HOW MICRO-SHIFTS IN TECHNOLOGY, KNOWLEDGE PRACTICES, AND CONTROL STRUCTURES TRANSFORM SERVICE INNOVATION TRAJECTORIES

INTRODUCTION

The metaphor of the tanker and the speedboat has become almost apocryphal in management circles: large incumbent organisations are seen as too large and unwieldly to generate innovation, so they instead send out (and equip) speedboats, with the intention that they innovate and explore, and bring new ideas back to the tanker. However, this approach is very top-down and directed, and fails to harness one of the most powerful theorised qualities of digital artefacts, namely their ability to be generative, or be repurposed beyond the scale and scope originally intended (Zittrain, 2006).

However, innovation in organisations large and small is also known to happen seemingly accidentally (Austin, Devin, & Sullivan, 2011; Shah & Tripsas, 2007). In an age of digital innovation characterised by as involving malleable and open-ended digital technologies (Kallinikos, Aaltonen, & Marton, 2013; Yoo, Henfridsson, & Lyytinen, 2010), and often leading to unanticipated, generative, outcomes, it is striking that we have such poor understanding of *how micro-level digital technology diffusion leads to service innovation*, whether in an incumbent organisation or otherwise.

This paper adds to our understanding of service innovation in incumbent organisations, and structural changes to the organisation in particular, by developing a model of how micro-shifts accumulate to guide service innovation trajectories. Our study of GlobalBank focuses on how the introduction of a new mobile application, itself a small-scale innovation, eventually redefined frontline customer service in the bank's branch network.

DIGITAL INNOVATION AS SERVICE INNOVATION

It is broadly understood that digital technologies affect how professionals carry out service work (Barrett, Davidson, Prabhu, & Vargo, 2015; Dery, Kolb, & MacCormick, 2014; Lusch & Nambisan, 2015). Indeed, the generative nature of digital technologies suggests that the accumulation of digital artefacts may have the potential for cumulative service innovation (Yoo et al. 2012).

However, the understanding of what is a service is often implicit—and grounded in a concrete description of a service, typically as a service concept, client interface, service delivery system, and technology, or some combination of these (den Hertog, 2000; Miles, 2008). In contrast, the service dominant logic envisions a service, and with it service innovation, as a process rather than a discrete product (Vargo and Lusch 2008; Barrett, Davidson, Prabhu, & Vargo, 2015).

A Service-Dominant view on Innovation

Through this lens, service innovation arises when there are changes within the service processes, for instance when new spheres of knowledge are developed or when informal procedures are formalised (Gallouj, 2002).

This approach to understanding services suggests that service innovation entails changes to otherwise "self-contained, self-adjusting system[s] of resource-integrating actors connected by shared institutional logics and mutual value creation" (Lusch & Vargo, 2014, p. 161). Typically, the market (and thus customers) is thought to drive this service innovation, as it presents an exogenous shift in expectations in relation to these institutional logics and ideas around value creation (Lusch & Nambisan, 2015). However, it is equally likely that endogenous changes within an organisation (e.g. Greenwood & Suddaby, 2006; Lounsbury & Crumley, 2007) can lead to service innovation. It is from this starting point that we begin to investigate how digital technology diffusion leads to digital innovation, specifically through micro-shift accumulation.

Service Innovation Trajectories

The innovation and diffusion of digital technology is often presented as an end in itself. However, within an organisation it can also lead to further innovation and value creation. The wider a digital technology proliferates, the more possible unanticipated uses the technology can come to—prompting further recombination and innovation, including service innovation. Existing literature propagates at least three views of the mechanisms whereby digital technologies lead to (service) innovation, namely through technology, knowledge, and control (see Table 1).

First, technology-centric views assume that properties of digital technology such as programmability, data homogenization, and self-reference stimulate more open-ended innovation (Kallinikos et al., 2013; Yoo et al., 2010), increasing the chances of pursuing multiple trajectories simultaneously. Second, knowledge-centric models of digital innovation premise that the process necessarily involves distribution across multiple competences and knowledge resources (Boland, Lyytinen, & Yoo, 2007; Van de Ven, 2005). Finally, control views suggest that digital innovation is largely beyond the single application, service, or system(Henfridsson & Bygstad, 2013; Tilson, Lyytinen, & Sørensen, 2010), resulting in shared control across distributed actors. Each one of these three views (technology, knowledge, control) offers plausible perspectives on the distributed nature of digital innovation. They suggest how digital innovation consists of multiple contributions. However, little attention is

paid to how small-scale contributions assemble and accumulate into trajectory changes through digital innovation. While pioneering work using sequence analysis has offered initial views in the context of design routines (Gaskin, Berente, Lyttinen, & Yoo, 2014), inquiry into how small-scale shifts of digital innovation leading to trajectory changes is imperative. Adding to the emerging literature on digital innovation and existing views of the distributed nature of digital innovation, this paper zooms in on small-scale interactions to further understand how they collectively enable structural innovation.

