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Health Information Systems Affordances: How the Materiality of Information Technology Enables and Constrains the Work Practices of Clinicians

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HEALTH INFORMATION SYSTEMS AFFORDANCES: HOW THE MATERIALITY OF INFORMATION TECHNOLOGY ENABLES AND CONSTRAINS THE WORK PRACTICES OF CLINICIANS

BY
CHAD ALLEN PAUL ANDERSON

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of
Doctor of Philosophy
in the Robinson College of Business
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ACCEPTANCE

This dissertation was prepared under the direction of the candidate's Dissertation Committee, and it has been accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Business Administration in the Robinson College of Business Administration of Georgia State University.

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Abstract

Health Information Systems Affordances: How the Materiality of Information Technology Enables and Constrains the Work Practices of Clinicians

By

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The IT artifact is at the core of the information systems (IS) discipline and yet most IS research does not directly theorize the IT artifact or its nomological network (Benbasat and Zmud 2003; Orlikowski and Iacono 2001). This research seeks to answer a repeated call for more direct engagement with the IT artifact and its nomological net with affordance theory adopted as the basis for this theoretical work.

An exploratory case study was conducted to answer the research question, *how do the material properties of health information systems enable and constrain the work practices of clinicians*? The study was conducted at a large urban acute care hospital in the Midwestern United States with registered nurses working on inpatient care units as the clinicians of interest. Through interviews with nurses and other clinical stakeholders and the observation of nurse's work practices on three patient care units in the hospital, theoretical insights were developed on the nature of affordances for information systems research.

IS affordances are defined in this study as relationships between abilities of an individual and features of an information systems within the context of the environment in which they function. The concepts of an affordance range and an affordance threshold are proposed as

theoretical constructs in the nomological network of affordances that help to explain the use of information systems as a function of the difficulty of acting on IS affordances. The relationship between affordances and constraints is theorized and linked to the affordance range and threshold with the assertion that constraints are closely associated with the difficulties experienced by users in acting on IS affordances. The challenge of studying IS affordances in all their complexity is discussed with the suggestion that researchers take the user's perspective of affordances to alleviate the need for repeated decomposition. Finally, the role of information systems in facilitating social interaction is emphasized through the concept of affordances for sociality.

The contribution of this research to the IS field is a more nuanced understanding of the nature of the IT artifact and its relationship to the users of that technology.

Chapter 1

Introduction

1.1 Overview

In discussing the identity of the information systems (IS) discipline, Benbasat and Zmud suggest that, "a natural ensemble of entities, structures, and processes does exist that serves to bind together the IS subdisciplines and to communicate the distinctive nature of the IS discipline to those in its organizational field - the IT artifact and its immediate nomological net" (2003, p. 186). They argue that the IS research community has not given sufficient theoretical attention to the IT artifact and its nomological network and this has raised issues regarding the boundaries of IS scholarship and IS's legitimacy as a discipline. Figure 1 shows their illustration of the IT artifact and its immediate nomological network.

