Building Information Modeling in the Architectural Design Phases

And Why Compulsory BIM can Provoke Distress Among Architects

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Abstract: *The overall economical benefits of Building Information Modeling are generally comprehensible, but are there other problems with the implementation of BIM as a formulized system in a field that ultimately is dependent on a creative input? Is optimization and economic benefit really contributing with an architectural quality? In Denmark the implementation of the digital working methods related to BIM has been introduced by government law in 2007. Will the important role of the architect as designer change in accordance with these new methods, and does the idea of one big integrated model represent a paradox in relation to designing? The BIM mindset requires changes on many levels.*

Keywords: *BIM; Building Information Modeling; architectural technology; design approaches; mindset.*

The BIM incentive

Though the overall economical benefits of Building Information Modeling on a theoretical level are generally comprehensible, its implementation in the field of architecture has been dealt with in slightly different ways. Already many examples are known of what results a properly applied BIM method can ideally add to the architectural process in matters of economic gain. But is the so called lean or smooth way of designing really contributing with an architectural quality? This paper will discuss in a larger perspective some of the problems related to BIM in the architectural design phases, and illustrate why an even more imperative questioning about BIM, as a system connecting processes, must be addressed

in order to understand the BIM realm and its borders from the designing architect's point of view.

Crisis as condition of development

The situation we are facing on a global scale has recently turned our attention towards both the economical and environmental aspects of our societies to a degree that forces us to reconsider many of the traditional ways we have been dealing with the world. This is reflected all the way from a financial crisis through the micro scale of everyday life of the citizens of western society, to the macro scale of the climate change, and thus the entire planet's well being. It is in many ways a situation of multiple crisis coming together, and in this regard the seriousness of the actions needed to be taken are beginning to
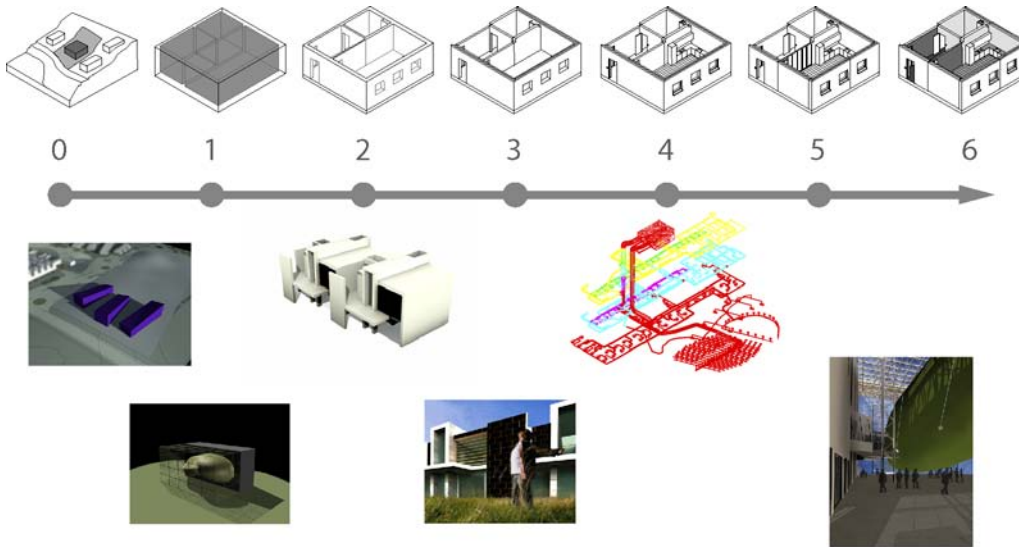
manifest on all levels, including the construction sector. The current conclusion is a demand and an urge to build sustainable, and raise efficiency, in order to counteract some of the scenarios a mindless increase of cost of living and depletion of the resources most likely will create globally in a not so distant future.

