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From 'Intelligent Pumps' to 'Skinny Risers': Technological Metaphors in Engineering Greater Servitisation

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ABSTRACT

There is growing interest in the sector moving beyond product-based operations towards greater levels of service orientation. Extant scholarship on servitization has often taken for granted the essence of service-oriented business models. However, such models tend to downplay transitional journeys that providers and users make in order to reach greater service-orientation. Therefore, the focus of this study is to examine the transitions that people go through as they move from a product-based way of working to more service-based operations. Through a series of interviews in ConstructCo, we explored the gap between what our interviewees said they did in their everyday organisational routines and what was desired by ConstructCo in its aspirations to become more servitised. We detected how organisational change was occurring gradually, rather than radically. Rather than the business model driving change, we found that our interviewees were continuously making sense of what servitisation meant for their everyday routines. This sensemaking process often entailed the use of technological metaphors. We observed how people, technology and organisational processes were often entangled as ConstructCo evolved to become more servitised. Attending to such sociomaterial entanglements is quintessential for researchers and practitioners to understand the actualities of construction organisations changing towards more servitisation.

KEYWORDS: organisational change, servitisation, sociomaterial entanglements, technology

INTRODUCTION

The "servitization of business" (Vandermerve & Rada 1988) refers to the growing trend in product manufacturers re-positioning their business towards offering supplementary through-life services with their products. These firms are increasingly attracted by the promises of lucrative long-term revenues from their combined product-service offering as they develop capabilities to address more effectively the needs of their customers. Customer spending patterns indicate that value increasingly lies in the provision of those services that ensure product availability and reliability through the product life-cycle rather than in the manufacture of the initial product. This trend has begun to raise questions concerning the value of service activities and who should be responsible for the delivery of these service activities. The research reported here identifies how this emerging theme takes on particular importance in the construction industry where, given the proliferation of Build-Operate-Transfer and Public-Private-Partnership schemes, design and construction contractors are increasingly taking greater notice of operation and maintenance concerns.

In this article, the wider servitization literature is reviewed to ascertain what the main drivers and challenges are for design and construction contractors looking to play a more prominent role in the operational phases of the project life-cycle. Through this literature, it was observed that the servitisation literature tends to consider the product-service model as the end-point, often driven from a top-down business-model perspective. Such an approach focuses heavily on the importance of high-level strategic commitment towards greater servitization and takes an instrumental view in prescribing how servitisation might be realised operationally. However, this emphasis, it is argued, neglects the focus on the transitional routines and practices that firms enact as they move gradually towards more service-oriented provision. It is this transition that forms the key focus of the research reported here. So, in treating servitization mainly as a business model that governs organisational routines and

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practices, just how organisations move towards greater service orientation through transitional routines and practices remains relatively under-explored. Rather than to take the servitisation 'business model' as a new planned state in organisational change, we are concerned with more contemporary view of organisational change which takes a processual view. Such a view places the question firmly on the transition, the hyphen between the provision of the product and service, and conceptualises transitional routines and practices as emergent rather than prescribed or planned. Yet, Therefore, it is argued in this article that research on servitization in construction should shift away from a strategic, business-model approach, and move towards treating organizational routines (see e.g. Pentland & Feldman, 2003) as the unit of analysis to examine how construction organisations can change (and are changing) to become more service-oriented.

In this article, we report on some preliminary findings from exploratory interviews in ConstructCo, a large UK contractor, that allowed us to look into transitional routines and practices more carefully. Through these interviews, we were struck by references made to particular technologies that appear to shape our interviewee accounts of how change was happening as ConstructCo was moving towards a greater degree of servitisation. In talking about these technologies, our interviews were littered with technological metaphors as our informants attempted to describe their experiences of everyday life as ConstructCo geared towards the aspiration of delivering more service-oriented provision. In this paper, we were inspired by two particular metaphors, known colloquially within ConstructCo as "skinny risers" (to represent the modular vertical distribution units) and "pump intelligence" (to represent embedded technology within pumps that enable them to perform more efficiently over the whole-life cycle). Examining these metaphors enabled us to to explore how technology, and technological artifacts, were constantly appropriated as our interviewees made sense of how these technological changes transformed what they did within ConstructCo. Thus, we were able to render visible how their everyday routines within ConstructCo were changing through their talk of people (humans) and technology (non-humans), and how they interacted, and in some cases, became entangled as our interviewees made sense of their journeys towards servitisation.

