CONTROL, SURVEILLANCE AND THE 'DARK SIDE' OF BIM

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Various BIM (building information modelling) technologies are increasingly being positioned as a way to improve coordination horizontally across construction disciplines and vertically between design, construction, manufacture and, increasingly, facility management. The arguments for implementing BIM are persuasive, with potentially significant savings in terms of reducing the re-working of information across the supply chain, and reducing the high levels of physical waste generated. They are also now supported by the recent UK government mandate to use BIM on public projects by 2016. But there are other more problematic considerations with the mobilisation of integrated information management systems, especially around issues of control, surveillance and power. Primarily drawing on Foucault inspired studies of information systems use and surveillance in this paper we look at some of these implications for the division of labour and for control during the construction process. We use empirical material from two longitudinal case studies of BIM implementation; a new airport terminal and two large PFI hospitals, both in the UK. We draw out the issues around the potential and limitations of this technology as a method of imposing control across disciplines and down the supply chain. Whether these technological change initiatives are initially intended to be an instrument of leveraging control over other actors is difficult to ascertain, but our empirical evidence shows that negotiations over who has the power to enforce or resist the technology and processes supporting it are fundamental in shaping how implementation plays out.

Keywords: BIM, control, ICT, labour, power, resistance, surveillance.

INTRODUCTION

BIM (Building Information Modelling) is the process of integrating and coordinating the information required to design, construct and operate a building or facility. Commonly associated with 3D CAD modelling, a Building Information Model is a digital representation of the physical and functional attributes of a building, which can be used throughout its life cycle. Computer-aided design and 3D representation along with various forms of electronic communication and document management are well established, even ubiquitous, technologies, especially within large construction projects (Whyte, 2002). But BIM represents something other than just the use of these technologies; it implies a seamless integration and sharing of data across projects,

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organisations and disciplines, a reconfiguration of when and what information is provided for the model, and a commitment to reproducing the digital model on-site. Numerous case studies have demonstrated the benefits of BIM modelling in areas such as reducing the re-working of information across the supply chain, and reducing the high levels of physical waste generated (Olofsson *et al.* 2008). Proponents have high expectations for BIM's potential in overcoming many of the problems faced by the industry – even assigning it the power to transform construction, the construction industry, the economy and society at large (Rezgui *et al.* 2009; Crotty, 2011). This optimism is reflected in recent UK government policy decisions to encourage BIM and to mandate its use BIM on public projects by 2016.

Much BIM research, and that into ICT on construction in general, treats implementation of new technologies and tools as unproblematic technical activities. It is positioned as politically neutral and generally beneficial if implemented 'correctly' taking care of the human and social issues 'arising from' the technology. However, such a technologically deterministic approach is only one of a number of theoretical paradigms that can and have been applied to the study of technology. Alternative approaches include: market determinism; labour process accounts; process approaches that emphasises political shaping; and numerous forms of social constructivism (McLoughlin, 1999). The differences between these approaches are about the relationship between technology and organisation (Orlikowski, 1992). The extent to which these approaches should be seen as competing or complementary is subject to some debate (Lewis & Grimes, 1999). However, drawing on Morgan's (1986) advocacy of the use of metaphor in organisational research, both McLoughlin and Lewis & Grimes have argued for a multi-paradigm approach to research on technological change. This paper seeks to apply this approach to the study of BIM in construction. Given the already extensive coverage of the managerially necessary and beneficial aspects of control in the construction management literature (see Tuuli *et al.* 2010a, 2012b) we present a thoroughgoing application of a political paradigm to analyse issues of surveillance and control in two case studies of BIM implementation and use on two major construction projects in the United Kingdom.

ICT, SURVEILLANCE AND CONTROL

In order to think about the issue of control in managerial implementations of BIM, it is useful to look at the work of Foucault. Foucault's work, along with other social studies of technology, has a methodological commitment to revealing the specific conditions under which certain types of knowledge become powerful and persuasive (Kendall & Wickham, 1999). Foucault's work has been extensively applied in research into information systems and the ways they configure working practices. In 'Discipline and Punish', Foucault traces the historical evolution of control from being based in direct, physical, individual punishment to a new "general recipe for the exercise of power over men" (Foucault, 1991: 102). New modes of control moved away from acting on the physical body, towards a more general level of pervasive observation, located deep within society. More generally, society is effectively controlled by the imposition of ideas and norms of behaviour onto individuals which define whether their actions are normal and acceptable, or not.