Perhaps it could be useful to consider the idea of crisis as a condition for our modern society? Modernity, as a permanent state of crisis, that can not be solved completely, but must be dealt with constantly, in order to secure our survival. The definition of modernity by Saggio (2007), inspired by Jean Baudrillard and Bruno Zevi, as what gives rise to a new 'aesthetic of rupture', is exactly a transformation of a crisis into value in a contradictory moral.

Then value becomes exactly how to turn crisis into something useful, apparently by aid of technology. Value is not, however, development of more and more advanced technology in itself. It is obvious, and ironic, that many of the problems we are facing now and in the years to come, have been created through, or alongside, new technology. But that is exactly why crisis could be called the condition. We can not afford to *not* react, but our reaction is on the

other hand not necessarily in itself a progress - rather a temporary cure for chronic condition. The crisis of our modern times is not an evil which can be fought off, but a condition that needs constant concern if we shall succeed in not contaminating our civilization and the generations to come above its pain threshold. In other words: the current crisis might have an impact on the mental picture of value in general. This impact is already reflecting throughout many levels of society.

An example could be the change in popularity of cars of different sizes. Not many years ago big fuel-consuming cars were the accepted symbol of status, but now, with a heightened awareness of economical accountability, the ecological atmosphere is spreading an ethical fashion hype, which pilots a growing branding of smaller and more fuel-efficient cars, also as a statement of sustainable responsibility. The popularity of small cars is of course also due to fuel prices and legislation - raise of taxes on vehicles such as 4WDs and MPVs (http:www.dst.dk/nytudg/10915: June 2009).

This same trend can also be observed among architects, and in the construction sector in general,

where it has become much more common to promote sustainable or 'green' approaches than it has been before. The crisis leads to new ways of reacting, and new mindsets are needed in order find solutions. Thus BIM is part of a new mindset. The idea of BIM is older than our present situation of crisis, but its *implementation* is still going on very much today and must therefore naturally take part in the troubles we are facing in the area of the construction industry.

Nordic BIM

In the Nordic countries the governmental institutions have been eager to bring the level of technological operability within the construction sector to a higher state. In Denmark this has been done through a government initiative *Digital Construction* [Danish: *DDB / Det Digitale Byggeri*] by a series of demands and declarations of obligatory use of digital tools and specifications about digital working method. The aim of these laws is to improve the efficiency and quality of construction, and the driving force is therefore the construction industry not the architect. This is interesting since the Nordic BIM motivation of architects is as a result not entirely based upon the economic or other benefits, but based on the legislation. In Denmark the demands imposed by the government since 2007 is summarized in these four categories:

Client demands

The digital *client demands* scheme consists of a range of specific individual demands organized in four areas:

- Call for tender, bidding and tender via the Internet
- 3D models
- Project web also on site
- Electronic hand-over of data from the construction project that are relevant for operation

The demands apply to new construction projects totaling DKK 3 million or more. However, electronic hand-over is only demanded for projects exceeding DKK 15 million. Finally stricter demands are applied to construction projects exceeding DKK 20 million. The demands also apply to renovation and conversion project. (http://digitalconstruction.dk/digital-client-demands-scheme: May 2009).

The request for a common description of the building phases has resulted in a working method dividing the construction process of the 3D model into seven phases with different levels of information, each containing more enriched detailing. The idea is obviously to facilitate the communication between the different stakeholders, but it is a linear way of thinking, and therefore opposing the iterative processes of architectural design. Though this division is not what most of the architects I have been interviewing in relation to my research, are referring to as a principal problem, it is considered rigid. In general this way of working must be altered to fit the way architects and other actors in the building process actually deal with a real-life project.

The division of the process into so precisely defined phases, in some way requires an additional effort exclusively from the architect. The ambition from the legislators is that a model at information level 1 should be capable of communicating the project to a degree where the contractor can get preliminary cost estimates. But many of the decisions necessary, even for an estimate, can only be made after considerations of factors such as position of window openings, which, according to DDB, are placed in the information level 2 and 3. This means that the architect must always be way ahead of the consultants in order to supply the information in a reliable way. That is obviously not the idea of BIM as collaborative tool. This example shows that the working method is presented as linear, but that there actually is a need for a more iterative approach.