In analysing what we were hearing and seeing from our interviewee accounts, we borrow the concept of sociomateriality (Orlikowski & Scott 2009) to examine the multiple ways in which these technological metaphors played a crucial part in stimulating or stymieing change in ConstructCo. Such a framework allowed us to detect how ConstructCo's transitioning from product to service built on the accumulation and use of not only intangible human skills and information, but also material flows of physical assets (Campbell et.al 2012). Every service has a material substrate (e.g. the service of cooling and physical components of ducting, control units and meters), but the material aspects are often overlooked in the servitisation literature. Therefore, in this paper, we acknowledge the importance of object-orientated philosophies (Latour 1985, Orlikowski 1992) in arguing that the physical, tangible asset (in this case M&E equipment) must be considered as equal to the human actors if we were to understand that the complex entanglements of routines and how these play a critical role in shaping the organisational changing (not change) towards more servitized operations. We use Orlikowski's structurational model of technology to illustrate the complex, reciprocal relationships between technology, institutional processes and human actors as ConstructCo goes through the transition towards greater service-orientation.

THEORETICAL BACKGROUND

Traditionally, construction contractors have focused their attention predominantly on the design and construction of tangible goods. Whilst they were normally involved to some extent in services related to the operation and maintenance of buildings, these service

obligations were often subsidiary to their design and construction responsibilities. There was a tendency to view these service activities as mundane, reactive and routine; hence, organisations overlooked the potential value they could offer their business (Johnstone et al. 2009). Organisations would provide additional services (warranties etc.) free just to secure a product sale or deliver layers of services that did not actually address the customer's needs (Anderson & Narus, 1995). Changing customer demands are increasingly forcing these organisations to re-evaluate their product-dominant practices. Supplementary service plays a critical role in ensuring products are aligned to the customer's function, the performance of products and the reliability of products. Increasingly customers see these aspects as at least as important as the products themselves; spending patterns of customers are moving in this direction (Wise & Baumgartner 1999). These changing mindsets towards product and service are encapsulated convincingly in Vargo & Lusch (2004)'s challenge to academics and practitioners to move towards a service-dominant logic, the premiss of the argument being that suppliers must co-create value through-life with their customers, with Prahalad & Ramansay (2004) asserting that this value co-creation process increasingly lies outside the suppliers' organisational boundary, lying in the interactions between a network of internal and external actors.

The catalyst for this emerging logic has been a recent trend in product-orientated organisations moving from product delivery towards the provision of integrated combinations of products and services that deliver value-in-use (Baines et al. 2007). This process of product manufacturers moving towards holistic service provision was first acknowledged within the academic literature in the work of Vandermerve & Rada (1988) who coined the term "servitization". Emerging trends of servitization have taken on particular importance within the construction industry as the continued proliferation of PFI projects challenges contractors to take a more holistic approach towards the design, construction, commissioning, operations, maintenance and post-occupancy of buildings (Leiringer et al. 2010). Success stories of firms moving towards more innovative and collaborative relationships with their clients through "servitization" (Windahl & Lakemond 2006). Alonso-Rasgado et al. (2006) have studied the applicability of such an approach outside the construction sector. For instance, within the aerospace sector, engine suppliers such as Rolls Royce do not just manufacture engines anymore, they also provide through-life maintenance for their engines and lease out the use of their engines in the form of "Power by the hour" (see also Smith, 2013). Whilst the applicability of cross-industry innovation must be treated with caution (Enkel & Gassmann, 2010), the evolution of the Rolls Royce TotalCare model, as well as similar innovations from other engine manufacturers within the aerospace sector, call into question whether the M&E supply chain in building construction can play a more effective role in the operation and maintenance of building systems.

Brady et al. (2005) introduced the idea of servitizing within the construction and infrastructure sector, as they observed increasing provision of "integrated solutions" which combine products and services to address a customer's unique requirements over the life-cycle of the project. Case study research within the evolving "integrated solutions" literature in a construction setting focuses predominantly on the provision of PPP/PFI projects (Roerich & Caldwell 2012, Johnstone et al. 2009, Storbacka 2011). Certainly, the process of servitizing and bundling products and services into one unique solution resonates quite clearly with the PPP/PFI framework where the emphasis is upon not only the delivery of the built assets but also the servicing of these assets over a 20-25 year period. The underwhelming performances of early PFI projects have been widely documented (see Akintoye et al., 2003). Consequently, there have been reforms in the way PFI projects are commissioned and maintained in the construction industry, as seen in the development of the PF2 framework. Therefore, the challenge for construction contractors to adapt to the

government's adoption of a more servitized framework for project delivery continues to be a key debate.