Foucault describes Bentham's 1791 design for a prison, the Panopticon, to illustrate how these contemporary modes of control function. Bentham's design consisted of prison cells arranged in a circle, with walls between each cell but which were open (except for bars) to the front and back, with a watchtower in the middle. Someone in

this tower could see into every backlit cell, but all that the occupants of each cell could see was the watchtower. Prisoners knew that they could be being watched at any time and this threat of surveillance was supposed to be enough to deter any abnormal behaviour. The prison is described by Foucault as embodying a pure form of panoptic surveillance, but he translates it to other institutions throughout society such as schools, hospitals, military institutions and, importantly in this case, the workplace. Panoptic modes of surveillance make the surveyed visible in specific ways, and permit knowledge to be collected about them (the term Panopticon suggests total visibility; pan-optic). Just as in the prison, this gives the surveyor power, where individuals impose self-control because there is always a chance that they are being observed. Their behaviour is conditioned by their being rendered visible.

Foucault describes four main conditions of panoptic surveillance and control. The first of these is the spatial distribution of individuals, the segregation of groups with supervisors maintaining watch over them. The second condition is the control of activities where regularity of action and scheduling impose a framework of routine, normal behaviour. The third condition, exercise, is related to the control of the surveyed populations body through the imposition of physical techniques. The final condition Foucault calls tactics: the ordering of individuals as groups or collectivities which facilitates the subordination of individual behaviour to being one holistic unity. Foucault argues that such techniques create 'docile bodies', subjects who conform to behavioural patterns defined by those in control of the setting of these conditions. The connections between Foucault's analysis of disciplinary regimes and the design of work in bureaucratic organisations in general, and construction and design management in particular, is immediately obvious.

The significance of this line of argument for considering the role of BIM is that ICT itself can be regarded as a medium of or tool for surveillance and control. Poster (1990) and Lyon (1994) have described the encroachment of ICT into work practices (as well as into more private areas of life) and they write about how the capacity to monitor, store and manipulate large amounts of information allows a level of surveillance beyond that possible with human actors alone. Zuboff's (1988) ethnography of computer use in the workplace argues that panopticism is becoming a basis of contemporary management techniques, and that the potential for surveillance inherent in IT makes the activities of workers highly visible and leads to 'anticipatory conformity'. Like the prisoners in Bentham's Panopticon, the threat (rather than the reality) of being watched generates self discipline and hence conformity. There is also a growing body of work using Foucault to understand management practices more generally as part of an attempt to increase control of workers, through electronic and other means of surveillance (for instance the discourse of team-working, or the use of psychometric testing to make individuals comparable and calculable) and through the internalisation of norms associated with being an efficient worker (e.g. Brewis, 1996; Dean,1999; Townley, 1993).

CONTROL IN CONSTRUCTION MANAGEMENT

Construction management is largely concerned with achieving control over the design and build processes. Tuuli *et al.* (2010a) describe the "pervasive" nature of control in project environments, "encompassing all the devices and systems employed to ensure that acts, behaviours, outcomes and decisions of individuals, teams, and organizations in a project are consistent with meeting organizational or project goals, objectives and strategies" (p190). At the same time, the site-based nature of projects, lack of

integration, uncertainty and change also suggest the merits of organising construction based on principles of delegation, autonomy and empowerment, or at least the difficulties in imposing and realising systems and devices of control. Tuuli etal's case studies of modes of control (2010a, 2010b) identified a 'portfolio' of control mechanisms including (after Nieminen & Lehtonen, 2008): formal/bureaucratic control (both outcome-based and behaviour-based) and informal control (in the form of clan- and self-based regulation).

