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Sub-theme 06: Taken by surprise: Expanding our Understanding of Paradoxes and Contradictions in organizations

Balancing innovation and routine action: the microfoundations of digital capabilities

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Abstract

How does a firm respond to change that brings increased routinisation while simultaneously generating innovative solutions? This paper presents insights into this organizational paradox derived from a longitudinal study of a highly creative firm, for whom innovation is a competitive imperative. The 15 years included in this study covers a period during which time the firm is adopting a digital platform that enables digital innovations yet whose use demands an increased number of standards and routines. The actions that individuals take in using routine and innovative action to solve problems contributes to recent research exploring the microfoundations of performance in changing environments (Miron-Spektor, Ingram, Keller, Smith & Lewis, 2018; Eisenhardt, Furr & Bingham, 2010). The study reveals the ‘paradox mindset’ adopted by highly skilled practitioners adopting a new technology and suggests mechanisms individuals use to address this tension. By studying how innovative and routine action are used together in complex and changing settings, findings from this paper suggest that they form an important source in developing firms’ digital capabilities.

Introduction

Contemporary organizations face increasingly dynamic environments characterized by relentless change (Schreyögg & Sydow, 2010). An increasingly pervasive, yet little understood, source of organizational change stems from new technologies (Orlikowski & Scott, 2008). While some scholars encourage leaders of organizations to adopt fluid and adaptable forms of management in response to the dynamic environments created by external changes such as technological (Eisenhardt & Martin, 2000), others advocate the need to

balance the organizational contradictions that are emphasized during periods of rapid change (Hargrave & Van de Ven 2017). Although the significance of organizational paradox has long been recognized in research, for example it is central in March's seminal work on the dual role of exploration and exploitation (1991) and Tushman and O'Reilly's ensuing study of organizational ambidexterity (1996), more recently scholars have argued for the need to balance apparently opposing elements, to treat them as having a mutually constitutive relationship rather than a mutually exclusive one (Farjoun, 2010). Organizational paradoxes are thus viewed as dualisms rather than dualities (Smith, Erez, Jarvenpaa, Lewis & Tracey, 2017; Eisenhardt, Furr & Bingham, 2010; Schreyögg & Sydow, 2010). The need for firms to 'balance countervailing processes' in order to create a template for the uncertainty and complexity that change brings (Schreyögg & Sydow, 2010) has been applied to many related aspects of organizational life. For example, to fluidity and stability (Schreyögg & Sydow, 2010), structure and flexibility (Eisenhardt, Furr & Bingham, 2010); repetitive and non-repetitive actions (Obstfeld, 2012); routines and novelty (Feldman et al, 2016) and routine and innovative actions (Edmondson, 2012).

Returning to the philosophical and psychological roots of early organizational paradox scholars, recent studies identify individual actors as a highly significant but little understood factor in our understanding of organizational paradox. The microfoundations of organizational paradox are unpacked by exploring individuals' 'paradox mindset'- defined as "the extent to which one is accepting of an energized by tensions" (pp26, Miron-Spektor et al, 2018). This is adopted in response to competing tensions and demands that characterise organizational life. This paper draws on and contributes to this work by exploring how individuals in one firm balance routine and innovative action while adopting a new digital platform. It does so by presenting a longitudinal process study of a highly innovative design firm adopting a new digital technology that necessitates increased routinisation and standardisation. The process by which organizational actors balance the routine and innovative is analysed through recent accounts of work. Inductive reasoning is used to analyse the work of practitioners as they skilfully perform a balancing act between routine and innovative action, thereby focusing on the microfoundations of how individuals resolve one organizational paradox. The practice perspective of organizational routines is drawn on to theorise how routines and novelty co-exist (Feldman et al, 2016; Sonenshein, 2016). This paper concludes by arguing that this is a

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key digital capability for firms to develop considering the increasingly combinatorial and generative nature of digital technologies.

Routines and digital innovations in organizations

Research has established that routines are central in adopting new technologies. Early studies include Leonard-Barton's seminal paper that viewed organizational routines as enabling the mutual adaptation needed for firms to use new technologies (1988) to Edmondson, Bohmer and Pisano's later study of medical teams adapting and creating new routines in order to create digital innovations collectively (2001). More recent research emphasises the strength of the relationship between the two (Leonardi, 2011; Pentland & Feldman, 2007). If the use of digital innovations brings increased routinisation, it follows that the increased rate of digitization will necessitate firms to develop more organizational routines. An organization paradox arises however as digital technologies have also long been recognised as important sources of innovation in organizations (Rosenberg, 1982), more markedly with current digitization as afforded by their qualities of convergence and generativity (Yoo, Boland, Lyytinen & Majchrzak, 2012). Balancing these two demands is an organizational paradox that contemporary firms need to address in order to stay competitive.

