing people from parts of the construction industry that don't actually do 3D modelling talk of design file protocols, and assuming that the protocols answer everything. I don't think you are ever going to create decent buildings out of assembling a pile of data, however good the exchange protocols are. What is needed is strong systems control and spatial control.

BURRY: Back to the original question about structural changes in the office, I won't put a 'yeah' to it since I made a dreadful prediction in 1992 that still hasn't been borne out in 2006; but I do think that some scenarios are definitely possible. Take very competent mid-to-late 20s students who have had a good education and some techniques up their sleeves. This will allow them to undercut traditional practice, and get opportunities to move forward and emerge in ways that will be very compelling.

TAKE 5: But hasn't this already happened in part using conventional practice? Don't younger architects have more clout in architectural practices today that they did 15 years ago?

BURRY: I am not sure. One phenomenon I have observed—and this builds on one of John Frazer's previous comments—is the thirty-something-year-old CAD expert, someone who has gone through university recently enough to have acquired the 2D documentation skills of the computer, who remains convinced that that is the gamut and there is no more to it, and who is therefore discouraging of anybody using the computer for generative-type experimentation. It seems ironic to me that the thirty-something year olds I speak to on this matter are more conservative than their senior peers who can't use the computer at all. Again, cultural shifts are required, but there are forces of opposition to the experimental use of computing technology that are inhibiting its full take up.

Of course I understand the reasons. It must be very frightening for somebody who has had to ride the crest of opposition from senior members and nevertheless been able to bring efficiencies to the office through digital factors to find that there are others coming through who are able to program. When you use the computer and you are able to program, the productivity factor goes up by several times. Irrespective of whether that productivity is in documentation or design experimentation, it becomes threatening for those who feel they have already made the big leap forward.

TAKE 5: Does the profession understand the future implications of this commitment to digital technology and building information modelling?

BURRY: I don't know, but I can tell you this. We have been running an Australian Research Council sponsored research program, called 'embedded practice', for some time now; and when I first put it out and invited every keen

key practice in Sydney and Australia to attend a presentation in which we promoted the idea of a graphic thesis-driven PhD, where 90% of the time of the PhD candidate would be spent within the practice, fully immersed in the working context, we had only six takers. Of these, only four were able to make the commitment for a three-year period.

Very soon, we will be presenting the mid-term results at an open forum. I don't know how many firms will turn up, and we will see the level of enthusiasm and/or scepticism generated then. At the initial presentation, where we showed how to apply these tools by way of worked examples, from large scale to very small scale, husband-and-wife team projects, we were generally met by scepticism, and a 'Who are you to teach us how to suck eggs?' attitude.

TAKE 5: What do your embedded researchers do within the practices that accepted them?

BURRY: On the one hand, they bring digital modelling expertise and knowledge from working at a very high level within the university; on the other, they form an integral understanding of the operative environments of the practices they work with. This allows them to detect opportunities to take certain processes and procedures along a different line, and yet insert them into the actual structure of the office (FIGURES 4, 5, 6)