Servitization: The Dominant Discourse

Drivers

Anonocopolou & Konstantinou (2008) reflect on the fact that servitized business models are increasingly being viewed as "panacea" business operations. The academic coverage of servitization is typically optimistic and reflects an emerging mindset that the logic of the argument for firms to servitize is becoming more convincing. Central to this argument is the emergence of a more "connected, informed, empowered and active" customer (Prahalad & Ramasmanay, 2004) whose demands are increasing (Cohen et.al, 2006). Central to this argument is Vargo & Lusch (2008)'s claims that customers are more interested in developing long-term relationships where value is co-created between the supplier, supplier's network and customer through the life-cycle of the product. This value co-creation process seeks to address innovative ways in which the performance of these products can be improved through-life. In doing so there is reason to believe that suppliers can influence the consumption patterns of their customers relating to these products (Mont 2000) (Goedkoop et. al 1999) Tukker & Tischner, 2006). This becomes increasingly important for firms competing in markets, like PFI markets, where regulations are changing as to responsibility for the energy performance of products. Furthermore, the bulk of early literature on servitization was keen to stress not only the customer-based and energy-related drivers for firms but also the financial (Mathe & Shapiro, 1993) (Gebauer et.al 2006) and strategic advantages (Mathieu 2001) that lie in greater service-orientation. Finally, the argument to servitize turns on the established success of other firms in making the transition towards greater service-orientation (Wise & Baumgartner, 1999). Snapshot illustrations of firms like Rolls Royce, GE and Alstom depict a convincing picture of servitization.

Challenges

Whilst the early theme of the servitization literature was keen to illustrate the core themes of servitized business models and the drivers towards this mode of operating, more recent research has tended to focus equally on the challenges associated with implementing this business model. The reality is that a select group of widely documented successes of servitized practices have obscured the wider trend (Neely 2008) (Lay et.al 2010) of product manufacturers struggling to adapt to their evolving role within through-life activities as they move tentatively towards greater servitized operations. Consequently, case study research (Martinez et.al 2010)(Johnstone et.al 2009)(Ulaga & Reinartz 2011)(Windahl & Lakemond 2006) is increasingly focusing on the challenges encountered by those who have moved towards service. Such a transition requires a radical re-assessment of how firms intend to make money (Bonnemerier et.al 2010). Traditionally, business models have tended to reward equipment manufacturers with greater revenues when their products fail. However, servitization challenges firms to transform their business models (Ng et.al 2009)(Caldwell & Settle 2011) towards generating revenues on the basis of the reliability, performance and availability of their products through-life. Contractual arrangements must reflect this and seek to align the interests of the actors involved towards ensuring product performance is maintained at the pre-specified level through a series of pain-sharing and gain-sharing mechanisms.

Flexible organisational structures (Davies et.al 2006) which are more responsive to the customised nature of service provision are identified as a major hurdle for product manufacturers. This requires embedding a service culture (Martinez et.al 2010) within the

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organisation where performance metrics are geared towards effective service provision. The literature identifies commitment at a strategic level as being critical to successfully embedding a service culture. Effective strategic management and modification of performance metrics are critical to translating strategic intent into operational reality (Olivia & Kallenborg 2003) (Gebauer et.al 2009). Increasingly however, a shift towards service provision dictates the range of actors involved becoming more complex, with value increasingly lying outside organisation boundaries and between the focal organisation and its value chain (Storbacka et.al 2012) which will include suppliers and customers. This leads to another key challenge exposed by a number of authors, but perhaps most effectively in Windahl & Lakemond's case studies (Windahl & Lakemond, 2006), which is the need to transform supplier relationships towards supply chains driven by the customer's needs (Christopher & Lyals, 2014). Some of the more upbeat calls for product manufacturers to move into supplementary service (Cohen et.al 2006) seem oblivious of the fact that there isn't room for everyone in these after-sales service markets. Product manufacturers must pursue specific service strategies (Auguste et.al 2007) which differentiates them from existing service providers, some of whom have decades of experience in the area. This differentiation resides in the intimate knowledge they acquire during the design and manufacture of their products and also in their superior understanding of the technology utilised in the products (Wise & Baumgartner, 1999) (Smith 2013). By undertaking responsibilities for product and service, which require a number of departments both internal and external to the focal organisation (the systems integrator (Davies et.al 2007)), there is an emphasis on developing system integrative capabilities.