If, as Tuuli argues, construction projects need to find a balance between empowering teams and maintaining control of the process, then forms of unobtrusive and pervasive control offered by ICT-enabled surveillance will be attractive. In fact part of the control 'portfolio' identified by Tuuli *et al.* included use of an electronic document management system that "provid[ed] a full document history that can be traced and monitored". Other construction research has found international firms "developing more subtle and informal systems that are less hierarchical" to control their overseas subsidiaries and that they "recognized the importance of IS for the management and control of their international operations" (Neves & Bugalho, 2008; 11, 10). Whyte & Lobo's (2010) case study of coordination and control on a large infrastructure project found a document management repository "used to structure distributed forms of communication and control ... dictated a set of working practices [and] made visible knowledge about the audit trail of design deliverables" (563). It is clear that such systems can, intentionally or otherwise, impact on working practices through the imposition of standard processes and the collection of data (for instance to establish accountability and provide audit trails). What is less clear is how those systems are developed and embedded, what their precise effects might be, and who benefits from their introduction.

METHODS AND CASE DESCRIPTIONS

The empirical data analysed in this paper was gathered in the course of two independent, longitudinal case-studies of major construction projects in the United Kingdom: a new airport terminal ("Terminal") and two new acute hospitals ("Hospital"). Data collection on the Terminal project was through contemporaneous, ethnographic observation and semi-structured interviews (n=23). Data collection on the Hospital project was through semi-structured interviews (n=27). In both cases, additional data was collection in the forms of documents and notes from informal meetings.

In both cases the implementation of BIM consisted of use of spatially coordinated 3D CAD models in the design phase supported by electronic document management systems (EDMS) and processes. On the Terminal project, further organisational arrangements were put in place including collocation of all design team members at project offices and project-wide formal processes and procedures for CAD and information management. The Terminal BIM implementation was mandated and driven by a powerful client and required designers to work in a shared model environment. In contrast, on the Hospital project BIM was a project team initiative implemented through the mechanism of separate model files brought together in a read-only for the purposes of coordination. The Hospital project research also studied the development of 'Site BIM' implementation in the form of tablet PCs to read design information and capture progress data on site.

ANALYSIS

Terminal Project

It was widely acknowledged in the Terminal project that the benefits of single model coordination using BIM relied upon the production and sharing of transparent, compatible and accurate information. This would often be in the form of complex and highly specified documents, reflecting the level of detail required to ensure inter-compatible practices of, for example, CAD or EDMS use. This required working to standardised, documented practices and producing and entering 'metadata' that allows others to use the document management system. This rigour required both changes in established working practices and extra work for users to maintain these standards, on top of their 'usual' duties. The benefit and the need for control inherent in such coordinated working is reflected in the following from the head of engineering:

"when I go into this EDMS thing I'm looking at the latest version of that document [...] That [assuring everyone has the most up-to-date information] is of great benefit, but it needs discipline in how you actually use the system."

In order to achieve consistent ways of using across the project other methods of ensuring adherence were required. In the words of one application manager involved with supporting document management, "the process is very managed, but it needs to be… you need to make sure that they [the users] are adhering to the process definitely".

This managing was largely undertaken by the project's IT support services. As specified in project documents their role was to, "verify compliance with Document Management policies & practices, including verifying compliance of document control procedures operated within the various teams, using surveillance and audit techniques." These 'techniques' did include ICT-enabled surveillance; for instance IT support staff could "see how many people are logging on at any one time". This lends itself to a Foucauldian description of being under continuous monitoring although examples of resistance, conflict and negotiation identified (see Harty, 2005 and later this section) suggest that a regime of totalising panoptical surveillance was not in place. Instead (or in combination) a variety of human / organisational methods of direct surveillance and control were deployed. IT workers would seek to persuade rather than enforce usage. As one IT manager described it, "I used to walk around and see what was happening. Sometimes I hear a team aren't using it and I try to cajole them into using it…"

More formal and strategic methods for getting compliance than 'walking around' included training of new project workers. Training is often framed as support rather than control but on the Terminal project it was clear that "when a member of staff comes in they need to be running through what is expected and one of the things is how they should use EDMS, where they should be putting information and also following the project procedures"

The project required users to learn a number of new technologies, some of which, such as document management, were totally unfamiliar for many. But they also had to quickly begin actual work, producing design information, drawings and models. This drive to quickly get on with 'real work' is at odds with learning and applying new project-wide compliance behaviours. As such the impact of training is often limited:

"you get put through a EDMS course… but people go back to their desk, and they're not given any direction, from what I can see, as to how the task team leader expects them to use it."