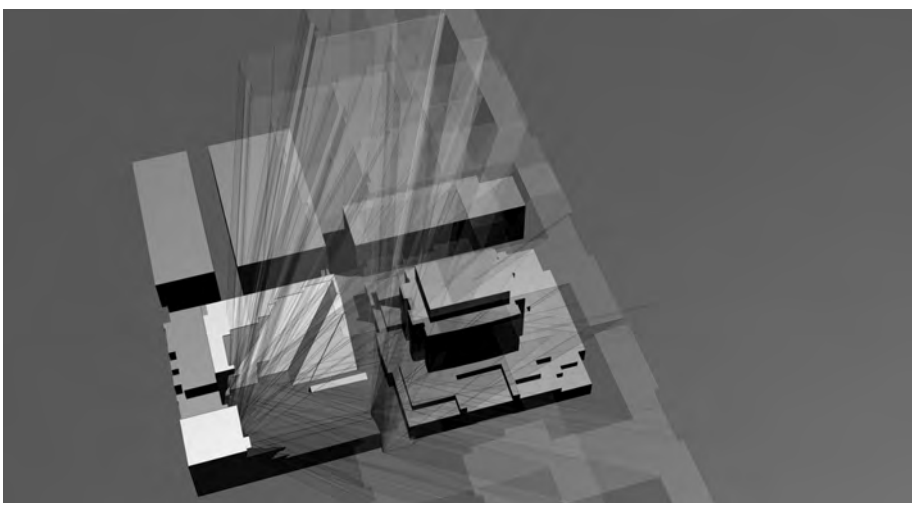


FIGURE 4: Marcus White and MGS Architects, application of a solid shadow subtraction tool to the public plaza of the St Vincent's Hospital in Melbourne for over-shadowing control purposes. (Courtesy of Marcus White)

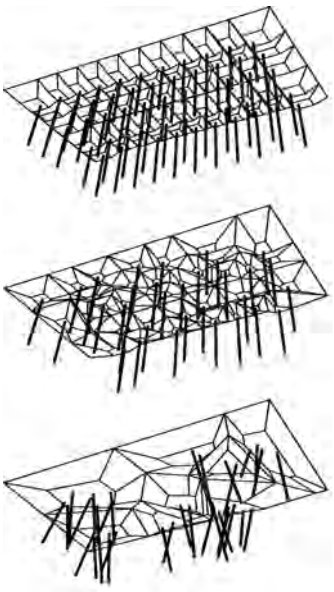


FIGURE 5 (above left): Paul Nicholas, engineer/architect interaction through generative design techniques: design iterations for a canopy at Arup. (Courtesy of Paul Nicholas)

FIGURE 6 (above right): BKK Architects and Rory Hyde, 'Pavilion', Pavilions for New Architecture Exhibition, Monash University Museum of Art, 2005. (Photo: Andr)

One of the problems, in fact, is that academics can show practice all sorts of new ways of working; but what they can't show is how an office can drop what it is doing sufficiently well in order to pick up potential new methods. It is just not realistic. And even if you can get a practice to admit that such-and-such technique looks great, or such-and-such software will produce benefits, if it is expensive in terms of initial outlay as well as workforce training, the take-up process will stop there.

TAKE 5: If the objective of this research programme is to study the introduction of digital innovation, why did you decide to embed your researchers within architectural practices rather than, for instance, construction firms?

BURRY: Because I am an architect, and I therefore have an allegiance to professional architecture. Besides, I am convinced that it is that small part of practice which is exclusively architectural that is at risk of being considered irrelevant. The way I see it, it is not irrelevant, it is crucial.

TAKE 5: At the same time, the findings that may come out of this research could be made viable because of their applicability to the construction process rather than the design process.

BURRY: My own experience is that the product doesn't matter that much; it is the way it is driven that is expensive and makes the difference. Even if a building contractor can see a new way of working, and even if they are deluded into thinking they can buy it out of a box, that is a small part of the commitment; the major commitment is knowledge.

TAKE 5: Yet the digital technologies we are talking about imply a high level of integration within the project coalition in terms of knowledge, equipment and understanding of each firm's objectives. If knowledge and understanding are not shared with the contracting side of the industry, how can architectural firms implement these processes on their own?

BURRY: This is the reason why we are collaborating also with Arup in Melbourne, Sydney and London: we see them as having greater knowledge of downstream integration than the architect. Working with both architects and engineers, and looking at the dialogue between them, will help us form a view of how to get the transfer across in broader sectors.

TAKE 5: Still, more than half of architectural firms in Australia have less than four employees and a moderate income. These characteristics generally translate in particular types of jobs, that is relatively conventional building, and a low level of capitalisation.

FRAZER: The example I frequently use in lectures is that of a very small boat designer I know, based in southern Ireland, who runs a very small practice from a little farmhouse with a very sophisticated computer system. He is able to control the complete construction of his boats to very fine tolerances, even if they are being built in a German shipyard a thousand miles away. This might be the model for small architectural practices, places of electronic craftsmanship capable to control the manufacture of the various building parts. And again, back to what we said a moment ago, there are those who are interested in this and those who are not. My job is to provide opportunities to the former.