Exploring the transition

What emerges from the literature is a detailed analysis of why product-orientated firms are attracted by more servitized operations and what challenges they will have to overcome in order to implement a more servitized business model. Whilst several authors have identified the need to analyse the transition (Olivia & Kallenborg, 2003) from product delivery to product-service solutions, they frequently approach this through case studies that draw the experiences of those who have successfully employed servitized business models (Antonocopoulou & Konstantinou, 2008) to identify what were the major obstacles they encountered in the transition. What is missing is an appreciation of what the transition entails and how this transition from product to service gradually manifests itself within organisations and their value chains. Attempts to focus on this tend to approach it from a top-down perspective, placing the emphasis on how management can overcome the widely documented obstacles to ensure aspirations of servitization at a strategic level are translated into operational reality.

Shifting perspectives towards organisational change expose the limitations associated with adopting this top-down perspective towards the transition. No longer is organisational change considered a linear process, which can be pre-planned and then implemented in a series of rational steps (Graetz & Smith, 2010. Instead, it is viewed as an emergent process (Bamford & Forrestor, 2003) where change is viewed as a continuous and open-ended, in which practices are continuously adapting to changing conditions. We also draw upon findings within the organisational-change literature that argue second-order organisational change (transformative, radical and divergent) at the macro-level can be the consequence of first-order organisational change (slow, steady, continuous and incremental) at the micro-level (Anderson, 1999). In turn the macro-structure of this complex eco-system of interacting actors then influences individuals, "and the evolutionary process moves constantly between micro behaviours and emergent structures, each influencing and recreating each other" (Mitleton-Kelly, 2003). This is pertinent to the construction sector where work is typically

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project-based, inherently multi-actor, unpredictable and emergent in its nature. Combining bottom-up and top-down perspectives of organisational change illustrates the role played by the changing organisational routines at an operational level in shaping the sort of radical change incurred by servitization at the mezo-level and macro-level. Therefore, this paper proposes we use organisational routines as the lens for observing how these incremental changes at a micro-economic level manifest themselves in the mash-ups of existing complementary and contradictory routines (Pentland & Feldman, 2003).

Examining Organisational Routines

By viewing the servitization transition through a processual lens, where organisational change is emergent rather than planned, we can utilise organisational routines as a unit of analysis (Feldman & Pentland, 2003). As this article seeks to understand the micro-level conditions and consequences for change, organisational routines provide us with a "zoom-in" (Becker et.al 2006) and identify how contested issues are played out in organisations and at organisational boundaries. Understanding routines as truces (Nelson & Winter, 1982), where inter-organisational conflicts are acted out and resolved, will allow us to explore how value is co-created when roles and responsibilities for the design, construction, commissioning and operation of buildings become more blurred under more servitized contractual frameworks as in PFI projects. The political conditions at play within the complex network of actors stand to jeopardise the delivery of assets on PFI projects; by appreciating organisational routines as a lens for understanding this conflict, there can be a greater understanding of the interests and expectations of different stakeholders (Antonocopoulou & konstantinou, 2008). Furthermore, Becket et.al (2006) examine how micro-level actions within organisational routines can be used to trace how new organisational dynamic capabilities accumulate and develop. To do so requires that we unpack routines and delve into their internal structure, which Pentland & Feldman (2005) explain reveals three elements: the performative aspect (or the acts of 'doing') of routines, the ostensive aspect (or the acts of 'patterning') of routines and the related artefacts. It is the interactions between these aspects of routines which then provide a deeper understanding of the sporadic and discontinuous change towards more servitized behaviour at the operational level. Therefore, to examine how companies make the transition towards greater servitisation, a crucial question lies in understanding how organisational routines, as a unit of analysis, are changing. It is surmised that the interactions between the ostensive and performative aspects of routines that provide a more textured understanding of how change towards more servitised way of operating could happen. In the next section, we will explain how this thinking informed the methodological approach for our exploratory study.

ARCH METHODS

For the purpose of this article, the analysis draws upon data collected from 12 interviewees (see Table 1 below), which formed part of the exploratory stage of the wider research on servitisation in ConstructCo. These interviewees were selected to represent perspectives across a typical project life cycle, from design to construction to commissioning to service and maintenance. The purpose of the exploratory interviews was to elicit perspectives from these interviewees regarding their experiences, highlights and challenges faced in their everyday routines. Because we wanted to capture perspectives that were relevant to the central theme of servitisation, we deliberately selected interview participants who had experience in projects within the private-finance-initiative framework.