The divergent theorizing that exists relating to organizational routines presents a promising route to address this paradox. Although scholars agree on the centrality of routines in organizational life, the role of routines has proved more contentious (Parmagiani & Howard-Grenville, 2015). One influential group of scholars present organizational routines as stable and habitual (Gersick & Hackman, 1990) and potential sources of inertia in firms. However, Feldman and Pentland's more recent practice-based model of routines views them as important sources of change in firms, as perpetually changing through the effortful accomplishments of actors (Pentland & Feldman, 2005; Feldman & Pentland, 2003; Feldman, 2000). Individuals are seen as the basis for routine change in organizations through their skilful performances. Much scholarly attention has been paid subsequently to the role of routine dynamics in driving organizational change, with recent research theorizing that routines and novelty are intermingled (Feldman et al, 2016; Sonenshein, 2016).

However, this model has attracted recent criticism. For example, Obstfeld claims that neither theory accounts for how firms pursue new (or innovative) paths. He presents an alternative

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theory showing the spectrum of actions in organizations, ranging from the routine to the innovative along a trajectory of actions (2012). In contrast to the recent work of practice-based routines scholars, he argues that it is this trajectory of actions that explains how organizations pursue the ‘markedly new’ through ‘creative projects’. The prevalence of innovative and routine action is described in Edmondson’s knowledge process spectrum (2012). At one extreme, she shows routine operations, for example fast-food restaurants, while at the other innovative operations are shown, for example pioneering R&D laboratories. In the middle of these extremes, complex operations are found in which one-off, novel solutions are combined with routinized, standardized work. For such organizations, the ability to manage the apparent duality of innovation and routine actions is compelling: old and new tasks interact to product novel or unexpected results. As complex operations become the dominant mode of activity in an increasing number of firms, so the ability to manage complex operations is becoming increasingly important. However, while both models suggest the wider role and significance of routine and innovative (or non-routine) action in organizations, neither address how individual actors balance and perform routine and innovative action.

The research setting

Building information modelling: standards and innovation

The process of organizational change studied in this paper relates to the adoption of Building Information Modeling (BIM) in Design Partnership. BIM is a parametric modeling technology that is being widely adopted in many national construction markets including in the UK. &It is commonly described as a ‘database with drawings’: at its heart is an information rich, common model with is shared across all organizations working on a built asset. For the built environment industry, it is a ‘game-changer’ (HM Government, 2015). As with past digital technologies introduced in the AEC industry (including the transition from paper based drawing to Computer Aided Design that occurred in the 1980s), BIM has the potential to deliver efficiency and quality improvements, and to extend the ‘art of the possible’. One of the central tenets of BIM is interoperability. In order to share a common digital model and information, firms, disciplines, professions and individuals have to work collaboratively (Dainty et al, 2017). This has been noted in research that describes BIM as an

‘unbounded innovation’ requiring collaboration between many firms for implementation to be successful (Harty, 2005), and later research that finds that its use can create waves of innovation across construction supply change (Boland et al, 2007). As more advanced applications of BIM emerge, the interdependencies created by BIM and the need to collaborate across traditional boundaries is likely to become more pronounced as BIM becomes a digital platform for other digital innovations (Yoo et al, 2012). Standards and routines have played an important role in enabling this necessary collaboration: numerous ones have been developed that address for instance different levels of detail required, that stipulate the timings and nature of data drops, and how cyber security is to be addressed across the team. During the time period analysed here, the number of institutional standards increased and influenced how BIM was used.

Method

This study uses a single embedded case study design which enables a detailed and intensive understanding of the evolution of the process of implementing BIM in an organizational setting. Single cases are suitable for detailed studies of processes of change, particularly longitudinal studies (Pettigrew, 1990). The first author collected data on the process of BIM implementation at Design Partnership over a 15-month period, between July 2013 and September 2014. During this time, she was embedded in the organization as a researcher, spending one or two days per week in Design Partnership’s UK head office. Contemporary and retrospective data was collected on BIM implementation in order to form a longitudinal study (Pettigrew, 1990). Through this deep engagement in one organization “thick descriptions” (Geertz, 1994) were generated, thus strengthening the transferability and reliability of this study (Lincoln and Guba, 1985). Data was collected using qualitative research techniques and drawn from several sources including interviews, archived information, internal meetings seminars and regularly updated field notes, as shown in Table 1. 54 Semi-structured interviews in total were conducted. 34 of these were conducted in Design Partnership where interviewees were purposefully drawn from a variety of professional discipline and a range of roles and seniority levels in the firm. Additional external data was collected to build an institutional picture of events taking place during the same time (2000-2016). This included 11 interviews undertaken with senior figures at another

firm of a similar size and providing very similar services to Design Partnership, which helped validate the findings. Additionally, 9 external individuals instrumental in setting institutional policy, and regulatory standards for BIM implementation, external media, websites and relevant conferences were interviewed. Validation of the emerging results and later data analysis was carried out through regular meetings with Design Partnership's then Director of Research and similar meetings with senior BIM policy figures. External media and the firm's own journal and other external scholarly publications were also accessed thereby building a more accurate picture of digital working across the firm during the time-period studied through techniques of data triangulation.