Table 1. Research Streams and Definition

Research Stream	Foundational Literature	Definition (of distributed digital innovation)	Example References
Technology views	• Modularity (e.g., Baldwin and Clark 2000) • Digital architecture (Benkler 2006)	The process by which multiple actors use the lowered entry barriers coming with digital technology to develop new designs that collectively create positive momentum for a specific technology	• Henfridsson et al. 2014 • Kallinikos et al. 2013; • Lyytinen et al. 2016 • Svahn et al. 2017 • Yoo et al. 2012
Knowledge views	• Path creation (Garud and Karnøe 2001) • Actor network perspectives (e.g., Latour 1987)	The process by which multiple human actors with heterogeneous competences collaborate to create new digital innovations	• Boland et al. 2007 • Lakhani and Panetta 2007 • Nielsen et al. 2014 • Van de Ven 2005
Control views	• Complexity theory (e.g., Holland 1995; Mol and Law 2002) • Control theory (e.g., Beniger 1989)	A complex undertaking where multiple actors' attempts to master their innovation environment are influenced by the intersection between far-reaching global technology and local needs of adaptation to contextual conditions	• Eaton et al. 2015 • Gregory et al. 2015 • Hanseth and Lyytinen 2010 • Henfridsson and Bygstad 2013 • Lee and Berente 2012 • Tilson et al. 2010

To this end, we propose the notion of micro-shifts to denote a locally initiated and bounded change that contributes to a particular service innovation trajectory. Close examination of micro-shifts and their relationships to each other may help us understand how new, radical service innovation trajectories are born out of small contributions.

Micro-Shifts and Accumulation

Apart from emerging work on sequence analysis in the area of design routines (Gaskin, Berente, Lyttinen, et al., 2014) and distributed knowledge (Tuertscher, Garud, & Kumaraswamy, 2014), the existing digital innovation literature is still to explore how and under what conditions small-scale contributions lead to service innovation, here envisioned through trajectory shifts. To understand this process, we propose the notion of micro-shifts.

A micro-shift is a locally bounded change to an innovation trajectory in terms of at least one of the following dimensions: a) digital technology; b) knowledge resources; and/or c) control structures (Garud & Rappa, 1994; Henfridsson & Yoo, 2014). Artefact change involves the instantiation of a particular design that performs a set of functions for a user (Baldwin & Clark, 2000). For instance, it can be tablets that help frontend staff to provide timely service to customers. Changes to knowledge resources involve transforming the access to and dissemination of knowledge including the mental schema by which actors make sense of digital technology (Garud & Rappa, 1994; Orlikowski & Gash, 1994). In a micro-shift context, such change of the mental schema may be isolated to the specific micro-level network involved. For instance, this may involve rethinking what the tablet means for a specific sub-group, and how it fits with the broader narrative of the firm and its innovation trajectory. Finally, changes to control structures involve balancing control and autonomy through alternations to the arrangements that order the action repertories of organizational actors (Wareham, Fox, & Cano Giner, 2014). As an example, changes in the reporting and incentive structures of service workers influence the actions they will take in interaction with customers.

We understand micro-shifts as building-blocks in the cumulative synthesis (Usher, 1988) of an emerging, new innovation trajectory. The study of micro-shifts allows for careful analysis of the emergent quality of service innovation. In fact, Usher's notion of emergent novelty captures the idea that innovations consist of many small changes, which individually may appear as unimportant, but cumulatively become significant. Service innovation therefore involves multiple micro-shifts, which rarely come with clear and predetermined boundaries, time brackets, or a fixed gallery of social and technological actors. It hosts the powers of multiple localized micro-shifts that accumulate to transform artefact, knowledge resources, and control structures.