Table 1. Profile of interviewees.

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Participant	Description	Typical involvement on project
A	Design Manager (M&E)	Early stage Design - developed design
B	Head of Design (M&E)	Early stage Design - developed design
C	BIM project manager	Design (Pre-win)
D	BIM Team Leader	Design & Construction
E	Design & Construction process engineer	Design (Post-win)
F	Design for Manufacture & Assembly manager (North)	Developed design - manufacture
G	Design for Manufacture & Assembly manager (South)	Developed design - manufacture
H	Director	Design -operation
J	Whole Life cost manager	Design -operation
K	Building services manager	Design -operation
L	Construction project manager	Construction
M	Commissioning manager	Commissioning

The interviews focused on each interviewee's role within the organisation. Specifically, we asked each interviewee to describe to us their responsibilities in their everyday organisational work, and how these related to the life-cycle of projects. In so doing, we sought to capture their descriptions of what they did in their everyday organisational routines (i.e. performative aspects of routines). We also collected documentary evidence to identify what the official organisational processes are, and how these compared with what our interviewees told us they did. This enabled us to contrast the performative aspects of their routines with the ways in which they actively thought about their routines through the official organisational processes that purportedly governed their actions (i.e. ostensive aspects of routines). Questions were also asked to establish the extent to which our interviewees were aware of ConstructCo's strategic aspiration in moving towards greater servitisation. We also explored with our interviewees their views of the implications of greater servitisation and how this might alter what they do in ConstructCo. We were, nevertheless, careful not to impose a singular theoretical definition of 'servitisation' on our interviewees, but simply framed the questions so we could explore their perspectives of how ConstructCo might better service the needs of their clients after the construction and handover stages. In doing so we were keen to capture different viewpoints of how our interviewees within ConstructCo were thinking about the satisfaction of their clients and end-users with the products (and especially M&E products) ConstructCo creates.

Each interview was fully transcribed, so that the transcripts could be analysed textually. The analysis initially followed an open coding framework aimed at highlighting the challenges and opportunities perceived by the interviewees in the context of ConstructCo's move towards greater servitisation. We were also keen to identify, from our interviewee accounts, a more textured understanding of their current routines and how these might alter when ConstructCo moves towards a more servitised way of working. This allowed us to articulate discrepancies between ConstructCo's aspirations towards servitisation and their current provision along a typical project life cycle of design, construction (both on-site and off-site), commissioning and handover, and post-occupancy in-use.

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From this coding process, it became quickly apparent that the interviewee accounts of their daily routines (and what might become daily routines post-servitisation) were deeply entwined with stories about technology. Our interviewees often use metaphors such as the *intelligence of pumps* and *skinny risers* to signify how ConstructCo's strategic intent towards greater servitisation has brought about new developments in technology and technological artifacts. It was also interesting to observe how our interviewees often, perhaps unknowingly, anthropomorphise these technologies through the metaphors they used. So, the pumps were not simply innate objects waiting to be mobilised by our interviewee participants in their everyday organising. Rather, these material objects had agential qualities (see e.g. Suchman, 2002, and; Barad, 2003). So, the pumps assumed human-like intelligence and the skinny risers enabled services to be streamlined. Thus, for the purpose of this article, we explored from our data how humans, technology and organisational processes were often entangled in our interviewee accounts of organisational change in ConstructCo. Here, we found Orlikowski's (1992) structurational model shown in Figure 1 below helpful. According to Orlikowki (1992), technology is not only a product of human action but also a medium of human action. So, in making sense of our interviewees' accounts of organisational change in ConstructCo, we attend especially to what, how and why technology conditions and constrains human action, and how such interplay can influence organisational processes (see also Orlikowski, 2000).
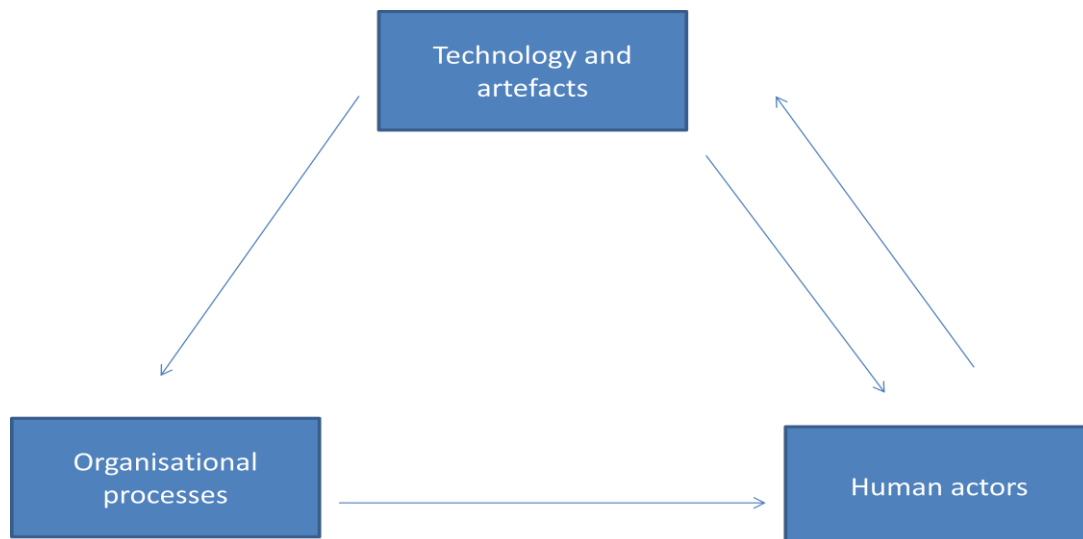