Data analysis was undertaken in two phases. The first phase of data analysis was carried out using a temporal bracketing strategy, which is a suitable approach for analysing process data (Langley, 1999). It involves identifying clear temporal break points and phases in longitudinal research. The single case study, such as is used here, is suitable for this strategy (Langley, 1999). From this, three phases of BIM adoption at Design Partnership were identified, driven by different firm strategies and reflected in changing industry and user actions (details of these are described in the findings of this paper). The second phase of data analysis involves within and across case comparative analysis of three projects carried out in the final phase of BIM identified.

Table 1: Data sources

	Number and type of interviews	Meetings / seminars	Archived information	Other
Users of BIM	18 – project designers and managers	Project review (22.1.14) Training event (17.10.13)	Current strategy document Numerous company reports (from 2000) Project sheets and reports Award submissions and external media NBS National BIM report 2014. Relevant academic peer-reviewed publications.	Field notes of observations and records of informal conversations
Firm (Design Partnership)	18 (total) comprising senior leaders and managers	Launch of BIM strategy in UK (29.1.2014) Meeting of BIM strategy team (17.03.15)	Background reports (retrospective since 2000) Current strategy document Annual reports, Design Partnership Journal (from 2000) Relevant academic peer-reviewed publications.	
Institutional (government, policy and standard bodies, professional institutions)	9 policy makers 9 senior industry figures	Conferences (various) Webinars	Policy reports (various) External media (press, institutions, reports) Websites eg UK BIM task force Relevant academic peer-reviewed publications.	
Total	54			

Findings

Design Partnership

Against a backdrop of a dramatic increase in institutional level BIM standards, firms operating in the built environment were faced with the challenge of responding to the

routinisation of BIM along with a competitive requirement to use digital technologies to create innovative solutions. The case study firm presented in this paper, referred to henceforth by the pseudonym Design Partnership, is a firm in which this paradox is particularly pronounced. It is a leading design firm in the global construction industry with a strong reputation for creativity and innovation. During its 70-year evolution, Design Partnership has been involved in many milestone buildings in the built environment sector, from landmark buildings to major infrastructure projects, earning itself a well-deserved reputation for innovation and creativity. Design Partnership operates from 90 offices in 38 countries spread across its five global regions, the Americas, Australasia, East Asia, Europe and UKMEA. It is sufficiently flexible to meet the demands of dynamic environments and has the capabilities needed to create complex products (Davies and Hobday, 2005; Salter and Gann, 2003; Gann and Salter 2000, 1998).

Design Partnership deals with complex problems, and prides itself on being at the cutting edge of developments in the built environment including in its current digital business. It has developed a reputation externally for its capabilities in complex operations. It balances innovation and creativity with pragmatism, always seeking to operate within the constraints of reality. As one of its business leaders said, “we build buildings for people – we are socially engaged”. The capabilities rely partly on Design Partnership’s ability to attract and retain skilled professionals. The firm has a strong reputation for undertaking challenging work on complex projects, which is a major attraction for professionals, who seek to use their creativity and professional expertise on a daily basis. Many practitioners working at Design Partnership are enthusiastic about being involved in complex projects. As an interviewee explained:

“If a client approaches you and says ‘I’d like the same airport as Chek Lap Kok [the airport in Hong Kong] please’, then there is no role for us. However, if a client says I want a zero-carbon airport, then that is interesting, then we can unleash the whole of our multidisciplinary skills.”

Most of Design Partnership’s considerable portfolio of projects (estimated as 10000 at any one time) involves complex operations, defined by Edmondson as combining old and new tasks within and between projects, resulting in the combination of mature and emerging knowledge, as shown in Figure 1 (2012). As shown in Figure 14, applying Edmondson’s

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Process Knowledge Spectrum framework to Design Partnership's works reveals a number of implications of the dominance of complex operations for the firm.