TAKE 5: For the Australian profession, however, work opportunities are not limited to new building construction. As we show later in the publication, the third building market by dollar value in the country, and the highest in terms of relative growth, is 'alterations and additions', a sector that has grown five times in the last 30 years. This means that a large number of architects are working on parts of buildings, or existing buildings, rather than entirely new buildings. Would digital modelling help architects at work on extensions?

FRAZER: To be honest, I really haven't given this much consideration. I would have thought that it is probably not worth building a digital model of something that already exists retrospectively.

BURRY: I can stick to my own experience co-running a small practice up until 1996, by which time we did all our work in 3D regardless of size (and nearly all our projects were small extensions or houses). I have always been scratching my head wondering what the forces are that make 3D modelling not the automatic choice of architects at any scale, because of the ease of being able to handle and extract the other information from the 3D model compared with the more conventional 2D abstractions. I would have thought that the tools that have always existed in our digital era are becoming easier to use and more current, and I would probably need convincing that a job could be too small for a fully detailed 3D model.

TAKE 5: You are saying you don't need to develop your 3D model capabilities in-house from scratch. You can make use of what is already available in the industry.

BURRY: Yes, and I will give you an example. There is one aeronautical software company in Australia that has been talking for over a year with us about organising a competition for building a house for secondary school children using extremely sophisticated parametric software. This tells me that, at some point in the future, we should expect young people coming into architecture programs already being able to model in 3D, and there are already a number of students who can do that. Architectural courses always work to the lowest common denominator, and the lowest common denominator is the person who hasn't turned a computer on yet. So we still see courses around the country where people are expected to learn how to use the computer as if they don't

know it already. At some point, the penny is going to drop. People coming into architecture schools, and eventually out to practice, should spend their time adding value to their existing ability rather than simply applying that ability to relatively mundane tasks.

TAKE 5: On the other hand, the construction industry in Australia tends to be fairly conservative, particularly in light of the bulk of the project housing (and now high-density housing) component within the overall building output. Since this component is developed by-and-large through the use of conventional technologies and, specifically, standard timber framing and tilt-up concrete slabs, where is the potential for digital modelling to influence the product as well as the related procurement processes? Or are the advantages of its adoption only applicable to building types of higher complexity and capital investment per unit?

FRAZER: Let me translate the question in a different way. If you are asking how these technologies will be taken up in Australia, I don't think mass markets will come first. I think the sort of things that will come first are export–related and individual vision-related. At the moment, there are a significant number of developers and fund managers who are looking for construction opportunities in Asia, where the use of these technologies is much simpler in legal terms and so forth. Locally, there are some visionary clients who are pushing to build exemplar buildings. I am seeing some healthy competition across the country at the moment.

TAKE 5: The word 'export' can indicate movement in both directions: Australian firms taking their services overseas as well as foreign firms exporting their services to Australia. If the situation in Asia is more conducive to the utilisation of digital building technologies, wouldn't their adoption in Australia facilitate the introduction of foreign competition?

FRAZER: Competition is a double-edge sword and goes back to what we were saying earlier. Local architects are in a stronger position here; but, if they decide not to compete on these grounds, others will come in.

TAKE 5: Will the adoption of digital technologies spur the vertical integration of building procurement structures, with contractors becoming developers on one side and design service providers on the other?

FRAZER: It is one of the likely future models of practice, perhaps the closest to what is currently happening in Hong Kong, but there are other possible variants on that. It also depends on the industrial context.

TAKE 5: Most of the work you have been referring to presupposes a connection with trade specialists and manufacturing. Could this mean that the architectural process will eventually by-pass general contractors and use system fabricators to affect building procurement and quality more directly?

BURRY: I don't know. I can see a situation where all that is required of a general contractor is to produce a viable ground level platform for a building, and for the rest to arrive on a truck at any scale. With the way technology is going, this scenario is not impossible. The obstacles to the viability of prefabrication seem to have been removed. So we have these two sides, two book ends; one is time-honoured procurement through small specialist trade organisations; the other is factory-finished production just being assembled, possibly robotically, on a viable platform.

TAKE 5: To reiterate something we asked at the beginning, will design and building performances become better as a result?

