COMPLETING DESIGN IN USE: CLOSING THE APPROPRIATION CYCLE

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Abstract

Users appropriate a technology innovation as they adapt and adapt to its capabilities. This paper argues that the appropriation of technology innovations – information and communication technologies such as devices and systems – is actually part of the design process. The design of a technology innovation is completed by users as they appropriate it. The contributions of the paper are to draw attention to the crucial role played by users' actions in completing the design process and to examine the implications for the design and implementation of technology innovations. The challenge for designers is to design malleable technologies that can be adapted to users' organisational, social and personal practices, and then to harvest users' needs from the appropriated innovation in order to improve its design. For managers, trainers and IS staff involved in the implementation of innovations, the challenge is to encourage and support users' appropriation activities.

Keywords: Technology innovation, design, technology appropriation, participatory design.

1 INTRODUCTION

The adoption and use of technology innovations is a central theme of information systems (IS) research. In IS, technology innovations encompass information and communication technologies (ICTs) such as devices and systems that are perceived by users to be new (see Rogers 1995). Much of the early work on technology innovation assumed that the technology was fixed (for example, Rogers 1983, Davis 1989). In many cases, however, users adapt or modify an ICT, configuring or personalising it for their needs and using it for novel purposes; this is reflected in terms such as drift (Ciborra 1996), tailoring (Trigg and Bodker 1994), reinvention (Rogers 1995), adaptation (Majchrzak, Rice, Malhotra and King 2000) and appropriation (De Sanctis and Poole 1994; Orlikowski 2000; Swan and Clark 1992).

Modification leads to a disparity between the intentions of those designing and implementing ICTs and their actual use. There are conflicting interpretations of this disparity. Some have seen the use of technology that is not faithful to its designers' intentions as dysfunctional (de Sanctis and Poole 1994) or the result of poor alignment (Leonard-Barton 1988; Majchrzak et al. 2000) that prevents users from gaining the maximum benefits from the technology. Others have seen it as an integral aspect of use. Studies of technology in history and sociology state that a technology can always be other than it is. Social constructivist theories suggest that technology is shaped by a range of influences as a part of its development and then reshaped in use (Bijker and Law 1992). Further, the same technology may be used in different ways in different settings, leading to different outcomes (Barley 1986). This reflects interpretive flexibility or "*the notion that any object, institution or process may mean different things to different people*" (Law and Bijker 1992: 298). Therefore, not only may a technology be adapted by different users but the same technology may be interpreted in different ways. Consequently, there is no linear, deterministic path between the design of a technology, its use and its impacts: users appropriate a technology innovation.

Appropriation describes the way that users 'take possession' of a technology innovation over time. This is more fundamental than configuring a packaged system prior to implementation or tailoring it to individual users' needs. Appropriation involves mutual adaptation: users reshape the features of an ICT, they may use it for unanticipated purposes and at the same time their practices are shaped by the ICT. There has been increasing attention to the way that users appropriate ICTs but little analysis of its role in systems development or its implications for IS developers. This paper argues that users, as they appropriate an innovation, complete the design process both of the ICT's features (configuring and personalising it) and the 'spirit' or theory of use embodied in the ICT (adapting the way that it is used and its purposes of use). The paper commences with a description of a model of technology appropriation and then the role of appropriation in completing design is presented. The paper outlines the implications of this view of the users' role in the design process for IS designers and managers. The paper concludes with some suggestions for future IS research and practices.

2 THE MODEL OF TECHNOLOGY APPROPRIATION

We have explored the appropriation of technology innovations including mobile technologies (Carroll Howard, Peck and Murphy 2002 and 2003; Herzsfeld, Carroll and Howard 2003) and CRM systems (Carroll, Kriss and Murphy 2003) by different user cohorts (young people, non-professional out-of-office workers and business people). This work has opened up the concept of appropriation and examined the way in which different groups of users select, explore and modify aspects of a technology according to their needs and thus take possession of it. One outcome of this research is a generic Model of Technology Appropriation (MTA) that can be populated with influences on a particular user cohort's appropriation of a specific ICT (Carroll et al. 2002). The Model of Technology Appropriation, shown in Figure 1, depicts the transformation of a Technology as Designed into Technologies in Use.

Technology as Designed refers to 'out of the box' devices, packaged software or information systems as they are developed. Technology as Designed is the outcome of a design process involving political, economic, social and technological negotiations amongst a range of stakeholders (Bijker and Law 1992) who may include managers, marketers, finance managers, user representatives, union officials as well as business analysts, cognitive scientists and IT specialists.