Having outlined the literatures upon which we base our study, we turn now to describing our case boundaries and data collection, before presenting some initial findings and a brief discussion.

CASE AND RESEARCH DESIGN

Case Description

GlobalBank is a global retail bank headquartered in the UK and dating back to 1736. It has 24,000 employees out-of-which more than 18,000 work in the UK branch network consisting of 1,632 branches. In February 2014, GlobalBank implemented a radical reorganization of the branch network across the UK. More than 1,600 branches had been or were in the process of a complete functional and organizational transformation. Equipped with mobile devices installed with a new digital banking system, branch staff abandoned the counters and moved out into the bank halls, shopping centres, and sporting events of their respective communities. Transactions were directed to self-service channels such as the web and mobile banking apps and newly developed self-service machines capable of processing transactions without the involvement of branch staff. A branch manager reflected on the customer service transformation noting that earlier:

> *"…cashiers balance their own tills, they have a safe with money in it, they have top drawers with money in. They've got glass in front of them and they do cheque processing" while now "…they'll have an iPad instead of a desktop so they move from behind the computer out into the bank hall with a portable device."*

We selected GlobalBank and its new frontline customer service system, BankApp, as our case setting for two reasons. First, there was no *a priori* plan for how the introduction of the device would lead to changes in service delivery, beyond improved accessibility. Instead, broader changes accumulated from multiple distributed adaptations made by actor groups across the organization. Second, the change was transformative across the three dimensions listed above: artefact (new approach to front line digital solutions), knowledge (changing underlying knowledge infrastructure, production, and distribution in the bank) and control (significant changes to the job roles and management systems of branches).

We conducted a two-year case study at GlobalBank, and were fortunate to obtain extensive access to data.

Data Collection

We structured our multi-method case study (Venkatesh, Brown, & Bala, 2013) as a two-step process (see Table 2). First, we traced a chronology of critical events relating to accumulation of micro-shifts and corresponding episodes of trajectory change at GlobalBank. We then moved on to analyse the actor-networks of the individual trajectory changes to determine the involvement of distributed actors in each transformation.

Table 2. Data Collection and Analysis

Research steps	Data collection	Analytical techniques	Outputs
STEP 1 *Establish chronology of micro-shift accumulation and trajectory changes*	• Interview study including 24 in-depth interviews • Document analysis of 89 design documents (technical specifications) and 43 presentations, minutes, and strategy documents 78 hours of participant observation at five different sites	• *Qualitative coding* (e.g. MacQueen et al. 1998; Berends and Lammers 2010)	• Chronology of 14 critical events in which micro-shifts accumulated to affect organizational change • Chronology of five episodes of trajectory change
STEP 2 *Establish occurrence and structure of individual micro-shift interactions*	• Digital trace data covering a 15-month period from the pre-release stage in December 2012 to May 2014 • Representing 2,338 connections between 1038 actors interacting around the BankApp project • Including 12,746 lines of text representing 1,937 specific interactions from digital trace data including announcements, feature requests, and discussions of technical and governance issues	• *Computational content analysis* • *Latent Semantic Analysis* (e.g. Deerwester et al. 1990) • *Social network analysis* (e.g. Granovetter 1973; Wassermann and Faust 1994; Venturini 2012)	• Identification of distribution of specific micro-shifts interactions in the actor network • Explication of micro-shift accumulation patterns over the course of the case history • Visualization and analysis of changes to micro-level networks

FINDINGS AND DISCUSSION

The GlobalBank case shows that micro-shifts, insignificant in isolation, may collectively shape radical trajectory change, manifesting in service innovation through artefact, knowledge resource, and/or control trajectory changes.

A micro-shift is initiated when an actor of a micro-level network proposes a new direction that diverges from the existing path of the micro-level network. If other local actors oppose this proposition, a synthesis can be formed through local negotiations or even tussles (Tilson et al., 2010); a micro-shift is realized through locally bounded change to artefacts, knowledge resources, or control structures. Such changes accumulate in specific patterns to shape the innovation trajectory in a more or less sustained way. Thus, micro-shifts possess at least three defining characteristics: 1) the potential to collectively effect change; 2) a specific distributed micro-level

network; and 3) a specific interaction dynamic that, combined with other micro-shifts, accumulates into radical change.