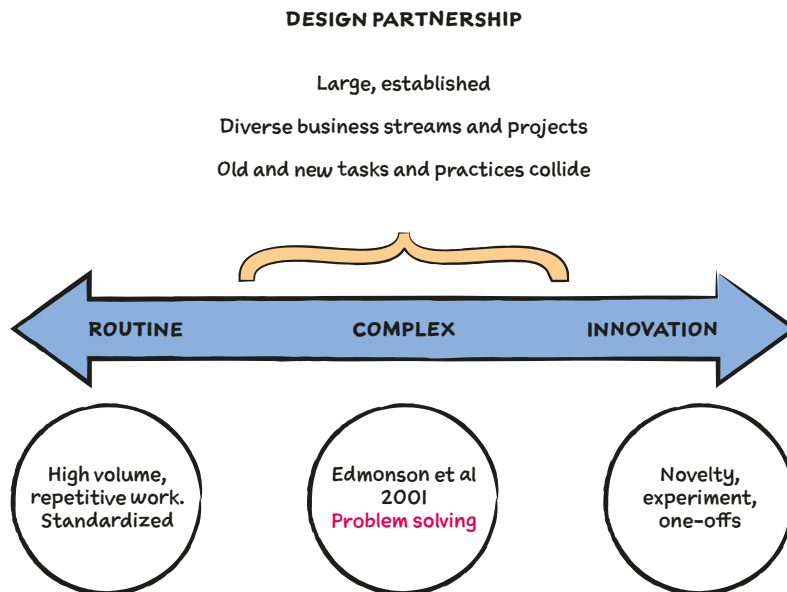


Figure 14: Complex operations in Design Partnership

Between 2000-2015, Design Partnership was going through a major organizational change process as it adopted BIM. The institutional and organizational events that occurred during this process are illustrated in Figure 1, which shows the contextual relationship between initiatives at organizational level and industry level. The longitudinal study covers a significant period in the implementation of BIM across the UK and global AEC industry.