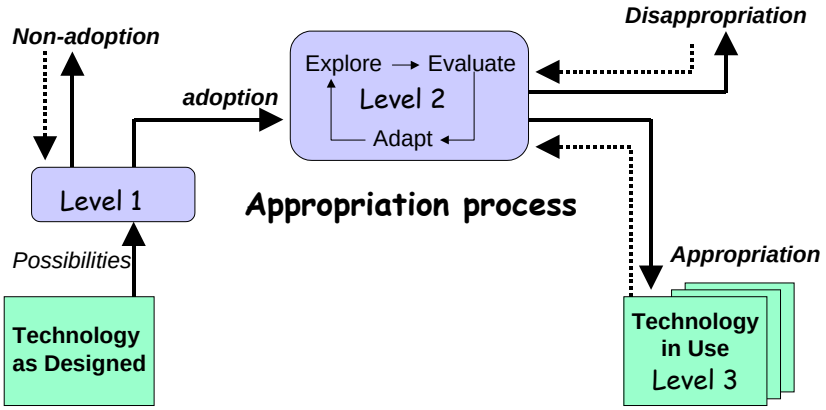

Figure 1 Model of Technology Appropriation (adapted from Carroll et al. 2003)

The resulting ICT has features, capabilities and an underlying theory or spirit. The features are built in during the design process; the capabilities reflect the malleability of the ICT (the degree to which the ICT can be shaped by the user); and the spirit is the underlying theory of use that is embodied in a Technology as Designed (De Sanctis and Poole 1994; Law and Bijker 1992). This theory may reflect beliefs about the role of technology in human activity and include rules about the behaviour of users such as the expected activities, resources and norms (Orlikowski 1992). Users adapt to this embodied theory, often changing their practices and situations of use to fit in with the technology in both intended and unintended ways. An organisation buying an ICT is also buying this underlying theory; for example, ERP systems are claimed to provide 'best practices' for the processes they support However, users may not adhere strictly to this theory and may employ the ICT in unexpected ways.

The features, capabilities and theory of use of the Technology as Designed provide a range of possibilities to users.

At Level 1 of the MTA, initial evaluation of the Technology as Designed is based on the features of the innovation and expectations of its value. Organisations facing a decision whether to adopt an ICT may undertake a formal process of mapping requirements against the ICT's features and capabilities. For example, an organisation implementing a CRM system may evaluate the purchase and expected ongoing costs, look and feel of the interface, culture of the vendor (including willingness to enter into a partnership), process replication, expected business value and ROI (Carroll, Kriss and Murphy 2003). There will be a different set of influences on an individual user faced with the decision of whether to purchase or use an ICT; for a young person encountering a new mobile technology, these influences include expected cost, fashion/style, expected usefulness, ease of use, features, adaptability, familiarity and whether users see the technology as 'our stuff' (Carroll, Hoard, Peck and Murphy 2003). The outcome of this initial evaluation is the decision to adopt or not.

At Level 2, users evaluate the technology as they use it – they will explore, adapt and adapt to it. The capabilities of the technology will afford and constrain users' activities, allowing them to perform some activities while making others difficult or impossible. Thus, users' activities are shaped by the technology. In addition, depending on the malleability of the technology, users may configure or

personalise it and use it for new purposes or combine it with other resources in unexpected ways to suit their needs. For example, young people used a speaker phone for pranking or playing jokes on their peers (Carroll et al. 2002); they also combined use of a speaker phone with a PC to enable simultaneous use of mobile voice and PC chat to arrange social activities. During Level 2 evaluation, some users will reject or disappropriate the technology.

Level 3 is achieved as, over time, the technology is stabilised and becomes an integral part of users' activities; we call this appropriation. Persistent use is reinforced by a number of influences; changes in the effectiveness of these reinforcers may lead to re-evaluation and disappropriation of the ICT. Similarly, the decisions to adopt or not, and to appropriate or disappropriate the technology are conditional and may be re-evaluated at a later time.

The stabilised technology is called Technology in Use. Figure 1 shows multiple Technologies in Use, reflecting the interpretive flexibility of the innovation as well as the various adaptations performed by different user cohorts.