Altered Service Innovation Trajectories

To understand how multiple micro-shifts accumulate to affect trajectory change, we examined individual micro-level interactions related to BankApp using natural language processing techniques. Specifically, we applied Latent Semantic Analysis with a search vector of 96 key concepts derived from the interview and document analysis. This analysis revealed that micro-shifts manifested in distinct latent semantic patterns throughout the case history. Specifically, we identified 119 semantic dimensions related to micro-shifts in the 1,937 interactions collected. In order to identify the occurrence of individual micro-shifts, we then visualized the corresponding micro-shift level for each latent semantic dimension over time. The resulting heat map in Figure 1 illustrates 2,016 potential micro-shift occurrences of which 1,194 have positive values indicating the occurrence of at least one successful micro-shift (names of each micro-shift dimension are intentionally greyed out). As the heat map shows, micro-shifts were evenly distributed across the semantic dimensions with no immediate sequence pattern or dominant dimensions. This indicates that the emergence of each trajectory change was affected through configurations of multiple accumulating micro-shifts.

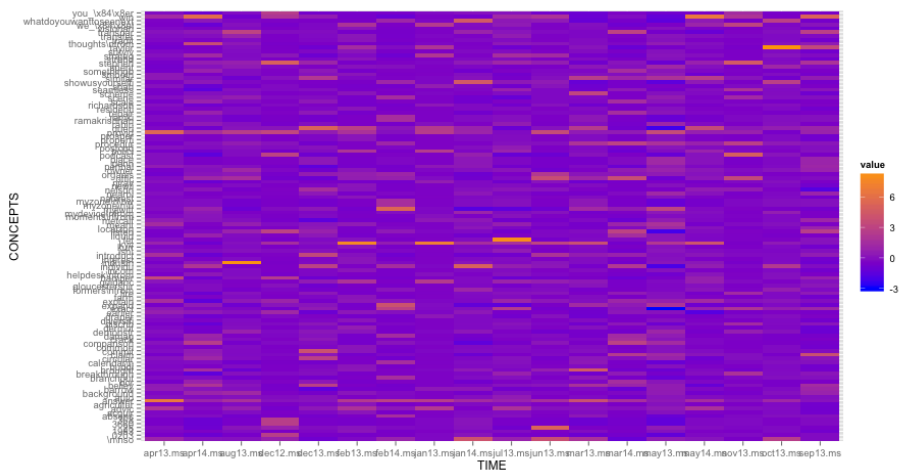

Figure 1. Micro-Shifts

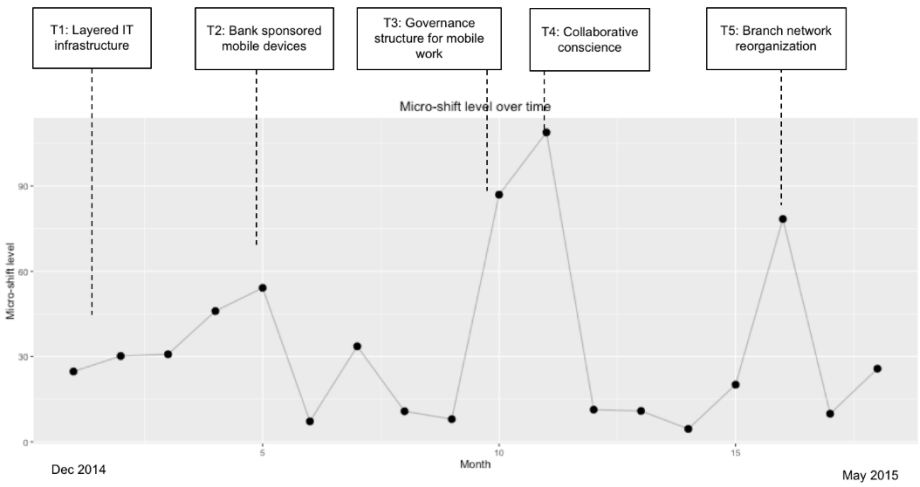

Figure 2. Micro-Shift Accumulation Over Time

To identify the accumulation of micro-shifts over time, we normalized the similarity scores for each record with the search vector using the highest score found in the document collection. We then determined the mean within group sum of squares for all records in each micro-shift dimension in each time interval to calculate a micro-shift level indicating a score for the accumulation of micro-shift related interactions. The graph in Figure 2

shows a number of spikes in micro-shift accumulation corresponding with each of the episodes of trajectory change identified previously. By comparing each spike to the occurrence of trajectory changes identified previously, we can establish that trajectory changes related to the BankApp project coincided with high levels of accumulating interactions semantically related to micro-shifts.