Here is a problem related to the distribution of work, and influence, across the project. Training is obligatory, but when the newly trained worker is 'released' onto the project they might not be under immediate pressure to follow the strictures imparted during the training. The electronic, remote surveillance continues, but the influence of team leaders and other users closer to the new worker can dissipate its effectiveness as a control tool.

Another of strategy employed sought to overcome the distance between IT support and design teams by installing designated 'document controllers' within each separate team on the project. This can be seen as an attempt to extend the surveillance capabilities of the IT network and those 'in charge' of it away from the particular centre of the IT support department, and to supplement electronic surveillance with face to face monitoring. It can also be seen as an encroachment of the capabilities of the IT department into each local team:

"you need to make sure that they [the users] are adhering to the process definitely. Most of the delivery teams do now have a document controller to keep an eye on things."

The role of 'document controllers' within each team was significant and formally established in project procedures to "ensure that the project's key principle of effective Document Management is adhered to [... and to] actively engage with the project on a day-to-day basis to promote and progress best practice in Document Management…"

The presence of the document controllers produced an increase in the use of EDMS but not just through surveillance and control. Instead, through mediation, and through negotiation, document controllers reconciled team activities and the requirements of using EDMS. This weakened the case for uncompromising resistance. Document controllers were able to solve problems encountered by users as they did their work, or find ways of integrating their practices with the utilisation of EDMS - sometimes by taking a whole set of drawings or information from the team to input into the database themselves.

A pattern of increasing use of EDMS was found over the course of the research, but a Foucauldian vision of strict control with no choice but to conform does not adequately account for increasing EDMS use on the project. Electronic surveillance, although present, only showed where conformity was or wasn't occurring; it seemed to do little to change it. There were significant limits to the ability of the EDMS system to bring about change in practice, and as these were discovered, different, non-electronic and less instrumental means were used, such as document controllers, to make the system work.

Hospital Project

The BIM implementation studied on the Hospital project differed from that on Terminal. The focus here wasn't on producing BIM models but communicating 'complete' design models and extending them to the work site via portable tablet computers. Another significant variation for the analysis in this paper was that the implementation was project-led (as opposed to client-mandated and top-down) and

system usage was largely voluntary. There were, however, similarities in how the BIM technology was established.

Significant for this was the role of Document Controllers that expanded into a "sub-IT Department function" which drove system development and promoted user adoption. Document Controllers became intermediaries, coming to occupy a similar organisational space to those on Terminal, albeit from a 'project up' rather than an 'IT down' direction. A further similarity was the substantial investment of time in training and support. Digital technology was novel for many users: "there's guys out there are still used to rolling up A3 drawings in the back pocket and then turning on a PC is quite a bit of fear for them actually". As well as formal training, one-to-one support and coaching was needed 'bed-in' the use of the technology: "it literally has been walk around for three of four days, hold their hand".

The other shared feature between the two cases was the central role ascribed to EDMS in 'delivering' BIM:

"You've got to have an electronic document management system that underpins any BIM type environment…because BIM itself doesn't do that".

On the Hospital project EDMS is directly controlled by Document Controllers who manually intervene to issue drawings – rather than automated workflow driving information. This retention of 'traditional' information management extends to accessing digital design information on tablets. The data gets to the tablet by explicitly synchronising them in the site office when the tablets are docked. This act of synchronising is seen as a useful form of control by the Document Controllers:

"… I think it's quite good that we've actually got the control at the moment. So docking information goes up and then you have to pull it down as well, so it makes them – if they want the information, they've got to go to a source to get it"

Despite the emphasis on the importance of controlling information – the reach of ICT-enabled control is limited and tacitly approved – even to the point of being made a virtue of:

"if [a Construction Manager is] in charge of the windows then [he's] going to talk to the person that looks after the windows at the architects or anyone else that's on it and the trade contractors know what's happening as well [...] you do have some guys that have got a very good relationship walking around with advanced copies of drawings because they've just e-mailed it to them instead of putting it on to EDMS so you do get that."