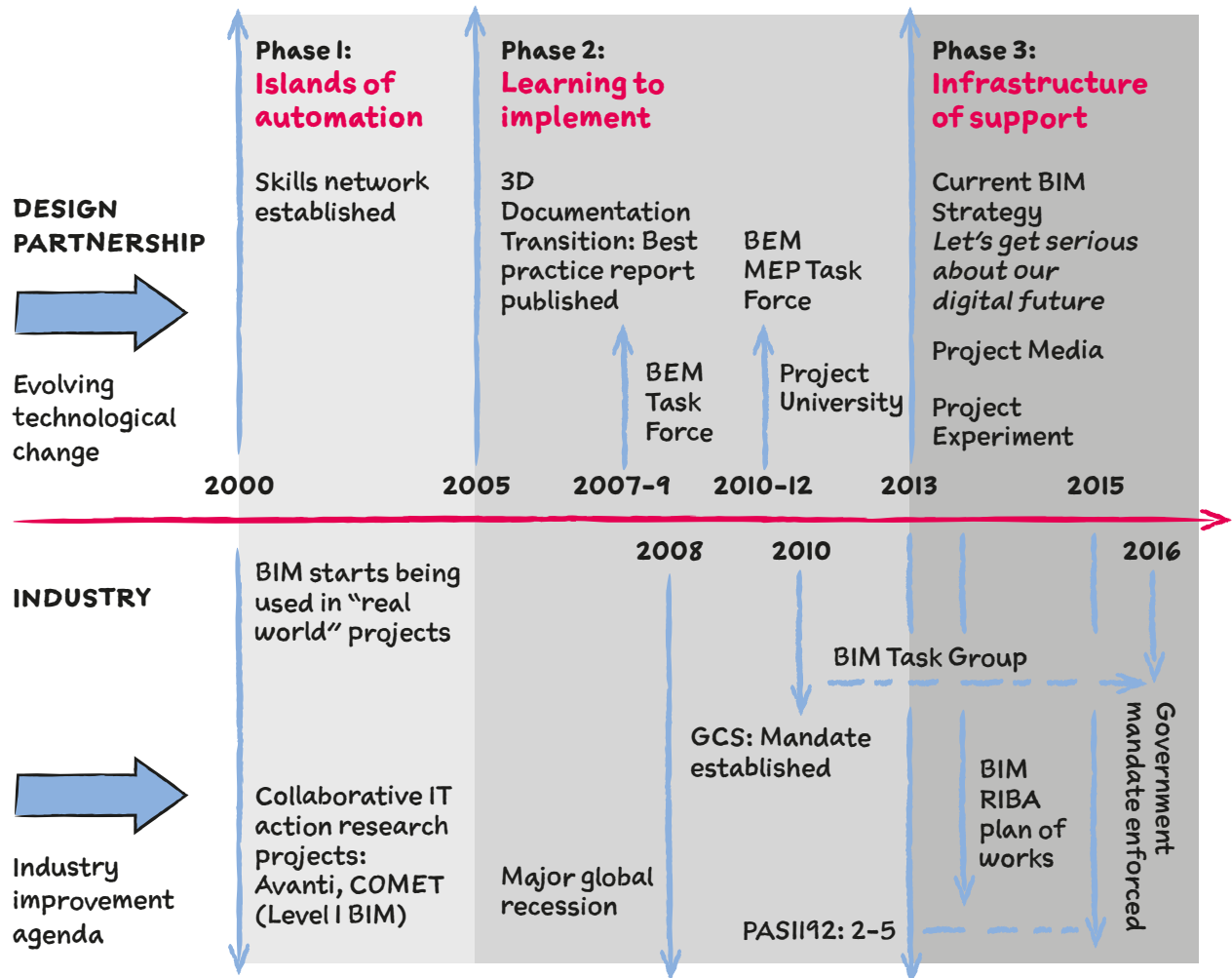


Figure 1: Three phases of BIM implementation at Design Partnership

Using a temporal bracketing strategy, major events at firm and institutional level were identified that formed the start and finish of each phase, as shown in Table 2. For instance, Phase 1 of this study starts in 2000 and extends to 2005. These temporal boundaries were identified as in 2000 scholarly reports show BIM being used on ‘real world projects’ (Grillo and Jardim-Goncalves, 2010) and major publicly funded collaborative research projects were initiated (Avanti and Comet in the UK). In Design Partnership, management funded the creation of an internal Skills Network through which early users of BIM could share knowledge across the firm. The end of Phase 1 and beginning of Phase 2 in 2005 is marked in Design Partnership by the launch of the firm’s first global initiative aimed at collecting best practice across the firm. Although this does not equate exactly with events at institutional

level, there were already indications of the forthcoming major global recession that impacted the AEC industry in 2007. The final phase spans between 2013-2016. It is marked by major events occurring at institutional and firm level in the form of the launch of the UK Government Mandate which catalysed the launch of a new BIM strategy in Design Partnership, aimed at achieving this mandate. The end of Phase 3 and this study occurs in 2016 when the mandate came into force and a number of objectives from Design Partnership’s strategy were achieved. Three core projects completed during the most recent phase of implementation, Project University, Project Media and Project Experiment were studied in detail.

Table 2: Temporal break points that identify the 3 phases of BIM diffusion at Design Partnership

	Phase 1 2000 - 2005	Phase 2 2005-2013	Phase 3 2013-2016
Design Partnership (users and firm)	2000: Skills network established.	2005 (start): 3D documentation initiative launched.	2013: New BIM strategy ‘Let’s get serious about our digital future’ launched. 2016: Government mandate comes into force
Institutional	2000: BIM starts being used in ‘real world projects’ Early collaborative IT project	2008: major recession hits global economies including the AEC industry.	2013: Major standards published including BSI’s PAS documents. 2016: Government mandate enforced in the UK, requiring BIM Level 2 to be used on all public construction projects.

Project University

Design Partnership started work on Project University in the middle of 2007 and the building was opened early in 2013. The client is a large UK university, with some 25000 students, studying in 8 different campuses spread across the city. The building reviewed here provides additional accommodation for the University’s Faculty of Media and Performance Arts and

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Faculty of Technology, Innovation and Development along with the city's Institute of Art and Design. Project University has recently won a prestigious architecture award and achieved the top rating for environmental design in buildings. Design Partnership provided MEP engineering design on the project, along with specialist engineering services including fire, acoustics, lighting, communications, transportation, security, and highways engineering. The client was clear that it wanted 3D modeling from the outset of the project. While physically consolidating the built facilities in its campus, it was also aiming to achieve virtual consolidation. Unusually for this time, BIM was a contractual deliverable; the design team was bound to use BIM and to hand over to the client a virtual model that matched the physical facility. The challenge of using BIM was considerable for all members of the wider project team; they were inexperienced in using BIM, many of the institutional standards that have been published in recent years were unavailable and BIM software available at the time was notoriously "clunky and unreliable". Many members of the team felt that using BIM for the first time on such a large, high profile project was risky. Indeed, one organization in the team initially had two internal teams working on the project in order to mitigate the perceived risk, one working in BIM and one using traditional processes. (They dropped this approach after the scheme had been through planning and their internal team only used BIM modeling.)

However, from early project stages a strong sense of collaboration existed amongst all team members, following the leadership of the client. From the outset of the project, the client established a strong commitment to learning collectively in the team. This is perhaps the most striking aspect of actors' accounts of working on Project University. As one team member recalls, "we were all feeling our way. All participants were making significant efforts to make it work." The client was instrumental in establishing this approach early in the project and supported the whole design team in their learning curve. Tangible evidence of their commitment can be found throughout the subsequent project stages. For example, they funded an initial workshop to help elaborate how BIM was to be used and financed ongoing external IT support for all members of the wider project team.

Because learning was undertaken collectively, extending across organizational and disciplinary boundaries, routines for using BIM were developed together from the outset of the project. For example, the team developed a BIM brief and collaboration protocol at the

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start of the project. This specified criterion for uses of BIM, for example it stipulated how data were to be managed including schedules for data drops and guidance around software use. It was drawn up at a two-day workshop, funded by the client and run by IT consultants, who were then available to help the wider project team implement this brief.