3 COMPLETING DESIGN IN USE

The differences between Technology as Designed and Technologies in Use reflect the gap between the expected and actual requirements for technological support. Technology as Designed represents the views of designers, marketers and users of the requirements captured during design, while Technologies in Use capture users' needs that are expressed through their actions as they undertake their everyday activities in their use situations. The features, functions and theory of use of Technology as Designed are shaped by a range of influences (social, political, economic and technical) during the design process. However, the technology has not yet reached its final and stable state. We suggest that the design of the technology is completed by users who configure and customise the technology, who construct 'workarounds' to circumvent the limitations of the embodied theory and who use the features and functions in unanticipated ways and for unanticipated purposes or activities. Technologies in Use thus represent the completion of the design process: the initial design process results in the development of an ICT that is adapted (changed features or functions) and interpreted (used in different ways for different purposes) within the capabilities provided by the Technology as Designed.

If users' appropriation of a technology innovation is viewed as the completion of the innovation's design process then understanding the influences on, and outcomes of, the appropriation process provides the basis for improving design. This is represented in the Technology Appropriation Cycle shown in Figure 2, where the lifecycle of a technology innovation is comprised of two inter-related processes:

- the design process, that is completed during appropriation, and
- the appropriation process, that is the basis of design.

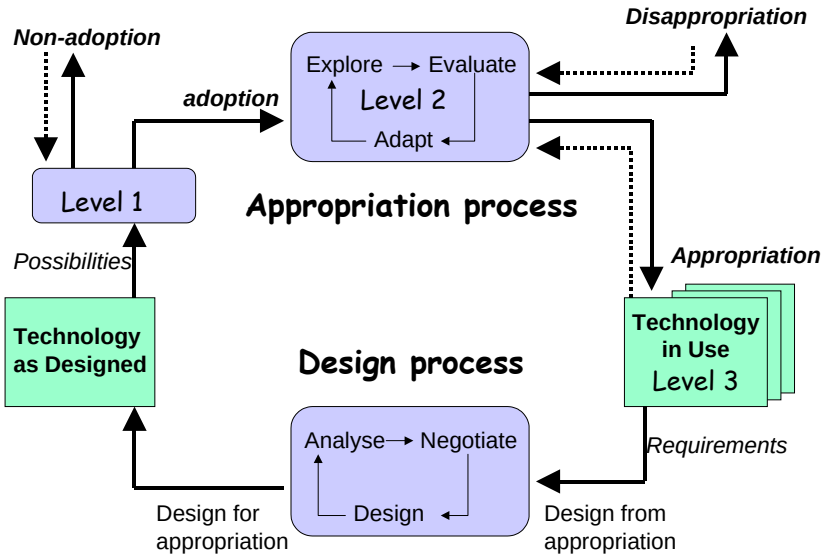

Figure 2 The Technology Appropriation Cycle

It has been suggested that increased understanding of the process through which a new technology is appropriated is important for improving the design process (Griffith 1999; Majchrzak et al. 2000). However, we faced the problem of *how* to use this understanding to improve design, where design includes both systems analysis and design (Turner 1987). Viewing appropriation as completing design in use is crucial to using understanding of appropriation to improve design.

The appropriation of an ICT innovation requires flexibility on the part of users and their practices – to identify and implement opportunities for adaptation – and the technology – so that it can be shaped by users. The challenge facing designers is two-fold: designing malleable technologies that can shape, and be shaped to, users' organisational, social and personal practices (designing for appropriation), and then harvesting users' needs from the appropriated innovation to design future versions or technologies (designing from appropriation). For managers, trainers and IS staff involved in the implementation of ICTs, the challenge is to encourage and support users' appropriation activities. If "*appropriation lies at the intersection of technical design and social practice*" (Dourish 2003), then its implications can be analysed in respect to technical (design) and social (practice) perspectives. These implications are explored in the following two sections.

4 TECHNICAL IMPLICATIONS

Understanding how and why users adopt, adapt and integrate a technology into their practices enables users' requirements to be harvested in order to design future versions or technologies. The technical implications of appropriation combine two themes:

- difficulties in determining requirements
- design of malleable technologies that can be appropriated by users.