This acceptance of flexibility in use of information systems was limited to ways of getting information out of the project systems. By the construction phase the model was largely seen as a closed, fixed source of data rather than an environment where users can add data in ways that suit them. So for the tablet progress monitoring system (specified largely by Document Controllers in their role as project IT support) there was only one format in which progress data could be entered onto the system. Also on the tablets, the defect system required free-text fields to capture the more unpredictable entities; therefore it was implemented so that defect descriptions entered in the field needed to be approved before they were processed - "it all goes in to an unapproved area so [Document Controllers] will check it, check that everything is correct and then issue it out to the trade contractors". And although the standard drawing viewing software on the tablets enabled users to 'mark-up' drawings on site this wasn't encouraged - "If you let them mark up drawings out on site that was on

EDMS, then you would have anarchy wouldn't you? There would be no control whatsoever."

As well as controlling how they used the software, tablet systems were intended to control the work of Construction Managers themselves, even to the extent of bodily 'helping' them to stay on site where "they should be". Once on site the systems are "controlling them to do their job because it's got to be done in a certain mode. It can't be done any other way [...] what we're forcing the Construction Managers to do is to actually go down the road of actually double checking and job checking everything they're doing and not just sweeping anything under the carpet." However, although the intention was that "people would go out clicking off progress in rooms" limited uptake and availability of tablets meant that this was not universally established. The progress database was still populated, allowing enhanced surveillance of progress, but site data was captured on paper and, "brought it back to the office and [given] to the administrator lady who then put it directly onto the database, as opposed to via a tablet."

DISCUSSION

Construction is a fertile area in which to consider the 'dark side' of ICT: there is inherent tension between empowerment and control (Tuuli etal, 2010a) and between projects' concern with action versus the centre's with compliance (Jacobson & Linderoth, 2010). Control is so pervasive in construction that it is not even perceived as such (Nieminen & Lehtonen, 2008) - Tuuli *et al.* (2010b) identified "the exercise of control in very subtle ways that may not be recognized by those being controlled" (p463). Our research identified numerous examples of intention and realisation of control through ICT but also limits to that control, the continuing need for human controllers, and 'user' resistance.

Evidence from both cases does not support the existence of effective and totalising panoptical surveillance from a single centre, or all-powerful controller which could force the project's staff into specific ways of working. Applying this particular lens to construction ICT was productive in identifying instances of surveillance and control but doesn't provide analytical tools to consider changes in control and how individuals respond to it (Cowton & Dopson, 2002, Knights & McCabe, 2003). One approach to this could be the distinction between 'strategies' and 'tactics' as proposed by de Certeau (1984). 'Strategy' is about manipulating exterior actors from a specific and strong position similar to Foucault's position where surveillance extends from a specific place and has the ability to control or regulate the activities of other actors. 'Tactics' are responses to strategy which, though intentional, are distributed and lack the consistency of strategic attempts to influence and control. The resisting actors may not be able to provide a strong and unified response to a strategy, and indeed may not actually want to, but can find specific weaknesses and gaps in strategy and exploit them.

The idea of tactics versus strategy provides a way to understand the dynamics at work on the Terminal project. The official IT system based on a number of technological artefacts, the single model environment and rigorous coordination of information, can be seen as a centre of strategy. This strategy involves panoptic practices of surveillance and the circulation of intermediaries and enabling supports such as guidance documents and training. The resistance towards using the EDMS system, with discussions about what was or was not considered legitimate activity, was less coordinated, and hence can be seen as tactical. But it was enough to bring about the

gradual escalation of other practices to increase use (such as negotiation, training and eventually, the introduction of Document Controllers). This can be seen as a pattern of strategic responses to this tactical resistance.

On the Hospital project, the lack of a strong mandate to use the BIM systems meant that this pattern of resistance and response was not occurring – use of alternative ways of working was tolerated and even framed as having the ability to transcend automated control. Ironically, a clear use of tactics could be seen on the part of the Document Controllers themselves who implemented the 'controlling' ICT on the project locally, unofficially and "under the radar" without authorisation from corporate IT support.

CONCLUSIONS

The cases discussed here show different ways that issues of control are bound up with the implementation and use of ICT systems like BIM. Rather than see these as neutral progressions or developments of technology use, they can also be seen as having a dark side - as opportunities to enact control over users, through imposition of standardised practices, and through surveillance and monitoring. This is perhaps more explicitly recognition of this on the Terminal project with its centralised system, patterns of resistance and the large scale efforts put in place to encourage use. But the Hospital project also shows the use of technology as a way of enacting control; over limiting access to information, and in using tablet based information on site to produce compliance. However, the implementation on the Hospital project itself can also be seen as tactical, especially in the way the use of tablet PCs on site was kept within the project and away from the gaze of the central organisation IT function. Using the idea of a Foucauldian notion of surveillance, and framing activities around the system as a dialogue of strategy and tactics is useful in revealing the control issues inherent in both the implementation of IT systems, and construction work in general.