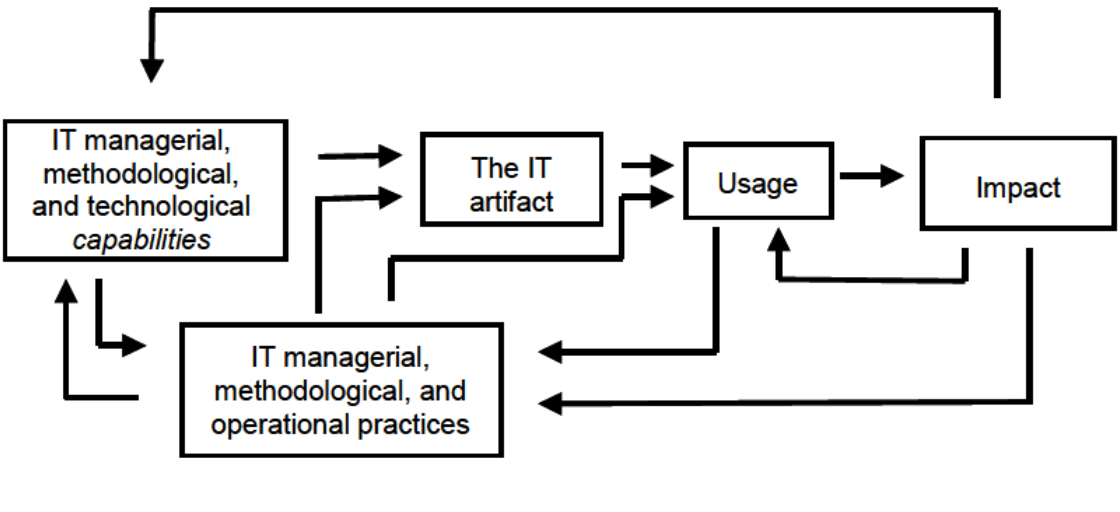

Figure 1. IT Artifact and Its Immediate Nomological Net (Benbasat and Zmud 2003)

Benbasat and Zmud call for IS scholars to more directly theorize the IT artifact and its nomological network and they are not alone in this call. Two years earlier, Orlikowski and

Iacona (2001) made a similar assessment of the state of IS research in which they pointed out the lack of engagement with the core subject matter of the IS discipline – the IT artifact. They argue that "IS researchers tend to give central theoretical significance to the context (within which some usually unspecified technology is seen to operate), the discrete processing capabilities of the artifact (as separable from its context or use), or the dependent variable (that which is posited to be affected or changed as technology is developed, implemented, and used)" (Orlikowski and Iacono 2001, p. 121).

More recently, scholars have lamented a lack of research on materiality which includes the material properties of IT artifacts. Orlikowski (2007) says that materiality tends to be ignored, marginalized, or relegated to specific occasions or events. This assessment can be viewed as an extension of Orlikowski and Iacono's (2001) call to theorize the IT artifact. It can therefore be argued that the study of materiality in IS research is the study of the IT artifact and its nomological network. This research intends to answer the call of these scholars through a purposeful focus on the IT artifact and by systematically theorizing its nomological network. The nomological net for the IT artifact includes usage and impact and IS scholarship is concerned with the use of information systems and the influence of those systems on users and other stakeholders.

The context of this research study will be a healthcare setting as the author has extensive experience in the field of healthcare both as a clinician and as a vendor of health information systems. The IT artifact in this research will be a health information system used by clinicians to provide patient care and clinical documentation within a healthcare organization. Therefore, with a theoretical focus on the IT artifact and its material properties within a healthcare context,

the specific research question for this study is; *how do the material properties of health information systems enable and constrain the work practices of clinicians*?

Benbasat and Zmud discuss borrowing from reference disciplines to theorize the IT artifact and state that, "We see no problems in adopting theories from reference disciplines, as long as we either apply them in investigating a phenomenon included within our offered delineation of the IS discipline or adapt them to reflect a unique IT or IS component" (2003, p. 192-193). This research presupposes that affordance theory, which comes from the field of ecological psychology, will provide an effective theoretical lens for answering the research question. This dissertation research is expected to provide a better understanding of the influence that information technology's material properties have on work practices. In addition, it is hoped that the findings of this research will facilitate the development and use of information systems that are more likely to generate efficiencies in healthcare and other organizations.

1.2 Materiality of Information Technology

The paucity of research on IT's material capabilities to enable and constrain behavior is, in part, due to an ongoing debate over the theoretical positioning and relative influence of material and social phenomena on the actions of people and organizations. Markus and Robey (1988) describe the sides in this debate as the "technological imperative" where IT determines individual and organizational behavior, and the "organizational imperative" in which humans determine behavior by designing IT around organizational needs. They argue that neither side has shown convincing evidence for its theoretical position and therefore suggest an "emergent perspective" as a middle ground, in which behavior emerges "unpredictably from complex social interactions" (Markus and Robey 1988, p. 588).

Other researchers have taken a similar emergent perspective on the causal influences of material and social phenomena. Barley (1986), through the lens of structuration theory (Giddens 1979), studied the introduction of CT scanners in two different radiology departments and found that the technology did not determine behavior, but instead became an "occasion for structuring" in which patterns of behavior emerged as the scanners were given meaning within the context of their use. In another example, Orlikowski (2000) theorized "technologies-in-practice" as rules and resources that function as templates for the situated use of technology.