4.1 Requirements

Problems in determining the requirements for innovative ICT devices or systems are well-documented (Carroll, Kjeldskov, Tobin and Vetere 2003). These problems stem from the inability of users to understand or articulate their needs (current or future), the inevitable changes in requirements as users learn more about the problem situation and the technological solutions that are possible, and the

changes in needs that occur in response to external changes (for example, other technology innovations, changing practices or lower costs). The difficulties in determining requirements are compounded by the fact that users appropriate technologies, using them for new purposes and activities in unexpected situations. This will bring new requirements to light that may be satisfied by further adaptation of the technology. However, the malleability of a technology is limited. Users may become frustrated at their inability to further adapt the technology. Alternatively, they may experience needs that are related to, but cannot be satisfied by, the capabilities of the current technology. Therefore, appropriation may lead to requirements for enhancements or the design of novel technologies.

While users may be unable to think beyond current processes and practices, the ability of IS professionals to determine requirements may be limited as they are unaware of the tacit knowledge embodied in current technologies and practices. Consequently, "*technologies are designed around a set of assumptions concerning what work processes are required and how they will take place that are often simply wrong*" (Gasson 2003: 32). Further, technology innovations are frequently placed in complex organisational 'messes' where neither the organisational problems nor success of possible interventions can be accurately analysed (see Checkland and Scholes 1991). Difficulties in determining requirements or freezing them early in systems development may result in a system that is obsolete when implemented.

The thinking underlying Figure 2 offers some solutions. Although users may be unable to understand or articulate their needs, they can express them through their actions as they interact with and appropriate the technology. Deriving requirements from an appropriated technology that has been refined and shaped to meet users' local, contextual needs offers a way of meeting users' real needs. Such a process can be seen as an extension of prototyping, overcoming the incomplete functionality and time limitations of conventional prototyping. This is an evolutionary design approach, where users complete design as part of the appropriation process; refined understanding of their needs is induced from the completed design and fed into subsequent versions of the innovation.

4.2 Malleable technologies

There are different responses to observations that a technology innovation is rarely adopted and used as a fixed and unmodified object. Some have sought to restrict the extent to which it can be adapted (for example, De Sanctis and Poole 1994; Dennis, Wixom and Vandenberg 2000). This may be appropriate for particular types of ICTs. For example, ATMs (Automatic Teller Machines) have little malleability and restrict use to a few pre-determined sequences. Packaged software systems may be configured or even customised for a particular organisational or cultural situation; however, any changes to reflect organisational needs and values must be balanced against the resulting difficulties in maintaining and updating the system.

Alternatively, others have supported the need for malleable technologies, also described as plastic, adaptable and able to be customised or tailored (Ciborra 1996; Majchrzak et al. 2000). Malleable technologies may be a means of overcoming the inability of users to articulate their needs and difficulties of understanding complex organisational situations and determining the requirements for technological support amid such complexity. If users are provided with a malleable Technology as Designed, then they can shape and adapt it to meet their needs within complex organisational situations; the appropriated Technologies in Use will then reflect users' actual situated needs. If users reach the limits of the malleability of a technology then there is need for innovation to provide a new set of candidate capabilities.

Creating malleable technologies is not straightforward or well-understood. An ICT is not just a set of features and functions but also embodies a theory of use (De Sanctis and Poole 1994); together these provide the ICT's capabilities that afford some activities and constrain others. An integral part of designing for appropriation is to construct a technology that is malleable but still embodies and represents a theory of use that is accessible to users. Dourish (2003) describes the characteristics of

the design of a malleable document management system. It provides multiple perspectives on information to accommodate different people doing different tasks; preserves visibility because, in order to adapt a technology, users need to know how it works; and makes control over information a matter for the application rather than the infrastructure. Such a technical design encourages users to explore and appropriate the system.

In addition, the importance of different features, functions and capabilities varies over time. Developers need to consider more than users' initial encounters with a new technology that lead to the decision to adopt or not. The features provided by an ICT are particularly important in the user's initial encounters: the influences at Level 1 of the MTA are principally related to the features (see also Griffith 1999; Rogers 1995). As the user explores the ICT in use, the usefulness of the technology (application of features in context, Carroll et al 2003) becomes more important. Adaptation of the features may lead to a more useful technology. Designers need to be responsive to the influences on medium- and long-term use and aware that the typical testing programs conducted during development are unlikely to address these Level 2 and 3 influences that appear central to successful appropriation (Carroll et al. 2002).

5 SOCIAL IMPLICATIONS

In the previous section, the importance of designing from and for appropriation is described. In this section, we examine how managers can assist users in appropriating a technology innovation and therefore completing its design. Three areas of managerial involvement are detailed:

- managerial policies to support the appropriation of innovations
- addressing specific influences on appropriation, and
- user participation.