REFERENCES

Brewis, J. (1996). "The 'Making' of the 'Competent' Manager Competancy Development, Personal Effectiveness and Foucault." Management Learning, **27**(1), 65-86.

de Certeau, M. (1984). The Practice of Everyday Life. Berkeley, University of California Press.

Cowton, C. J. and S. Dopson (2002). "Foucault's prison? Management control in an automotive distributer." Management Accounting Research, **13**, 191-213.

Crotty, R. (2011). The Impact of Building Information Modelling: Transforming Construction. London: Spon Press.

Brewis, J. (1996). "The 'Making' of the 'Competent' Manager Competancy Development, Personal Effectiveness and Foucault." Management Learning, **27**(1), 65-86.

Dean, M. (1999). Governmentality Power and Rule in Modern Society. London, Sage.

Foucault, M. (1991). Discipline and Punish the Birth of the Prison. London, Penguin.

Harty, C. (2005) Innovation in construction: a sociology of technology approach. Building Research & Information, **33**(6), 512-522.

Jacobsson, M. & Linderoth, H.C.J. (2010). The influence of contextual elements, actors' frames of reference, and technology on the adoption and use of ICT in construction projects. Construction Management and Economics, **28**(1), 13-23.

Kendall, G. and G. Wickham (1999). Using Foucault's methods. London, Sage.

Knights, D. and McCabe, D. (2003). "Governing through Teamwork: Reconstituting Subjectivity in a Call Centre." Journal of Management Studies, **40**(7): 1587-619.

Lewis, M.W. & Grimes, A.J. (1999). Metatriangulation: Building theories from multiple paradigms. Academy of Management Review, **24**, 672-690.

Lyon, D. (1994). The Electronic Eye: The Rise of the Surveillance Society. Minnesota, Mi, University of Minnesota Press.

McLoughlin, I. (1999). Creative technological change: The shaping of technology and organisations. London: Routledge.

Morgan, G. (1986) Images of organisation. London: Sage.

Neves, J.C. & Bugalho, A. (2008). Coordination and control in emerging international construction firms. Construction Management and Economics, **26**(1), 3-13.

Nieminen, A. & Lehtonen, M. (2008). Organizational control in programme teams: an empirical study in change programme context. International Journal of Project Management, **26**(1), 63-72.

Olofsson T., Lee G. and Eastman C. (2008). Editorial - Case studies of BIM in use, ITcon Vol. 13, Special Issue Case studies of BIM use, 244-245.

Orlikowski, W.J. (1992). The duality of technology: Rethinking the concept of technology in organisations. Organisational Science, **3**, 398-427.

Poster, M. (1990). The Mode of Information. Cambridge, Polity Press.

Rezgui Y., Zarli A. and Hopfe C. (2009). Editorial - Building Information Modeling Applications, Challenges and Future Directions, ITcon, **14**, Special Issue Building Information Modeling Applications, Challenges and Future Directions, 613-616,

Townley, B. (1993). "Foucault, Power / Knowledge and Its Relevance for Human Resource Management." Academy of Management Review, **18**(3), 518-45.

Tuuli, M.M., Rowlinson, S. & Koh, T.Y. (2010a) Dynamics of control in construction project teams. Construction Management and Economics, **28**(2), 189-202.

Tuuli, M.M., Rowlinson, S. & Koh, T.Y. (2010b) Control modes and mechanisms in construction project teams: drivers and consequences. Construction Management and Economics, **28**(5), 451-465.

Whyte, J. & Lobo, S. (2010) Coordination and control in project-based work: digital objects and infrastructures for delivery. Construction Management and Economics, **28**(6), 557-567.

Winch G. (1998) Zephyrs of creative destruction: understanding the management of innovation in construction. Building Research & Information, **26**(4), 268-279.

Zuboff, S. (1988). In the age of the smart machine: the future of work and power. Oxford, Heinemann.