This emergent perspective may be appropriate for studying the relationship between material and social phenomena, but it has resulted in a tendency to lean toward the social side of the relationship with a subsequently limited treatment of the role of technology's material properties on behavior. This lack of theorizing about materiality has been raised in a number of recent articles (Leonardi and Barley 2008; Markus and Silver 2008; Orlikowski 2007), with the repeated suggestion that researchers should begin including it in their theory development efforts. Leonardi and Barley (2008) suggest that the lack of treatment of materiality in the study of technology may be caused by an ongoing association with determinism, a sentiment shared by others (Smith 2006). Hardcore determinism has been criticized and therefore the tendency to equate materiality with determinism has led researchers to shift their focus to the social side of the relationship between technology and people. The result is research which marginalizes materiality and in doing so under-theorizes the IT artifact.

Orlikowski (2007) suggests that researchers would gain analytical insight by focusing on the ways in which the social and material intertwine and emerge in ongoing, situated practice rather than treating them as distinct and independent concepts. She describes the relationship between the social and material as "sociomaterial assemblages", without a hyphen to emphasis

their connectedness. Orlikowski and Scott (2008) posit that this concept of sociomaterial assemblages is the basis for an emerging stream of research on technology and organizations which has a logical structure of "relationality". This is in contrast to the traditional structures of variance and process found in most IS theories. Table 1, constructed by Orlikowski and Scott (2008), provides a comparison of the two traditional streams of research focused on variance and process structures with the third emerging stream of research focused on relationality. They suggest that the sociomaterial assemblages perspective already exists in a number of theoretical works including Latour's (1987) actor network theory, Pickering's (1995) mangle of practice, and Suchman's (2007) situated action. They also argue that this perspective has the potential to balance the treatment of social and material phenomena.

Table 1. Research Streams on Technology and Organization (Orlikowski and Scott 2008)

	Research Stream 1	**Research Stream 2**	**Research Stream 3**
Ontological Priority	Discrete Entities	Mutually Dependent Ensembles	Sociomaterial Assemblages
Primary Mechanisms	Impact Moderation	Interaction **Affordance**	Entanglement Performativity
Logical Structure	Variance	Process	Relationality
Key Concepts	Technological Imperative Contingency	Social Constructivism Structuration	Actor-Network Mangle of Practice
View of Social and Technical Worlds	Humans and technology are assumed to be discrete, independent entities with inherent characteristics	Humans and technology are assumed to be interdependent systems that shape each other through ongoing interaction	Humans and technology are assumed to exist only through their temporally emergent constitutive entanglement
Examples	Huber (1990) Aiman-Smith & Green (2002)	Barley (1986) Boudreau & Robey (2005)	Pickering (1995) Suchman (2007)

While this sociomaterial perspective may have the potential to equalize treatment of social and material phenomena, it may be going too far by combining everything in a theoretical mangle which overlooks the unique characteristics of both human agency and the material

properties of technology. I suggest that these unique characteristics potentially offer insights into the specific ways by which technology is actually used and should therefore be preserved in our IS theories. I would also argue that affordances, which Orlikowski and Scott (2008) place in research stream two, can belong in stream three as a theory that is relational in nature, but which also has the capability of preserving the distinctions between social and material phenomena.

1.3 Affordance Theory

The use of affordance theory in the study of technology has been suggested by a number of researchers. Leonardi and Barley (2008) hypothesize that materiality acts as both an affordance and a constraint on behavior. They suggest that we need to develop a language of affordances and constraints that allow us to better predict technology occasioned change. Zammuto et al. also suggest that affordances can provide an effective lens for explaining the "increasingly symbiotic relationship between IT and organization" (2007, p. 752) and Hutchby (2001a; 2001b) posits that affordances provide a theoretical mechanism for assessing the constraining influences of technology.

