DISORGANISING BUREAUCRACIES

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WORKING PAPER

1.0 INTRODUCTION

By asking how real bureaucracies' (government agencies, i.e.) action vis-à-vis digitalization of construction effects the order of work in the design phase I am going to discuss how the introduction of 3D modelling disturbs work routines, methods and processes. The discussion appears relevant because, as a matter of fact, several Danish practices rush to 3D digital modelling in response to, among others, public clients' request for 3D building models. In the transition from 2D CAD (Computer Aided Design) to 3D BIM (Building Information Modelling) several complicated issues call for the attention of partners and e.g. CAD managers. Object oriented modelling challenge existing work procedures, methods and routines and puts strain on the users' competences, e.g. their capacity to 'work around', to communicate and coordinate, to structure creative processes. Along with the debatable advantages of building modelling comes a plethora of challenges, namely the unforeseeable effects of socio-material associations. Sometimes 3D modelling transforms practice in surprising ways. Dealing with the managerial difficulties associated with adopting a 3D modelling practice the focus lies on the distribution of work and the composition of teams. In three relatively short story lines I illustrate how partners need to pay further attention to the manning up or down of project teams, to the breakdown of phases and to quality assurance procedures. As such, the underlying question that I want to discuss is the disruptive power of BIM – the 3D modelling tool's capacity to destabilize the organisation: How does BIM disorganise practicing?

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2.0 BUREAUCRACIES AT WORK

What I have set out to discuss is how the real bureaucracy's request for a 3D model manifests itself in practice in the form of more subtle bureaucratic measures such as highly complex 3D modelling tools that now set on architects and consulting engineers' PCs so as to interact with and disturb in unforeseen ways the existing socio-material organisational set-up already in place (hence the 'disorganisation'). If, as outlined in the call for papers, firms in the construction industry are bureaucracies managing projects my line of argument is that the 3D modelling software are bureaucracies disorganising firms' established routines and procedures. To follow this line of argument it is helpful to adopt an understanding which grants the technology a kind of intentionality, of agency, or say, 'actantiality'. However, before elaborating on this allow me to firstly clarify my understanding of BIM, secondly how I think of BIM as a bureaucracy.

2.1 BIM demystified

By 2008 BIM has become the buzz-word used by most software suppliers within the industry. Full fledged BIM models are executed on a central repository, a model server; also objects are kept in a database. The advantage is that each object, e.g. a column, a window frame, etc is described only once, but applied several times. If an object needs to be modified, you modify the object only once, however, the change is applied everywhere the object is anchored. Graphical and non-graphical documents, drawing and specifications, schedules and any other data, respectively, are included (Lee and Sexton 2007: 290). Complete BIM models or systems cover geometry, spatial relationships, geographic information, quantities and properties of building components, including e.g. manufacturers' details. The most advanced, integrated solutions *promise* to open-up for integrated building processes, supported by product/process models. Proponents of the technology anticipate that BIM may bridge the information loss normally associated with handing a project through the various phases in construction, e.g. from design to construction and through to operation by allowing each group of actors to add to and reference back to all information dealt with during the various phases of the construction process. When so much is to be done on a single representation, the 3D models become extremely complex – the number of objects held within it and the associated amount of data that must be handled to represent the building's design, its installations, it performance – are colossal. Thus, brand new 'quadro core' PC's loaded with additional RAM and the latest in graphical processor technology to serve preferably two big LCD screens appear very slow. Trivial operations, like e.g. deleting an element in the model, takes seconds, something that hitherto happened instantly. For every change the entire model must be calculated. Rendering may take hours – people put labels on their screens to signal that the PC is actually busy, they look for free work stations to continue doing what they have to do elsewhere or they start the process just before leaving the office and the machines for themselves – to operate overnight. Then, rendering farms are installed but the configuration often calls

for the attention of the IT - or CAD manager. On a personal level the new 3D modelling practice turns experienced architects into complete novices, lost in the application, as they fumble for a command, a short cut, and the like. Learning to use the new tools has become a matter of *fooling around* – in many cases because the users actually don't know what exactly what they are looking for or where to look. When that is not the case efforts are spend *working around*, trying out alternative routes to get the application do as intended. Indeed, we have only just begun – experiences are based on but a few pilot projects, communities of practice are about to establish themselves, object managers being hired, quite clearly, change is on the agenda.