5.1 Policies

Given a malleable technology, users should be supported in exploring, adapting and adapting to it. Users need to see the technology as flexible or ambiguous (Ciborra 1996) in order to change it. Introduction of a "tailoring culture" (MacLean et al 1990) where adaptation is encouraged and rewarded requires support from managers and especially IS professionals, whose work or systems are being modified. Often adaptation is a social process, influenced by peers and colleagues. Support when exploring a new technology may be provided in creative ways. One strategy employed by Novell is the Play Pen (Carroll, Kriss and Murphy 2003). A stand-alone demonstration version of a new system is installed on several PCs. Users are invited to 'play': they can explore the system, its interface and functionality. Users communicate their impressions and expertise to colleagues who are then encouraged to try the system. The Play Pen can be monitored so that queries are answered immediately, users' actions observed and supported and difficulties noted prior to system implementation. During system rollout, examples of experience from the Play Pen can be used to motivate users and training can be directed to overcome the difficulties noted and share some of the adaptations observed in the Play Pen. A similar strategy used by Novell is that of a CRM Café where coffee and tea are provided along with the demonstration version of the CRM system installed on PCs. Users can explore the CRM system in a relaxed atmosphere with their colleagues. Both of these strategies encourage users to explore the system as well as allow the designers and managers to support users as they explore, adapt and appropriate the new system. They are likely to increase users' acceptance of the innovation.

Users' initial perceptions of a technology may be shaped by marketing, word of mouth, training and experiences of trial use in a shop, training session or Play Pen. Managers' awareness of the appropriation process can positively influence these initial perceptions. Marketing the innovation's advantages or motivating users can build on understanding of the influences on users' appropriation of technology, as described in Section 5.3. Word of mouth and informal social networks can be fostered

through group activities such as the Play Pen or CRM café. Technology champions or mentors can be provided in each work group and technology-supported communication networks between users enabled using FAQs, on-line tutorials and internal newsgroups. On-going training should be directed to users' current progress in the appropriation process: initially to understand the malleability of the features and capabilities of the technology and the constraints on use, then later to support them as they adapt, and adapt to, the technology. It is likely that the timing and pattern of adaptation varies in different situations, influenced by the costs of adapting or not adapting the technology, the flexibility of organisational processes and the ability of users to adapt (either the technology or work practices) to changing needs (Majchrzak et al. 2000).

Implementation of technology innovation may involve significant change in working practices and processes, responsibilities and organisational culture. This change needs to be managed, resistance identified and addressed (especially if use of the innovation is mandatory; for example, the success of CRM implementation rests on a critical mass of users entering the required data so ideally use is mandatory) and success rewarded. Managers may facilitate sessions for users to reflect on successful adaptations, lessons learned and changes in work processes and procedures relating to the implementation (Majchrzak et al. 2000) in order to consolidate learning, stabilise practices around the technology and to plan future changes.

Of particular importance for managers is the issue of time. Appropriation of a new technology takes time as users explore the technology. In our earlier work we found that one month of use of a simple ICT was insufficient to move from Level 1 to Level 2 influences (Carroll et al. 2003); more complex systems may require significantly more time. Providing all the functionality of a major system at the one time may involve too much change for users to rapidly absorb, leading to widespread disappropriation and failure of the project (Carroll, Kriss and Murphy 2003). Using a waterfall approach to deploy the system in phases provides some improvement but tight timelines prevent developers from harnessing the requirements enacted by users and then addressing them in the subsequent phase (design from appropriation). One approach that is sensitive to the issue of time is to stagger the implementation process: implement a version or phase of a system that provides out-of-box or mission-critical functionality, allow adequate time for the users to appropriate it and then implement the next phase. This also enables monitoring of rejection of the innovation by individuals or groups; managers and IS staff must then understand the reasons for rejection and remediate through training, mentoring or adaptation of the technology.

The experience of Novell when implementing CRM systems has been that the initial phase should be delivered rapidly to capitalise on users' motivation and enthusiasm for the new system. Up to six months can be allowed for users to appropriate this core functionality; users are then involved in specifying their requirements, refined through their experiences of the technology. Later phases may take much longer, depending on the degree and complexity of integration and requirements to be accommodated (Carroll, Kriss and Murphy 2003). However, once the technology is stabilised (Level 3) it becomes invisible to users and they are less likely to adapt it further without breakdowns or external triggers that highlight its inadequacies (Tyre and Orlikowski 1994). Managers need to be careful that they do not push to 'close' the technology prematurely, preventing further modifications that may improve its effectiveness.