However, these collaboration protocols did not remain unchanged but evolved with demands. While the collaboration protocol specified that the team exchanged models every two weeks, this was leading to issues around workflow and communication: the design team often had to wait for other organizations to design and it was difficult to communicate changes in information exchange. As an architect working on the scheme recalls:

“Our main problem was around communicating changes in information exchange. We were exchanging models every 2 weeks. This created delays as we were waiting for other team members to design elements.”

Similarly, if the architect made a significant change in the design, for example by moving the ceiling grid, there were substantial delays in communicating this to other members of the team as data drops were made bi-weekly, and BIM software had restricted functionality to communicate these changes. This resulted in inefficiencies and clash detection became a major ongoing issue for the team.

Therefore, the collaboration protocol was adapted to reflect user experience, and a routine was developed to resolve this. As a member of the design team explained:

“We decided to streamline the process – to put placeholder elements in the model which acted as generic elements that identified zones. So, we didn’t have to wait for other members of the team to design.”

Project University was carried out before the advent of institutional standards, such as PAS 1192 and the CIC protocol, and specialist technologies, such as clash detection software (specifically NavisWorks Clash Detection) that help resolve issues around coordination and communication in contemporary projects. As these standards and technologies were unavailable, team members often relied on traditional methods of project communication to try and mitigate some of the more serious coordination issues. For example, colocation and other forms of face-to-face contact were found to be invaluable for day-to-day informal communication. The project’s lead MEP engineer says Project University showed that:

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“Coordination issues are potentially big problems – BIM doesn’t answer the need for coordination. If anything, the basics of design coordination are more important when working with BIM because they are flagged up quickly.”

The team found that in the wider project team, professional boundaries were in a state of flux. While some aspects of professional roles remained broadly intact – that, for example, the architect still did the setting out and designing – using BIM was changing the boundaries between the professions. Several unresolved questions arose because of this emerging situation. For example, how should architects communicate with engineers when using BIM? Who is responsible and when?

Project Media

Design Partnership started work on Project Media during Phase 3 of the BIM adoption process, in October 2013. The client is a major media organization which has commissioned a considerable level of repeat work, and has become Design Partnership’s largest grossing client today. The client wanted a bespoke building for a training academy, which is currently housed in a small room in the studios. It set an ambitious timeframe for the project, which was completed in September 2014. The original brief called for a temporary building, although this changed during the project and the building is now permanent. Timber construction was chosen early in the project, when the building was still envisaged as temporary, as it is easily demountable. For speed of design and construction, the building has a relatively simple orthogonal geometry, with forms repeated across its four floors. The division of Design Partnership working on Project Media offers architecture, structural, MEP and public health engineering services. It provided these integrated services through the design phase of Project Media, working in a co-located team based in its offices in London. During construction, it worked with the main contractor who are also providing detailed MEP engineering and a specialist timber fabricator.

The speed of the project is extraordinary in the UK building industry: from producing a project brief in October 2013, the building was in use in under a year in September 2014. Design Partnership was commissioned on the project in October and released a concept design report in November. The size of Design Partnership’s team on the project fluctuated according to project stage, during peak times the team comprised eight people, scaling down after design development was completed. Early activities were driven by the speed of the

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project and the need for the project team to work quickly and collaboratively. An additional challenge, came from Design Partnership's decision that engineers would do all the modeling on Project Media while designing, a role previously performed by technicians and a first for Design Partnership. Internally, some team members had concerns about the risks of using BIM in this way on a project with such challenging timescales.

Because Design Partnership's team on Project Media "hit the ground running", preparation time was extremely limited. They had just six weeks to produce a concept design. A formal kick off meeting was held at the beginning of the project that established some internal collaboration and coordination guides from the outset of the project. Experience had established that communication and coordination was particularly important when using BIM. During Project Media, this was pronounced because of the intense pace of the project. The project team learnt not to rely on the model to coordinate, and that face-to-face communication was still a valuable means of communicating and coordinating work. The project leader explained:

"The model is a tool that helps you coordinate but actually you should be talking to each other first ... you shouldn't rely on the model to miraculously do your coordination."

This was demonstrated early in the project, when the site coordinates were entered in error without communication between the team. This mistake was uncovered during a conversation in a design meeting and subsequently resolved. However, it took time, a scarce resource, and could have been avoided.

The co-location of the team helped enormously to facilitate informal ongoing communication amongst team members, this was particularly important on such a fast-paced project, which used BIM in a novel way for the first time. The team's physical proximity meant that discussion between members was readily available. Illustrating how this led to problems being collectively solved, a lead engineer recalled:

"We did have a lot of discussion about how people model things. For example, how you do tapering elements. If you've got a steel element, you just tell it what beam it is, you tell it from the library, whereas in concrete (and particularly in foundations where you've got pits and funny shapes) you have to make design decisions about where one element stops and another starts. So, do you model a slab to the side of the wall or do you model a slab all the way through? There was that sort of decision to be made."