Figure 1. Framework of Technology, Human and Organisational Interactions (after Orlikowski, 2000)

FINDINGS

In this section, we build on the framework shown in Figure 1 above to discuss preliminary findings from our exploratory interviews. In this discussion, we consider technology as a medium of human action, how changes in technology can lead to changes in organisational routines and processes, and the sociomaterial entanglement between technology, people and organisational processes.

Technology as a medium of human action

One of the technologies that featured quite frequently in our interviews was colloquially known as the 'Skinny Riser'. These are vertical distribution systems that were designed as modular units that could incorporate all the services that would otherwise be separate. Thus,

rather than to install individual component parts (e.g. pipes, ducts, wires) in-situ on the project site, the 'Skinny Riser' was a modular unit manufactured in the factory, which contained the various service components. The idea of such a system was to streamline (hence, the adjective 'skinny') services, contained in a singular physical place. This, it was claimed by interviewees, should make it easier for carrying out post-occupancy repair and maintenance. Yet, as Participant J noted, the perception of easy serviceability is not as clear-cut in practice:

> "my concern is you have everything going down this one single riser, you've got water and electricity, now from that if you can control it with the proper quality it shouldn't be an issue but just say with internal rain water , how do you fix a problem with it. You can guarantee it will be at the back of the riser, so anything is in there, you've got to pull it out and sort it out, so it's just that sort of thing of how it's been designed."

In this particular account, Participant J noted how water and electricity were conventionally treated as two separate services. With the 'Skinny Riser', the intent was to put these services within one distribution system to facilitate the ease of maintenance. However, this also meant bringing forward the coordination of water and electricity contractors much earlier on that what normally happened and this was potentially more troublesome. Thus, the 'Skinny Riser' did not remove the coordination problem between those responsible for water and electricity. Instead, the 'Skinny Riser' has front-loaded the coordination problem, and designers had to imagine all possible problems in future much earlier on in the design and construction process. Put another way, rather than to sort out problems with water and/or electricity in-use separately, the movement towards servitisation meant that ConstructCo had produced a technological artefact, in the form of the 'Skinny Riser', which in turn meant that those responsible for water and electricity had to be involved much earlier on in design. This signifies a radical departure from existing understanding of the project life cycle.