Other researchers have suggested that affordances may complement existing theories used in IS research that are limited in their treatment of the IT artifact. For example, Giddens' structuration theory provides little guidance for understanding the theoretical role of IT artifacts. Jones and Karsten (2008) suggest that affordances could remedy this problem by providing a theoretical way for IS researchers using structuration theory to construct a more consistent account of the IT artifact. Markus and Silver (2008) note that the concepts of "structural features" and "spirit" in Adaptive Structuration Theory (AST) were developed to support the study of IT effects. However, these concepts have seen little use by other researchers and Markus and Silver therefore suggest that in addition to "technical objects" and "symbolic

expressions", "functional affordances" could serve as an effective substitute for "structural features" and "spirit" to facilitate new research using AST on IT enabled change.

These examples provide evidence of the perceived value of affordances for theorizing IT enablement and constraint, yet the development of an IS theory of affordances is still unrealized. The challenge then is to develop a theoretical framework for understanding the specific ways by which the material properties of technology enable and constrain work practices.

Chapter 2

Affordance Literature Review

2.1 Gibson's Affordances

The concept of an "affordance" originated with James J. Gibson (1977; 1979) as a part of his theory of ecologically-based visual perception. Gibson was interested in the relationship between an animal and its environment and more specifically on how an animal perceives and interacts with its environment. He believed that the concept of an animal and an environment were inseparable with each term implying the other and that the relationship between the two was unique and important. Affordances were a cornerstone of Gibson's theoretical work on that relationship. Gibson conceptualizes affordances as behavioral opportunities available in the environment to specific animals and postulated that, "The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill" (1979, p. 127). Gibson provides many examples of how the environment can both enable and constrain animal behavior from surfaces, to substances, to objects, as well as other people and animals. For example, a horizontal, flat, rigid surface affords locomotion while a cliff face, wall, or chasm acts as a barrier to most large earthbound animals.

Gibson's work on environmental perception is a response to cognitive and behavioral psychologists who believe that perception is entirely an internal process of the mind. Contrary to this idea, Gibson theorizes that information about the environment (i.e. affordances) exists within the environment itself and can be directly perceived. This framing led him to hypothesize that affordances are relative to an animal, but exist independent of the animal's perception of them. In other words, an affordance exists in relation to a specific animal but it exists whether or not

the animal is aware of it. Thus, Gibson draws attention to the material characteristics of the environment rather than theorizing perception as a completely internal process. This is comparable to IS researchers treating IT in material terms rather than viewing it as socially constructed (Hutchby 2001b).

2.2 Perception of Affordances

Affordances have become a foundational theory for the field of ecological psychology and it has been utilized in other fields like human-computer interaction (HCI). However, the generality of Gibson's writings and his limited treatment of certain aspects of affordances have resulted in debate by scholars about various ontological and epistemological issues. For example, Gibson does not explicitly address how specific affordances are selected from among the many potential affordances available to an animal at any point in time. In other words, given that there are typically multiple behavioral opportunities available in the environment to an animal at any one time, what is it that leads the animal to act or not act on a particular affordance?

One answer is that the animal may simply not perceive the affordance. With Gibson's conceptualization that affordances can exist independent of an animal's perception of them, the total set of affordances available to an animal can significantly exceed the affordances perceived to be available. This was, in fact, Norman's (1988) basis for introducing affordance theory to the HCI field. He argues that all too often technologies are designed with affordances that are not perceptible or obvious to potential users (e.g. doors that are designed so that it is not clear whether they should be pulled open or pushed open). Norman suggests that when designing technology, designers should think about the affordances they are providing through the technology and attempt to make the perception of those affordances explicit to potential users.

This design focus, he argues, will lead to greater usability of technology. He even later acknowledges that he should have been more explicit in this regard in his early writings on affordances. "I should have used the term "perceived affordance," for in design, we care much more about what the user perceives than what is actually true. What the designer cares about is whether the user perceives that some action is possible (or in the case of perceived non-affordances, not possible)" (Norman 2002, p. 1).

Norman (1988) also promotes several design principles that increase the chances that users can perceive actual affordances. These principles include: *natural mapping*, which takes advantage of physical analogies and cultural standards to improve the recognition and understanding of available affordances; *visibility*; which makes affordances easier to perceive; and *feedback*, which provides information to users about actions they have initiated and the results of those actions.