One of the reasons for this could be the strong focus on the digital model in the DDB. Building Information Modeling is, by the DDB, often translated into Danish as 'Building information model' [Danish: *bygningsinformationsmodel* (http://detdigitalebyggeri.dk/component/option,com_rd_glossary/: May
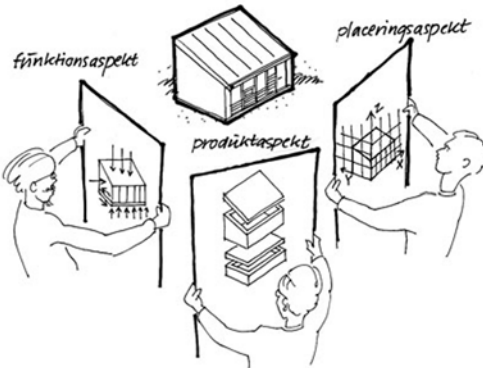
2009)], which indicates a produced *model*, and not the actual *act* or *process* of model*ing* the information related to a building.

DBK

The problems in relation to the process phases and information levels have, in the construction sector in general, possibly been overshadowed by the frustration of another cornerstone in the client demands; the national classification system DBK.

In the first category of the client demands the use of the specified bill of quantities based on the new Danish construction classification system, DBK, has become mandatory in 2009. This is more in theory than practice though, and it is a major concern among the architects. The argument is that this national classification system is simply not applicable in its current state. The idea behind the classification system is to be able to view different aspects of a building's information through their codes. There is hence:

- Function aspect – describing the functions and purposes of the objects of the building.
- Product aspect – describing how building components are constructed and what they consist of.
- Placement aspect – describing where the building components are placed in the building structure.
- Form aspect – describing the shape, geometry,

and look of the building components.

Though the idea of common standards is of extreme importance in order to facilitate communication, the DBK attempt has not yet been successful according to the response from architectural offices and the construction sector in general. Actually a close to boycott-like situation would be more precise to describe the way it has been received.

A test performed by Digital Convergence [Digital Konvergens], a collaboration between six of the leading operators in the Danish construction sector, have revealed some of the problems that need to be solved before DBK can be operational in the construction sector. They point to the problem of ownership and responsibility. Nobody seems to be willing to take the responsibility of developing and maintaining the system, which might be a sign of the vast amount of work still required. Also the development of learning material and the integration in the relevant software applications together with an ongoing attempt of internationalization are needed. (http://www.digitalkonvergens.dk/da/news/20090213: May 2009) Of course these are problems that do require attention, if the DBK should ever be operational as anticipated already many years ago.

These are broad problems for the whole construction sector. They are not entirely the same as the before mentioned specifically architecturally related concerns about the implementation. The focus on the 3D model as the main information bearer could be a deceitful attempt to support an idea of one big software package as the solution to the whole BIM-lifecycle working method. There are many interests at stake in this matter, but if the main objective is to ease to communication of information it might be helpful to distinguish between BIM as the working method and BIM as software applications.

BIG BIM - little bim

In my BIM research in Danish, Swedish, and Norwegian architectural offices some trends can be spotted. In the Nordic countries BIM is a buzzword, and therefore it can be difficult to distinguish, on the

surface, to what extend the different offices are actually working with BIM. This confusion can to some extend be clarified by introducing the distinction between *BIG BIM* and *little bim*, originally set up by Jernigan (2007). BIG BIM as the overall building information working method, and little bim as the various software applications that support the mindset of BIG BIM.