BURRY: Better in relation to what? It depends on what we want to sustain. We could decide to sustain practice and tradition for maintenance of human dignity, for example. Or we could argue that better factory components more robustly assembled on site might lead to a building that leaks less or requires less maintenance. Or, further, we could argue that such a process would lead to building components that could be reused and recycled more adequately. I don't have a position in terms of absolute value other than being intensely interested in seeing what plays out, and perhaps playing my own part in reminding others that any scenario is viable depending on the prior definition and sustenance of our overall cultural objectives.

TAKE 5: Will the architectural field level in the future as a result of the inevitable development or adoption of building information modelling?

BURRY: As I reach what is generally termed as 'mid-career' the pressure is off. Until recently, I kept asking myself 'Why is everything so slow? Why aren't we doing things more quickly?'

For twenty five years, I have been watching how often the blindingly obvious is ignored technologically and process-wise. Yet this has not prevented architectural culture from growing. We still acquire great buildings around the world. So I have stopped worrying about it. If I was leading the profession I still would, I'd worry about the opportunities for my members. But in terms of a cultural perspective, I don't have any worries at all. Certain opportunities might be suppressed at present, but it's like squeezing a balloon, they will just re-emerge somewhere else, and someone else will take them up.

My long term view is that it will all balance out. There won't be any architects pushed out of the profession, but there won't be any luddites left either, in that there won't be anything for them to do. There will be a new generation of architects who did not have to be pioneers but who are comfortable assuming their role in a post-digital construct. I just can't put a timeframe to it.

TAKE 5: What are the implications of this view about the future for the procurement process and the type of contracts currently in use? Will traditional procurement go out of the window once the traditional set of contract documents is no longer needed?

BURRY: About two years ago, I spent a whole weekend locked in a conference room with Frank Gehry and the other members of his advisory committee arguing about the legal status of documentation and the lack of status of a 3D digital model. The impression I got from the people present was that, if that was overcome, if proper legal status were given to a 3D-driven document, everything would change overnight.

TAKE 5: Why?

BURRY: Because you would have one single armature from which to hang every piece of information and its qualitative implications. The armature is the legal structure, like a meta-document to the actual building. You don't

have to have the conventional building documents in order to have the meta-document describing the building as a fact. And you can't do anything with it prematurely because you don't have sufficient information to build from it. Until you produce, literally, a completed digital facsimile of the building. Also, with a comprehensive 3D model, the various parties can begin to work in 4D. In other words, by bringing in a time function, very realistic simulations of the construction program and actual building use can be made, all of which will positively contribute to quality and efficiency.

TAKE 5: But it remains to be seen who is to produce the facsimile.

BURRY: I once heard a major construction company explain how stupid it was to have received architectural documents and engineers' drawings in 2D, then for the construction company to build a 3D model. The reason why they had to do it was to work out where all the clashes were, without having to argue with the engineers and the architects.

The example they gave was a 20-storey tower block built from conventional documentation where, for every staircase, the designers had forgotten to include an allowance for 10mm plasterboard sheeting, which required the contractor to shave 10mm of concrete off every single fire staircase in order to fit in the slightly reduced stairwell. Had they built a 3D model, this would not have happened.

As I pointed out to some academic colleagues at the time, the writing was on the wall. If the builders were now building digital models from some architects' pathetic little abstractions, well, that was it. I remember one colleague looking absolutely stunned, saying, 'Since when have architects built the building?' This person regarded what happened as a natural transfer to the builder, who would make this 3D facsimile as part of his or her contribution to the effort, leaving the architect free to concentrate on what architects do best, which is to ideate. That comment was made about eight or nine years ago and reflected what I think is a reasonable cultural dilemma.

TAKE 5: One could say that the dilemma is more than cultural, since the architect does not have the ability to produce a model that takes into consideration, or preempts, all the contributions coming from the industry. If one cannot pre-nominate subcontractors, for instance, it becomes difficult to build specific information into the model. From this perspective, the general contractor may be in a stronger position due to the ability to manage a more complete set of data.