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While the team learnt that the 3D model couldn't be relied on in isolation, there were instances where it proved a valuable tool. The model was used to facilitate discussion at the periodic design team meetings, where it proved a particularly valuable tool for showing the building elements and their relationship to each other. For example, during design development stages, the team was able to quickly identify from the model that the timber structure was getting very large, therefore the architects were able to increase the floor height to mitigate the proportional effects and allow more room in floors and ceiling voids for services. Design Partnership's lead designer for Project Media sums up their learning saying that:

“Virtual models allow you to talk about specific bits and to see problems with them – because the physical model is just architectural it doesn't allow you to see the services and raised floors and so on. A virtual model enables us to coordinate much more and see the little nooks and crannies and spot problems with clashes.”

As Project Media moved into construction phases, other organizations became involved as well as Design Partnership. The BIM model was then used in ways that further illustrate its versatility. For example, timber manufacturers B&K used the model as the basis for timber fabrication and were able to reduce their tendering program by a week. The contractors for the project used the model for 4D programming; effectively they developed the model to show the building being constructed. By doing so, they calculated constructability (or logistical) details that account for other activities on the site: where to site the cranes and delivery wagons and offloading the timber, and then rearranging plant as needed. During costing stages, the model was used to clarify information with other manufacturers. For example, a senior structural engineer at Design Partnership used the model to show that the wrong calculations and price estimates had been made for concrete beams.

Work processes between the disciplines change using BIM, potentially creating efficiency gains and allowing the design team to work faster. One senior structural engineer provided an example of this:

“Structural engineers generally fix geometry whereas the service engineers traditionally write performance specifications and get trade contractors to do the final installation drawings. But when using REVIT [*a 3D modeling software*], the building service engineers have to specify more detail in their design up-front. On this project, because all the risers and cores are made out of timber panels, all of the openings for the services are cut in them. So, our

building service engineers predefined that so that when our model went to B&K it had all the building work in it.”

Design Partnership learnt how to use the 3D model and its value and limitations as a communication aid. They realized that in different settings, audiences, and project stages the virtual and physical models are perceived differently and therefore guide decision-making differently. Through their work with external organizations, they learnt about the model’s flexibility, and how it can be used beyond design stages into construction. Design Partnership’s technical learning also grew on Project Media, advancing their experience of modeling and BIM capabilities.

4.3 Project Experiment

The last of the three projects presented, ‘Project Experiment, is the most recently completed. By definition the goal of this project is to be innovative. It is an exemplar BIM project funded by Design Partnership in order to “develop an engaging case study that demonstrates the real advantages of BIM” (NBS National BIM Report,2014). It showcases Design Partnership’s capabilities in BIM and provides opportunities to innovate, learn and develop these capabilities. It was carried out in 8 weeks between September and December 2013. During this time, an interdisciplinary team modeled a 35-storey, 170m tall building, based on the human form. Initially a member of the team was measured using a 3D laser scanner. The resulting data was used as the basis for modeling a building that incorporates architecture, structures, MEP and public health engineering. The design uses bodily systems to produce a building that takes the form of a human being.

Project Experiment was the idea of two BIM enthusiasts in Design Partnership. The concept gained leadership support and therefore secured business investment. Getting the right team together to realize the project was a challenge that involved compromises but was crucial to its success. Team members needed to be skilled, enthusiastic and prepared to work on Project Experiment in parallel with fee-paying projects. In the team assembled, there was considerable variation in team member’s experience of using BIM and knowledge of the software, ranging from novices to experienced users of BIM model. There was also marked variation in the approaches and outputs used by the different engineering disciplines, from well-developed mechanical and structural BIM models to a more limited use of BIM in electrical and public health engineering.

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The initial project concept was first developed into a realizable project: turning the two project leaders' idea into a collectively owned and deliverable scheme. The team sought advice from scientists at Imperial College in London about human anatomy and mapped these into engineering systems, designing different components to correspond with bodily functions. For example, the public health engineers decided that the stomach would be a water system and the bladder would be grey water harvesting. In parallel, the team was addressing the technical aspects of the project: how such a complex, interdependent form was going to be modeled. They decided together to work on scanned data. In partnership with an external IT company they developed a 3D scan - produced by laser scanning the body of a member of the project team- and used this as the basis for ongoing modeling.