The experiences of Participant J with regard to 'Skinny Risers' reveals the need to understand technology, maintenance personnel and design personnel as a sociomaterial entanglement of practices. Throughout the life-cycle of the technology a series of human actors are enrolled (Latour 2005), but the shift towards greater servitization, has disrupted traditional boundaries as the roles between design, construction and maintenance becomes increasingly blurred. In this case we see that the modular design of the 'Skinny Risers' was initially a response to calls for making post-occupancy service more convenient and cost-effective. But, it was not until people – in this instance, Participant J – physically interacted with the 'Skinny Risers' that the benefits of separating services, rather than integrating them, became realised. So, for all the exhortations of integrating services much earlier in the design process, the quote from Participant J suggests the possible merits of pulling things apart, and the difficulties of predicting all eventualities associated with service delivery. Nevertheless, we can see the agential properties of the 'Skinny Riser', principally serving as the medium of human action (Orlikowski, 2000). On the one hand, the 'Skinny Riser' represents a potent force for mobilising people who would not otherwise be involved in such detail at the design stage to talk about service requirements. Thus, we see the 'Skinny Riser' as an enabling power to facilitate collaboration much earlier on in the design and construction process. At the same time, we also see 'Skinny Risers' as a constraint, especially in terms of affording flexibility should things go wrong. As Participant J alluded to, we are potentially stuck with the rainwater pipes situated at the back of the 'Skinny Risers', which would make it difficult to sort out.

Technological change and changes in routines: information processes as a mediator

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In the preceding sub-section, we identified how the 'Skinny Risers' were driving designers to consider more closely operational concerns much earlier on. As Participant H described how maintenance teams would be asked to comment on design options as a result,

> "[…] you start putting this in front of maintenance teams and say how would you input into this, how are you going to maintain it, what would you do differently, what don't you like about it and the whole point of investing into the [information] model […]so you can do the safety side of it as well the maintenance and 'buildability' of it"

Yet, this is often easier said than done. We have already noted Participant J's concerns that the 'Skinny Risers' were potentially, physically too rigid to allow for any flexibility in fixing problems later on in-use. Indeed, Participant J proceeded to explain how, in order for 'Skinny Risers' to work, one needed to see a transformation in the ways we collect and use information about design, construction and post-occupancy service.

> "Yeah absolutely but that's where the Design and construction process engineers need to catch up. So we are very good at using it for design, digital engineering, very good at using it for construction but it needs to be handed over because you're using this model for four years, five years perhaps in the construction process, if you hand it over you can then use it for the next 50 years"

We have already discussed how the 'Skinny Risers' meant that those who were conventionally involved much later on in the project life cycle had to become more involved earlier on. This meant that information requirements had to flip from back to front. That is, information about post-occupancy use had to be collected and utilised not only for service and maintenance, but in predicting outcomes much earlier on during design. At the same time, the quote above suggests that information now needed to be stored for possible analysis over a much longer period of time, beyond the life of a typical project. Indeed, we observed that concurrent to ConstructCo's aspirations to move towards greater servitisation, effort is also expended to transform the organisational of information capture, dissemination and use through Building Information Modelling (BIM). So, while conversations were taking place about how 'Skinny Risers' were being configured to ensure the most optimal means of repair and maintenance and most efficient ways of end-use, parallel discussions were observed that revolved around the types and formats of information required to ensure that information was fit-for-purpose throughout the whole life cycle. Smith (2013) stressed that critical to a servitized strategy is a robust information infrastructure. Thus, here we see not only how technology mediates between the material artefact (in this case, the 'Skinny Riser) and human actions, we also see how this then translates into changing information requirements and the adaptation of organisational processes to support this transformation. Although front loading the right information in a project is only an intermediary step, it is still a crucial one.

Technology, people and processes entangled in sociomaterial interactions
In coding our data, we found it extremely difficult to separate out technology from the work that people did and the organisational processes that governed such interactions (see e.g. Orlikowski and Scott, 2008). We saw how the changing interactions between humans and technology transformed organisational processes, and how these organisational conditions in turn helped and/or hindered the actions of humans (Orlikowski, 2000). At the same time, we also noted how these interactions between humans and technologies simultaneously shaped the forms in which technology is embodied (see also Giddens,

1984).In discussing pump technology, for instance, Participant F's description is somewhat telling:

> The software and intelligence of a pump and the circuits available within that pump and some of the control mechanisms around aren't necessarily brought together to be to the most optimum solution for the building, you've got a control system that could control everything but doesn't necessarily always do so because there are budget elements, then you have a pump that could speak to other things and do so much more but doesn't.