2.2 BIM as a bureaucracy

And change was the intention when in 2002 the Danish government wanted growth on purpose ("Vækst med vilje") (Regeringen 2002) and later on, when the National Agency for Construction and Enterprise issued its 10 commandments (attachment to the statutory order no. 1365 of 11 December 2006): as of 1 January 2007 public clients should demand that a IFC-compatible 3D model was developed as part of the contract. I have described elsewhere (2007) how digitalisation of construction was brought about as the answer to most if not all the industry's problems (flaws, mistakes, delays, budget overruns) and how an actor-network composed of different kinds of human and non-human actors got interested and later on enrolled – to promote digitalisation, to promote BIM: Digital Construction was nothing less than a revolution, a new alphabet, a shift of paradigm. Now the statutory works like an obligatory passage point – if a studio wants to respond to public tenders it needs the software. What we witness is public clients *pushing for demand* of 3D modelling software and what happens. Modelling software is being developed, localized (to some degree), licenses bought, applications installed, and experiences made. Consider the applications themselves bureaucratic entities. In conventional terms bureaucracy refers to the structure and sets of regulations in place to control activities, as is actually the case with architectural work. Despite architecture may be referred to as the queen of all arts, and architects as being creative anarchists, their work practices are fairly rigid. And so is the new technology. It requires users to structure their work according to strict principles, standardized procedures, and hierarchies. In the 3D model objects are relationally defined and connected, organised in families. It should be all very well organised but, to me at least, it appears as if there is more resemblance with the kind of bureaucracy that e.g. Deleuze and Guattari's (2005 (1980): pagination) talk about: relations dissolved, distributed, boundaryless. The 3D model holds lots of potential but try for a moment to look at it as a labyrinth in which users move around, in this and that direction, facing an endless series of problems that need attention, more pressing issues, news question to which only vague answers are given. When the output from the 3D model looks like something you would never present to the client, you feel intimidated – metaphorically speaking it's

like learning a new language: you don't master it and appear foolish. When the number of drawings explodes, probably it is because of that particular vendor's software – or is it us. When the virtual model is so heavy, perhaps we should not have included the lavatories and the basins as 3D objects because actually, we don't need them – the argument goes. When the up- and download of the model is so slow then, is it because of our internet connection or is it the servers of the project web supplier – nobody is going to tell because nobody really knows. When we embark on the 3D adventure then, is the true total cost / person bigger than DKK 200,000 (arguably, yes) – and will the investment be fruitful. When I have spent the whole morning getting nowhere with my work, then what do I say – to whom or what do I put the blame (myself?).

3.0 METHODS ASSEMBLAGE

To study the technology in question and understand its impact on the way we organise work I have applied a methodology normally referred to as ANT, actor-network theory. According to Fuglsang ANT is something as singular as a "constructivistic, objectivistic/realist, relativistic, non-rationalist theory" (2004 (2005): 435 (my translation)). ANT is seen as a provocation against well established strands within social sciences, against the tendency to commit to pre-established perceptions, models and categories (Latour 1987; Olesen and Kroustrup 2007). Implicit in post-ANT accounts (Jensen, Lauritsen et al. 2007) are a move beyond the dichotomy of impact/use; it entails an engagement with the socio-materiality of work practices as this is enacted ongoingly, contingently and multiply. ANT shares, in line with e.g. symbolic interactionism and post-Foucualtian post-structuralism, the conception that relational effects are the result of ordering processes in the socio-technical field (Law 1994; Gherardi 2000). For many, including myself, the most contra-intuitive aspect of ANT are the two central tenets of ANT, namely actor and network, because, in principle, there is no difference between them: *actors are networks* (Jensen 2003: 7) and the actor-network is shaped as a result of the incessant interweaving (cf. Gherardi and Nicolini 2006 who talks about texture) of entities in points and connections (Jensen 2003; Olesen and Kroustrup 2007). There is nothing but networks, and nothing in between them (Latour 2006 (1997): 210). It has no beginning, nor end, but only a middle from which it grows; you can turn and modify it, detach, connect or reverse it. It is an acentered, nonhierarchical, nonsignifying system (Deleuse and Guattari 2005 (1980): 29).

3.1 Application

For me ANT is a research strategy, a way of approaching the field and the research issues in question. Above I had tried to outline, from a multiplicity of sources, what ANT is and how to apply it to serve the purpose here, namely to describe, analyse and discuss relational effects for managing a practice when object-based modelling is introduced within and across architects' and consulting engineers'

practices. ANT works within a paradigm, a mind set, within which you can solve puzzles of all sort of questions. When ANT researchers study technology at work they do not look for interaction of separate entities but rather for socio-material intra-action (Barad 2007) – the interplay between man and machine. With ANT you stay open for *surprises* and unanticipated events, not only coming from the research subject but from all (human and nonhuman) participants involved (Latour 2004). You look out for associations, translations, relations and make no a priori assumptions. Keep in mind that "it is the tracings that must be put on the map, not the opposite" (Deleuse and Guattari 2005 (1980): 29)). Zoom in, zoom out, to balance you're account between, on the one hand, a singular, reductionist ontology about one world, and, on the other, a fragmented ontology about many worlds: *More than one, but less than many*. The tension is found between the multiple versions of reality and the fractional. Disentangle what you study - make your intervention from within (Mol 2002). In an ANT analysis everything is put on the same level - one does not discriminate between e.g. people, power, scripts, materiality, tools.