An understanding that BIM implicates more than changing the software in the office is crucial. Among the Danish offices, which have been obliged to use the client demands, the most aggravating problem is often that there is little real encouragement to use BIG BIM - BIM as a working method. There is, according to interviewees from my field research, also a disproportion between what is *desirable* to understand and what is *possible* to understand, among the implicated actors. The limits of the technical know how are different on different levels.

The architect cannot possibly know as much about engineering and computer programming as the professional engineer and professional computer programmer. He is not an engineer and not a computer programmer to the same degree as professionals in these fields. Nevertheless there must be a motivation for knowing sufficiently about other disciplines to be able to interact. The role of the architect in the digital age seems, in this perspective, not so much to be pursuing the ambition of performing as a computer programmer, but rather to be able to understand how to apply the skills of the programmers, as it has also been the case earlier in collaboration with the engineers. But let the programmers do the programming, and let the architects do the designing.

BIM is a working method that requires a new mindset, and possibly new roles and job descriptions. Someone must be responsible for the digital information, and someone must be responsible for the maintenance of the archives and systems. The more automation in the systems, the more important it is to be able to keep track with the automation process. A failing automated system could, if unattended to, in the worst case scenario cause an automated catastrophe.

Linearity and absolute control

The working method per se encouraged by the government administrations is an attempt to save money. This is probably understandable as a government incentive, but some of the side effects this potentially contains, could have a much more dubious consequence to the whole field of creation seen in a larger perspective, if not applied carefully and solicitously. Is this linear description of workflow providing enough room for the creative part of a project? Is the architect able, or should one say *supposed* to adapt to that idea for the reason of cost reduction?

The BIM promise, if one can agree to this term, is that one day all data and information of a project will be available at the right time to the right people through a building information model - being a virtual 3d model or a diagrammatic 'scientific' model. The achievement of this is questionable on many levels. First of all it is historically unlikely that any system can be devoid of errors. One could claim that this is evident and the real goal is not to reach absolute control with the building processes, but to refine and optimize the control through perpetual updates in the system in *striving for* an absolute and complete system. But is that at all the right goal to aim at? Is the idea of absolute control through BIM perhaps counterproductive as a method for designing, seen in the perspective of its own impossibility?

A complex system
As anticipated above, the BIM promise deals with the whole cycle of the building. Everything is systematized and named from the first design and planning stages through construction to facility management and disposal of the building materials after demolition. Thus the building information model is a system that claims to update and evolve over time.

As Kwinter points out in Architectures of Time: From the moment a system is understood as
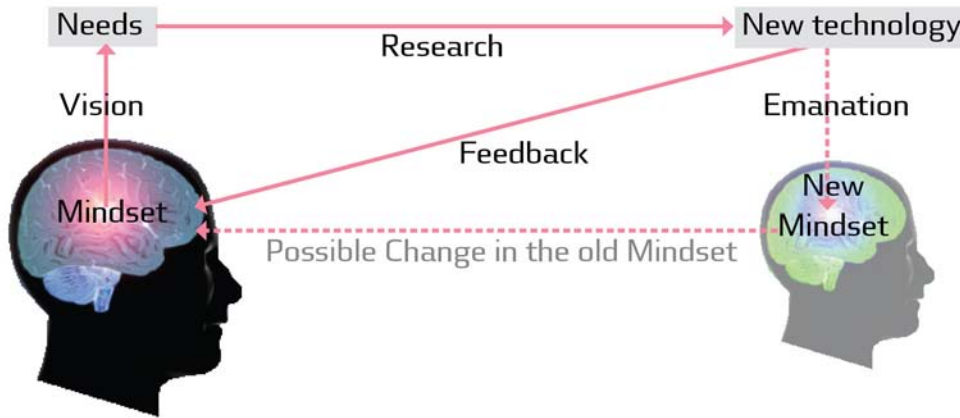
evolving over time, what become important are the transformations it undergoes, and all transformation in a system is the result of energy – or information – moving through it. (Kwinter 2001, p.23).