In this extract, we see just how a constellation of technologies and technological artifacts (including the pumps, the software, the control systems) are entwined with human actions to control optimal throughput and usage, whilst concomitantly aligning with organisational processes of budgeting and "so much more". We see that the pump assumed a human form in Participant F's account. The pump does not just serve the function of pumping water through the engineering system. The pump has "intelligence" and can "speak to" other parts of the organisational system too. Thus, in deciding what pump technology to mobilise in any specific project, we see design teams (the humans) becoming entangled in an assemblage of technology (the pump and all the other embedded technologies that come with the pump), and the organisational processes that matter (budgets and everything else). The 'everything else' that matters too becomes more pronounced in the following quote by Participant F:

> Now in the M&E industry you can get handheld devices that measure the performance of our equipment but we don't do that, we don't necessarily want it. When you've got a cost plan to work to, you've got a program to work to, you've got our internal KPIs to work to. as a delivery as a project manager your focus is about getting the job done in time, within H&S performance criteria, cost plan performance criteria , commercial performance and program.

Thus, we can sense in this quote the multiple performance objectives that are creating tensions for Participant F, and shaping what technological artifacts are desirable or not. These tensions, embodied in cost plans, time schedules and health and safety requirements, meant that Participant F, a project manager, is more concerned with delivering the product on time rather than to think about what might be optimal in terms of using the M&E products. We also see how Participant F is resisting the intelligence that these technological artifacts (e.g. the handheld devices) might yield. Thus, in contrast to the story about 'pump intelligence', which is seen as potentially useful in conditioning control systems around its optimal use, the view taken on handheld devices is less sanguine. Put another way, the pump was recognised as a legitimate agent in ConstructCo's journey towards servitisation, and the handheld devices are not (at least for now).

PRELIMINARY CONCLUSIONS

As construction companies seek to sustain their competitiveness, the imperative is growing for companies to move up the value chain and expand their portfolios to provide more service-oriented offerings. Yet, with all the promises that servitisation as a business model brings to construction companies, the existing literature indicates that the path towards greater servitisation remains fraught with challenges. In this article, we have reflected on the findings attained from a set of exploratory interviews with ConstructCo to illustrate the challenges faced by our interviewees in making the transition towards greater servitisation, an area that is relatively under-researched in the field. Through our interviewee accounts, we have shown how organisational processes, including the conventional life cycle of design,

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construction and service/maintenance, along with key performance indicators of time, cost and health and safety, serve to constrain companies like ConstructCo and their aspirations to move towards greater servitisation. Such conventional ways of thinking locks in the focus on delivering products on time, without adequate consideration for through-life service and maintenance.

Nevertheless, we have also captured the process of change in our informants' accounts of how their everyday routines are changing. There are signs that ConstructCo is evolving to consider greater degree of service when designing and constructing products. In their journey to provide more service-oriented offerings, we have seen how ConstructCo sought to develop new integrated technological systems such as the 'Skinny Risers' and 'Intelligent Pumps'. But, the story does not start, nor does it end with such technological innovations. Rather, we argue that the transitional journeys taken by our participants in ConstructCo are shaped by a complex web of sociomaterial entanglements, where people constantly interact with technologies and technological artifacts, which simultaneously mould the organisational processes that both govern and are governed by these interactions. Therefore, the point of departure in our work is that we do not take the servitisation business model for granted. Rather, we attend to the micro-foundational processes of technology, work and organisation as these unfold in and through our interviewee accounts.

Two main conclusions can be thus be drawn from our analytical effort. Firstly, in order for companies like ConstructCo to move towards greater level of servitisation, the reliance of a 'business-model' approach is insufficient. Our analysis of how the everyday routines of our interviewees are changing (even as we undertook the interviews) show just how it is important to pay attention to the physical, tangible and experiential interactions of technology and accompanying material artifacts. The idea of early involvement of M&E services in the design and construction process is not new. Despite decades of calling for early involvement of M&E services in the design stage, there are still challenges that remain. We argue that progress is slow in embracing early involvement in practice because existing frames of thinking lack consideration of how human actions can combine with organisational processes and the physical experience of technology. In articulating sociomaterial entanglements in ConstructCo, we have attempted to show how one needs to bring together not just the idea of early involvement in design, but also to connect the abstract in the everyday practices of working with the artifacts. Only by getting to grips with how people relate physically to such technologies as 'Skinny Risers' and 'Intelligent Pumps', can we fully understand how people make sense of new ways of working.

Secondly, we identified that technology and technological artifacts are not innate objects. Rather, they possess agential properties that are anthropomorphised in the metaphorical accounts of our interviewees. Put another way, our technologies actively do stuff. They have intelligence that shape our decisions, and they speak to parts of the organisation. In some cases, our human actors go along with these; and in other cases, there is resistance. It is, therefore, important that we delve deeply to understand the power contained within these material objects in driving actions that either reinforce or resist change.

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