5.2 Harnessing influences on appropriation

Understanding of the influences on appropriation can be employed to increase the chances of successful technology implementation. Research indicates that the influences on technology adoption are different to those on medium- and long-term use (Carroll et al 2002; Karahanna et al 1999); therefore, training, motivation and support should be tailored to the particular influences that are in operation. For example, focusing on ease of use to long-term users is ineffective as they are more interested in usefulness (Davis 1989; Carroll et al 2002). The generic Model of Technology Appropriation may be tailored for the characteristics of particular technologies and user cohorts;

effective management of technology implementation can build on understanding of the relevant influences and apply them to ensure persistent and effective use. The value of understanding the influences on appropriation is illustrated in the DT case (Herszfeld, Carroll and Howard 2003). DT introduced an SMS-based job allocation system in the construction industry. Understanding of a higher-level driver of persistent technology use (Level 3), a sense of belonging and community amongst users, was deliberately used to ensure successful acceptance and appropriation of the new system. This suggests that managers and leaders who heed the medium and long-term influences on appropriation may ensure more successful implementation of ICT innovations.

5.3 User participation

Viewing the appropriation process as completion of design has implications for IS professionals. There is widespread belief – but inconclusive research findings - that user participation is an important prerequisite for IS success (Howcroft and Wilson 2003). Conventional approaches to user participation (for example, Kensing and Munk-Madsen 1993) focus on the users' roles prior to system implementation (an exception, applied to a limited set of circumstances, is Henderson and Kyng 1991). The tools and techniques of participatory design include mutual learning activities with users and designers, modelling and low fidelity prototypes (Carmel, Whitaker and George 1993). However, viewing the appropriation process as completion of design indicates that user participation can be expanded beyond the role of users as (partial) participants in the design process prior to implementation. Effective participative design would then include users as *co-designers*, imbuing the design process with their tacit knowledge, unexpressed needs and diverse purposes through their activities in shaping an implemented system in use. The resulting design process capitalises on the professional skills of designers, building on negotiated requirements to design technology features and functions and embody an agreed theory of use in the system that is implemented. It also capitalises on the practical skills of users, who complete the design through their actions in everyday work contexts. Such a design process enhances the likelihood of achieving successful information systems that satisfy the richness of users' needs, expressed through their actions in 'taking possession' of the systems over time.

6 CONCLUSION

The main contribution of this paper is to draw attention to the crucial role played by users' actions in completing the design of a technology innovation and to its implications for designers, managers, trainers and IS professionals. Existing research has noted that many technology innovations are adapted by users (for example Ciborra 1996; Orlikowski 2000; Swan and Clark 1992) and the influences on users as they appropriate a technology have been examined (Carroll et al. 2002, 2003). It has been suggested that understanding the processes that shape technology may help in creating better technologies (Bijker and Law 1992) but little guidance about how this understanding can improve systems development. The central argument of this paper is that the design of a technology innovation is completed by users as they appropriate it. Therefore, understanding the influences on the appropriation of a specific technology or family of technologies is an essential part of the design process. If we assume that the intention of design is to ensure long-term use (rather than purchase or adoption of the technology) then understanding of the influences that act on users from the initial acquaintance through to persistent use must be reflected in the design process. This paper argues that this can be achieved in two ways: designing *for* appropriation and designing *from* appropriation. In addition, the 'packaging' around a technology - its presentation to the market, training programs for users and change management techniques outlined for managers - must be sensitive to these influences also. It is not sufficient for developers, marketers, trainers and managers to support the adoption of a technology, rather it is important that they are mindful of the influences that affect persistent use when designing and marketing technology innovations and training and managing staff throughout the appropriation process.

The lifecycle of technology innovations is currently the focus of much academic attention, with researchers suggesting either that more attention should be paid to the early design process, where the features, capabilities and spirit of a technology innovation are negotiated (Gasson 2003) or noting that discussions of the social construction of ICTs has focused largely on the design process and has paid less attention to the shaping of the developed ICT after it is adopted (McLaughin and Skinner 2000). The Technology Appropriation Cycle presented in this paper indicates the inter-relationship of these processes, suggesting that attention to both is necessary for successful design and use of technology innovations. Future research into the inter-relatedness of design and appropriation is needed to build on the arguments presented in this paper, with particular attention to the implications for managers and IS professionals.

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