3.2 Data collection

The story lines that I will now turn to are based on but a few interviews made quite recently, however, the broader reception of BIM is rooted in data collected in a longitudinal fashion, by combining desk research with multi-site, multi-model ethno-methodological field studies (Marcus 1995): texts, inscriptions, screen dumps, interviews, observations, photos, video footage, etc. In quantitative measures primary data is generated as a result of some 25 interviews with informants spread across the industry as well as an equal number of days spent observing two different practices. All data has been collected following the entry into force of the said statutory. Most if not all findings presented here can – and has been – tested against a large quantitative survey (269 respondents) made by bips, a local professional body. As a researcher I participated in the design of the survey and got full access to the database.

4.0 STORY LINES

In this section I am going to illustrate how BIM disorganises practice. The cases stem from a couple of pilot projects in which the design phase is either finished or on-going. In both cases it is middle-sized, Danish practices that have embarked on 3D modelling. Upon having presented the cases I will discuss the implications.

4.1 Manning up and down the project team

The introduction of 3D object oriented building information modelling (BIM) adds additional stress on the organisation of project teams; with BIM the division of labour changes. When designing a building

based on 2D CAD drawings various tasks could be distributed across the studio, according to a particular hierarchical way of thinking. Less experienced members of staff could assist in e.g. counting the number of doors across the building project, changing perhaps, while doing the counting / revision, the direction in which particular doors opened and closed. Other colleagues could be called upon to make revisions on sectional view, plans, elevations, etc. They were able to this without knowing very much about the project in question; tasks could be distributed according to availability of almost *everyone* in the practice.

However, when designing in 3D BIM the complexity increases – the consequences implicit in e.g. moving the modular line becomes, according to a partner interviewed, *"immeasurable": "If you have 500 drawings linked like in a crossword puzzle then thinking through the consequences of moving a modular line somewhere in the project becomes un-humanly immeasurable"*. Doors, walls, windows, are relationally linked and a hitherto simple change in one place may have unforeseen and definitely unwanted effects in other places. When you take a decision, to e.g. move a wall, a column, or perhaps just a door, it might have implications across the entire models' various hierarchies. In that case it becomes quasi-impossible for someone not deeply embedded in the project to assist the core team. The simple tasks of e.g. moving around door may have consequences on a number of drawings. Similarly, if you change something in the lists of items those very changes are reflected in the model. The result is that the promised advantage of changes being automatically updated throughout the 3D model has become an issue of managerial concern. The composition of teams, the relatively uncomplicated task of manning up and down, needs to be done according to new measures.

As was explained to me in an interview based on the experiences of a middle-sized practice upon having completed the design of some 60,000 m2 office complex to be built in Copenhagen, the traditional way of handling tasks, of dividing work according to sectional views, plans, and elevations had to be divided according to particular areas or functions of the representation of building: one should be responsible for e.g. the facades, another for the auditorium (examples mentioned) and each person or sub-team should then take on full responsibility for all details related to that specific area. You might say that it actually makes work more interesting however, it is a managerial challenge that must be addressed.

4.2 Breaking up phases

One of the primary goals for the actor-network originally promoting digital construction in Denmark was re-use of data, from cradle to grave. As it was, data was reproduced up to 6 or 7 times – every time with the risk of losing out something and of wasting time. The reproduction was linked to phases

in which construction takes place – sketch, scheme design, main project, etc. Now, with BIM more work is called for in the initial phases. The modelling software calls for detailed information about objects – already while sketching: *"To take advantage from this there is an enormous workload in obtaining… you have to be very far ahead in the lay-out of a building, I mean, in your imagination, before you can translate it to 3D … In relation to the standard division of phases we need to be pretty sure that the client also thinks it is a good idea that we continue designing the building this way because [with BIM] there is such a big work load in the first phases that [with CAD] maybe previously lied in the later phases."*

Before BIM various project processes co-existed almost up to the very dead-line of a project: When designing in 2D CAD the team could keep on designing on combination of project levels, however, in the transition to 3D BIM one process must be finished before the next one can begin. The result is that the projecting partners wait in line for one and each other, forcing certain design procedures to be completed earlier on – to the regret of one partner: *"If we could decide ourselves how to plan, when to use Revit and other kinds of digital tools then I think that, as the situation is right now, that we would not start modelling before we knew what the house was going to look like – I don't think we would do that."*

4.3 Quality assurance (QA)

A practice's quality assurance (QA) procedures are likely to be challenged by the introduction of 3D BIM. This is in part related to the touch and look of *views.* The problem is that (in this case also) Revit does not deliver views of a quality desired: *"If you subsequently manipulate views and drawings – which we do to make them communicate what we want them to communicate, you can't always get the machine, the model, to do it automatically. We need to work around to get the software to do what we expected it to do … and suddenly it responds and does things you didn't want it to do. … It knocked us out, a bit, I dare admit that."* In this case the quality of drawings had deteriorated – compared to the traditional standards of the studio.