In order to better understand the ways in which micro-shifts accumulated into trajectory change, we compared the micro-shift analysis to the previously established accumulation events and trajectory changes. This revealed how each type of trajectory change emerged from multiple accumulation events that, in turn, resulted from multiple micro-shifts. Below, we detail the resulting trajectory shifts and how they relate to service innovation.

Technological Trajectories

Artefact shifts refers to the replacement or improvement of existing technological or physical infrastructures due to a breakdown or insufficiency of its capabilities. For instance, the architecture of the existing monolithic server infrastructure at GlobalBank restricted innovation on a distributed level. As the limitations became increasingly evident, propositions for a new infrastructure emerged among distributed micro-level networks in the bank. Our research shows that such suboptimalities are essential also on the micro-level(Magnusson & Ottosson, 2009; Thrane, Blaabjerg, & Møller, 2010; Wagner, Morton, Dainty, & Burns, 2011). The GlobalBank case suggests that locally-bounded constraints result in diverse propositions, and, in turn, adaptations of the new technology among multiple micro-level networks.

Knowledge Resource Trajectories

Knowledge resource shifts denotes the creation of new knowledge resources through a change in the knowledge practices of actors within and across micro-level networks. In the case of GlobalBank, practices associated with knowledge resource production and distribution were disrupted as new technology was introduced. BankApp resulted in greater distribution of knowledge consumption and production as staff generated and curated content such as instruction videos and interactive discussions about best practices for specific business processes. The transformation of knowledge resources is intimately linked to the affordances (Leonardi, 2011) of distributed digital infrastructures that in turn affect knowledge practices (Gaskin, Berente, Lyytinen, & Yoo, 2014).

This represents a self-reinforcing pattern of distributed innovation where technology and knowledge practices are mutually reshaped. As shown in our study, knowledge resources were affected by micro-shifts in two ways through changes to a) the distribution and access to production of knowledge resources through information infrastructures (Boland et al., 2007; Yoo, Lyytinen, & Boland Jr., 2008) and b) the perceptions of knowledge practices at play in the organization (Faraj, Jarvenpaa, & Majchrzak, 2011; Leonardi & Barley, 2008)

Control Structure Trajectories

Control structure shifts refers to changes to rules and policies resulting in new operational procedures at various levels of the organization. At GlobalBank, such change was manifested in the introduction of BYOD policies adopted. Interestingly, this introduction involved some level of pro-social rule-breaking where existing rules were broken in order to promote a common strategic objective (MacLean, 2001; Morrison, 2006) or as a precondition for further innovation (Grand & MacLean, 2003; Olin & Wickenberg, 2001). In other words, the control structure change pattern (Figure 8) involves the interplay between innovation of digital technology and transformation of the rules of governance surrounding its use. For instance, existing GlobalBank regulation initially posed a barrier to the adoption of BankApp as it prevented staff from using private mobile devices. Consequently, changes were made to both specific governance policies and to the management structure of the local retail banking organization.

Also, this pattern works both ways in the sense that use of new digital technology can lead to the breaking of organizational rules, which are then changed, and that the transformation of existing rules lead to new potential uses of digital technology spurring further technological development. As a result, control structure change embodies some level of self-reinforcement (Henfridsson & Bygstad, 2013) in which digital infrastructures lead to distribution of organizational control (Yoo et al., 2008). In turn, this leads to changes to organizational rules and policies, affecting service delivery.

CONCLUSION

While it is well established that digital innovation takes place in distributed actor networks (Svahn, Mathiassen, & Lindgren, 2017; Yoo, Boland, Lyytinen, & Majchrzak, 2012), we address Yoo et al.'s (2010) calls for research on the process by which distributed micro-level actions accumulate into wider changes—in this case, service innovation.

We propose the accumulation of micro-shifts as a mechanism whereby the introduction of a new technology snowballs into wider trajectory changes at the level of service innovation. We isolate three specific types of trajectories that are affected by the accumulation of micro-shifts, namely artefact, knowledge resource, and control structure, aligning service innovation in this case with extant digital innovation literatures.

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