Regarding output, BIM is like a system: no input equals no output. The required input in this case is indeed information. This information, about a building, is to be moving through the whole time span cycle of the model, but can only be measured in time, and not in advance. There will be feedback mechanisms, and the information will potentially produce events on other heterogeneous levels in the system that by definition are unpredictable. These states within the system that are instable and unpredictable are exactly why an absolutely controllable BIM system is paradoxical, and might be undesirable in relation to designing. Perhaps these unpredictable differences, singularities, are necessary in order to create architecture. In that case we must allow our building information modeling systems to be sensitive to time in order to avoid that it constrains itself entirely to the use of predefined parts and routines. If this sort of time aspect is to be implemented in a BIM system, the technology must be much larger than a single software package. It must be a method, and

it must reflect the mental impact the computational shift of paradigms has had on the modern mindset.

Architectural technology
As the architectural tools have evolved over the years, so have the way of *designing*, and the way of *thinking* architecture. For instance the invention of the perspective in the renaissance had a major impact on the construction and visualization of buildings, as had the idea of mass production and the systematization for the modernist mindset and the architectural design of that era. Our digital tools will as well shape (and are shaping) the way we think and design architecture. The diagram below illustrates the very basic idea of this link between mind and technologies (figure 3).

As a way of describing what could be the terms on which a new technology such as BIM is functioning, the idea of mindsets can be used. A vision spurs in the mind, i.e. the architect's great building setting. This vision produces needs that must be fulfilled in order to realize the vision. This is done through research, which then again manifests in a certain new technology. This technology helps to accomplish the vision in fulfilling the needs required. Though this is

already a closed circuit in the system, of course presupposing the efficiency of the developed technology, there is a possibility that the new technology emanates something unexpected. This could manifest in the form of a completely new mindset that deals with premises not possible to take in consideration before the technology was researched. This leads back to the before mentioned topic of a system and the singularities. This unexpected, or incommensurable emanation, is exactly what *must* be included in a BIM system if it should be able to provide aid also in the essential architectural design phase. We must accept that the creative instigation cannot be calculated or formalized to the degree of the rest of the project phases.

Integrated or distributed model

As suggested by Ibrahim et al (2004) a BIM model can be integrated or distributed. The integrated system aims for the whole package containing structural analysis, mechanical systems, cost estimation, code checking, and maybe even design suggesting system all within one big system.

The distributed model however is a system that relies on references. This model can point to different systems outside itself where the needed information is stored, without necessarily embedding it in one big geometric model. Every system does what it specializes in and passes the information between the other systems.

In relation to the this discussion, it seems most likely that BIM as a distributed model will be the best way to ensure the room for the essential creative phase to be linked and relate its information to the rest of the different systems needed in the process of construction.

Conclusion

Learning from experiences in the Nordic countries, the distress contemporary compulsory BIM can provoke among architects is in consequence not totally without reason. The concerns related to suggestions

of a linear working method that promotes the reduction of the creative loops in favor of systemic optimization, is one topic that must be addressed by architects.

BIM as a working method that focuses on the process of modeling or perhaps better *managing* information, requires a change in the mindset both on strategic and tactical levels, and not only on the operational level. Without BIG BIM, little bim is not a very potent tool. But without a creative input, BIG BIM will have nothing of quality to work with. The software must be applied as a collaborative tool, and must take in consideration that not every part of the building process can be measured and calculated to the same degree.

BIM, as it is currently perceived in Denmark, relates more to construction than to architecture. Though it is of great importance that the architects remain a strong important part of the game, and make room for their role as designers and certifiers of the architectural quality of the construction sector, it is likewise important that they take on the challenge of exploring the new digital methods of collaboration.

The recommended focus should in the near future be in the distributed model as a more flexible and open way of dealing with BIM. The paradox of absolute control within one BIM model should be considered wisely. Relying on one integrated model could mean an eventual loss of control with real value of the architectural quality: to create meaningful and beautiful spaces for real people.

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