As already illustrated the 3D model never really acts quite the way you want it to: *"And that requires that we re-think our QA procedures when we hand over a project – we have to stop earlier compared to drawing in 2D … Hold the design phase, stop the corrections sooner and say, 'now we drop the pencil, or the mouse', or whatever we say, to do a QA, to do a complete and systematically audit of the project … There are some mechanisms in the 3D model that, well, I can't explain them thoroughly"*.

5.0 DISCUSSION

Having thus outlined a few but hopefully interesting (important) managerial aspects following from the transition from 2D CAD to 3D BIM it is time to discuss the further implications. It should be clear that barriers to BIM are many, and diverse. One of the most striking challenges is that BIM is such a pervasive technology, an actant that, in order to function effectively, associates itself with numerous aspects of what it means designing a building. Professional traditions and uncertainty vis-à-vis new work procedures might be among the major barriers. We have learned that the way BIM is enacted, the way it manifests itself in practice, points to a situation where two practices are running in parallel. We can image that this is likely to go on for quite a period of time, 5-10 years, not least for the first movers like in these cases. There is an educational backlog where only a fraction of all architects and consulting engineers have received training. High costs associated with training people are put on the shoulders of first movers, because they can go nowhere and just hire experienced people. Return on investment then is uncertain – for two reasons. It is difficult to actually estimate whether or not BIM improves overall efficiency (for some time it apparently does not) and the risk of losing those actually trained is likely to be higher in a situation where few are experienced (given that BIM actually takes off). Manning up or down teams is in fact not the only challenge in relation to the division of labour. In fact the bare composition of a team can be difficult because what to do in the case of e.g. a competition. The people you have at hand, the colleagues who have got training and gained sufficient experiences to act as competent users of one or two 3D applications might not have the right profiles needed for a new project – not all new projects need to be designed in 3D. In that case the architect in charge might very well decide to include in the team exactly the person(s) who are likely to have the desired competences (e.g. knowledgeable in light, façade, function – education, hospital), ignoring 3D competences. In that case the initial composition of teams becomes a matter of sheer availability of human resources at all. And there is another problem because 3D competences need be maintained continuously; the curve of oblivion is said to be particularly steep.

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6.0 CONCLUSION

The 3D BIM modelling practice by far exceeds the 2D CAD drawing practice in complexity. The 3D model is a highly relational entity that reaches out or associates itself with other entities of a practice; in that process it translates what it relates to. One of my informants actually said so: *"But it [CAD] was a linear process, this [BIM] is no longer a linear process. Now we begin sketching in a tool that at once ramifies in all directions and it follows that if there are people who mesh with this process, who do not know what they do, then suddenly, the ignition defaults. Then the engine cuts out on one*

cylinder, and then the whole model is torn apart. It is insanely demanding to keep track of everything, and it becomes exponentially worse the more data you have in the model – you loose perspective."

Flexibility is a corner stone in most medium-sized practices. You can't afford to lose it, because it is a matter of survival. Being capable of moving around human resources is an imperative. It is not only a matter of motivation, of training, of changing routines and procedures, it is also a matter of data discipline, of setting-up QA procedures that take into account the potential harmful result of just minor mistakes. It is a matter of reconsidering traditional phases – well established (Danish) traditions and tender procedures are not necessarily compatible with the way in which foreign software developers have optimized their software; traditions are different in the UK, US, etc.

BIM was set about, in a Danish context by what we normally perceive of as a bureaucracy, but the software applications are almost perfect bureaucracies it themselves. When modelling is associated with existing practices working routines, quality assurance procedures, project phase models and much more are disrupted. The bureaucracy of BIM works in a way that existing practices get disorganised. Whether or not that is for the good or for the worse depends on your perspective, on the way you proceed. But the two paradigms are here, they will co-exist for a number of years to come. It is a challenge that comes with a price tag, but it is a challenge with both pro's and con's. I am uncertain as to degree the professed visions of BIM will come through but I have come to the conclusion that when the spokespersons of the actor-network hinted that BIM would initiate a revolution, a shift of paradigm, a new alphabet, they were right. The question remains, however, if the character or quality of the revolution is what they thought of.

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