Although the purpose of Project Experiment was to innovate, the project leaders chose to use what they called an "old school methodology" to manage the project. They did so because of time pressures generated as Project Experiment needed to be completed in time to present it at a conference and because the team was working on it in parallel with fee-earning work. As with Project Media, the physical proximity of the team and co-location of the disciplinary units, helped substantially with informal communication. Formal project communication occurred through team meetings, held every two weeks, where tasks and deadlines were agreed. The team was hierarchically organized, with project leaders and heads of each engineering discipline. Using these traditional project methods, a number of technical advances were made during this stage, often through collective problem solving carried out during design meetings. For example, significant technical innovations were also made in MEP engineering. In modeling airflow systems, team members managed to embed formulae into the mechanical equipment families and thereby automate a vast array of calculations that rely on the total airflow:

"We established that it was possible to use the total airflow to calculate the heating and cooling loads for each piece of equipment in the ductwork system, alongside the water mass flow rates required by this equipment to meet the calculated loads."

Not only does this innovation automate a traditionally manual process, it synchronizes calculations to the geometry of the model and links the ductwork system to the pipework system so that a change in one automatically updates the other.

Discussion

The process presented here shows how individuals skilfully perform the balancing act between routine and innovative action; with routines providing a frame within which collective innovation takes place and vice versa. The creation and adaption of these organizational routines is catalysed by institutional standards, which are often aimed at enabling the coordination and collaboration needed to use digital platforms like BIM to generate digital innovations across organizational and professional boundaries. Comparative analysis of the three projects provides support for this. as shown in Table 3. For instance, in Project University, collaborative routines and protocols created by the design team (including client) were instrumental in enabling the innovations realised in this project, in using BIM for the first time and in delivering a ‘digital twin’ to the client (i.e. a digital and physical built asset). In Project Media, the organizational routines that specified how the common 3D model was to be used, enabled innovations that benefited not only Design Partnership but many members of the supply chain (Boland et al, 2007). The existence of Project Experiment was to be innovative: to push the boundaries of BIM knowledge in the firm by developing a digital model of a human form. The innovative goal of this project was achieved however by drawing on existing traditional routines for project management.

	<i>Organizational routines</i>	<i>Innovations</i>	<i>Firm level digital capabilities</i>
Project University	Collaborative workshop and protocols	Using BIM on a project for the first time. Delivered the client a virtual and physical copy of the built asset.	Understanding of the need for flexible collaboration protocols. Codified in Design Partnerships current BIM strategy.
Project Media	Common 3D model	Entire project team modeling building for first time. Very fast delivery time. Wakes of innovation established across the supply chain.	Technical learning around modeling with BIM and appreciation of the limitations and opportunities presented by the common model. Led to innovative applications of BIM model on Design Partnerships current work in logistics and cost planning.
Project Experiment	Traditional project management tools	Overall aim is to create an innovative BIM model. Technical innovations on MEP engineering solutions.	On the most innovative projects, digital working requires significant attention to be paid to cross disciplinary coordination. Traditional project management tools are essential.

Table 3: innovation and routine actions leading to firm digital capabilities

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By attending to the microfoundations of organizational paradox (Miron-Spektor et al, 2018), this paper contributes to our understanding of how routines enable or constrain innovation and how they are used in novel situations (Feldman et al, 2016, Sonenshein, 2016). By focusing on the actions of individuals whose professional education and experience revolves around balancing multiple tensions at work to create innovative solutions, the ways in which their ‘paradox mindset’ enables them to address tension: specifically, to create innovation using routines is unpacked. The data presented here suggests however that the relationship between routines and innovation is not linear but is mutually constitutive, whereby they shape and are shaped by each other. Adaptations occur between them, often informed by collective learning. For example, in Project University, the collaborative protocols created at the outset of the project were adapted according to issues arising later in the project process. In Project Media, learnings arose when modelling the building that informed the routines used at design meetings.

An additional contribution is made in this paper, in the implications of the findings at organizational level. The process of organizational change presented does indeed emphasize an existing organizational contradiction that many creative firms constantly face between innovation and routine actions. In such a dynamic environments created by external changes such as technological (Eisenhardt & Martin, 2000), managers need to perform the ‘balancing act’ described by Hargraves and Van de Ven (2007). This finding echoes Schreyögg and Sydow call for firms to ‘balance countervailing processes’ in order to create a template for the uncertainty and complexity that change brings (2010). The data presented here suggests that the organizational rewards of managers and leaders doing so successfully are significant: the innovative solutions and use of collective routines presented here may form a basis for firm level digital capabilities, as illustrated in in Table 3. For example the experiences of practitioners working on Project University relating to the importance of creating flexible collaboration protocols in order to create digital innovations are now codified in the firm’s strategy document on digital working. Similarly, the work of individuals on Project Media informed Design Partnership’s capability in how 3D models should be used, and their value and limitations as a collective communication aid. They realized that in different settings, audiences, and project stages the virtual and physical models are perceived differently and therefore guide decision-making differently. Through their work with external organizations,

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they learnt about the model's flexibility, and how it can be used beyond design stages into construction.

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