BURRY: I accept all this. Yet this could also mean that the contracting team might take the brief, and might employ optimisation software to ensure that every floor plate had the best possible layout, that is a scientifically provable, optimised layout. Then the last thing they need to do is go to an architect in the same way as one goes to a hair stylist, and say, 'OK. Now give me something for this building that gives it its necessary chutzpah'. And that is only the first conversation. They might not even need to get an architect for that; they might have a light facade and they might need to go to a media artist, or my postgraduate student referred to earlier and say, 'I want to have a set of 400 different effects for this facade to play with'.

I just find the emerging sophisticated software modelling suites so complex that I prefer not to say 'This is what and who will drive industry'. I can see the subcontracting of overly difficult components being an obstacle to the full effectiveness of the building information model as far as they can perform currently, and I can see contractors being powerful enough to absorb all the various subcontractors into a regime driven by the understood protocol of the 3D model defined to a lowest common denominator of performance.

TAKE 5: What sort of training challenges does such a regime create? Vocational or professional ones?

BURRY: The industry certainly needs to be trained in order to make best use of the opportunities they are confronted with. Architects need to be informed of what these opportunities are, and how the category might best contribute to them. In my view, however, the training of the architect should first and foremost be concerned with the social contribution of the discipline. Interaction with the many other players leading to a building comes second.

TAKE 5: If the architect's contribution is of a social kind, why should architects be concerned with 3D systems?

BURRY: If what you propose as an architectural construct is completely conditioned by building procurement then, *ipso facto,* the training of an architect must encourage expertise in the negotiation of that process. If in fact you can separate the two because of the automation that digital techniques allow, then I see no reason for it.

TAKE 5: How can we then make decisions as to what training is required?

BURRY: It is an individual choice. Personally, I put the social and cultural significance of architecture above its procurement processes. Therefore, as an individual, I am compelled to do whatever I can to make sure that, every year, there is a group of architects best placed to make a cultural contribution, and savvy enough to negotiate whatever paradigm is in existence for building procurement so that they are not alien to it. But I can listen to somebody who makes a compelling case that this is an outmoded way of thinking about the production of buildings of cultural significance.

TAKE 5: In some ways, we are still facing the old dilemma of what architecture is or stands for: an intellectual domain where buildings of note are produced, or the metier through which proper urban fabric is conceived. Could the adoption of 3D modelling help us find some closure? Will BIM help the industry produce a larger number of quickly disposable buildings or make it easier for average output to raise its qualitative levels?

BURRY: It is a double-edged sword. The wrong side of the sword could undoubtedly lead to a dumbing down of our architectural procurement, with most people being able to take part in it, irrespective of the architect's role. As an optimist like John, I see it going the other way. For a start, the sort of people who decide to study architecture tend to be among the brighter members of the community. If they are coupled to new tools and new work paradigms, there is a chance that the cultural value of all our buildings will be positively affected.

TAKE 5: Isn't political will part of the equation?

BURRY: If anybody asked me what the real issue is in today's Australia, I would say it is getting architectural awareness into learning curricula at primary school level or earlier, so as to create a future informed clientele. This is why I don't particularly look for huge changes in the short term. If we had a situation where an awareness of the physical and cultural value of the built environment started being developed very early on, people would understand exactly how the built environment works—what its impacts are, what it means culturally as well as practically—by the time they leave school. And this may raise everyone's expectations of what a building is or does. If we started with primary school now, by the time this generation graduates the tools will be well in place to make sure that most of the obstacles to cost-effective high quality building will have actually been surmounted.

TAKE 5: You are saying that the underlying issue is one of demand rather than supply?

BURRY: Yes.

TAKE 5: If so, what is the role of our architectural institutions in this?

BURRY: Leadership. We can't hang around waiting for a time, say 25 years from now, as if then we would suddenly have a universally well-informed clientele emerging. We all have to be optimists now and do the best we can, understand what is happening around us contextually as best as we can, and try to adapt as best as we are able to all the cultural, political, and economic forces currently at play, while still boxing clever.

Quotation on back cover:
Manfredo Tafuri, Conference at Princeton University, 1974. The text was published in the same year in *Oppositions,* 3 as 'L'architecture dans le boudoir: The language of criticism and the criticism of language', and then included in the book *The Sphere and the Labyrinth*; Cambridge: MIT Press, 1987.