The interest in HCI on making affordances perceptible in technology design led Gaver (1991) to propose the affordance classification matrix shown in Figure 2. He suggests that the relationship between the availability of perceptual information for an affordance and the actual existence of that affordance generates four possibilities: perceptible affordances, false affordances, hidden affordances, and correct rejection. A door provides a useful example of each of these possibilities. An actual door that can be perceived and used represents a perceptible affordance. A painting on a wall made to look like a usable door represents a false affordance. A secret door that looks like a blank wall and requires a person to know how to open the door in the absence of visual cues represents a hidden affordance. A blank wall with no door in it represents a correct rejection of the affordance of a door.

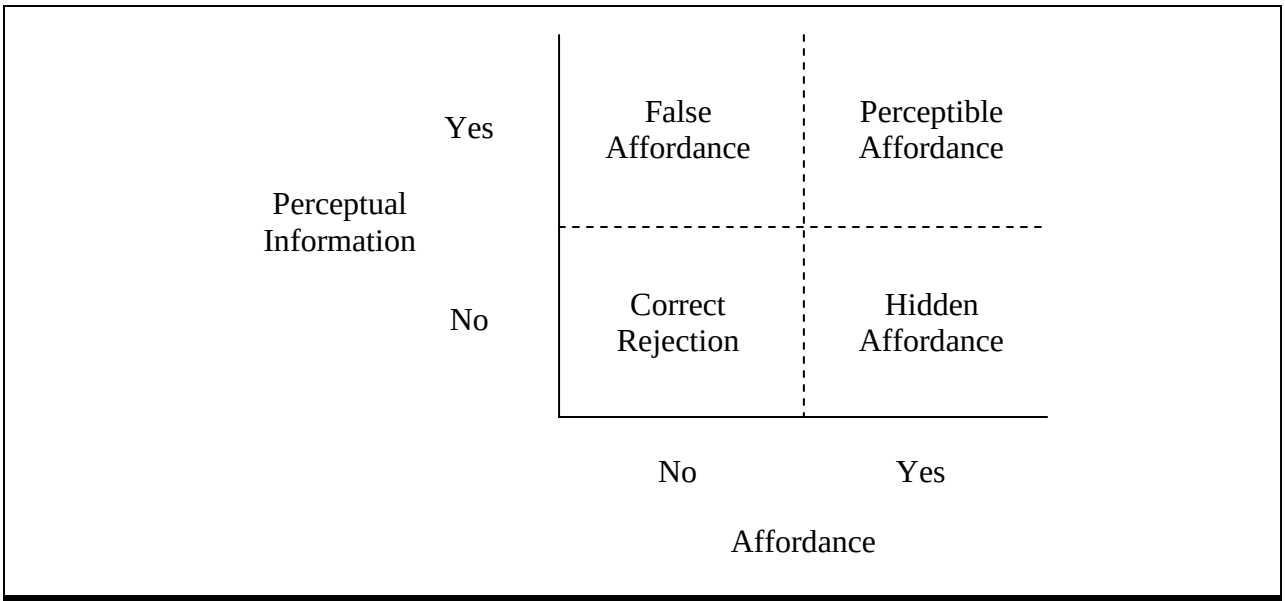

Figure 2. Gaver's Affordance Classification Matrix

The intent of this classification scheme is to emphasize the importance of creating perceptible affordances and the avoidance of creating false or hidden affordances in the design of technology. In terms of acting on affordances, users will typically engage with perceptible affordances or attempt to engage with false affordances intentionally and with hidden affordances only by chance. Therefore, the set of real affordances that an animal can be expected to act on will be limited to those which are perceptible.

Gaver (1991) also conceptualized ways in which affordances could be related to each other through the concepts of sequential and nested affordances. Sequential affordances define how affordances can be revealed over time and occur when acting on one affordance leads to information about other affordances (Gaver 1991). For example, clicking an icon affords opening a program which, once the program is open, provides information for additional affordances available from that program. In other words, access to certain affordances requires a user to first engage with a preliminary set of affordances. Nested affordances, in contrast, define how individual affordances may be combined to produce a new affordance (Gaver 1991). For

example, a wireless phone system produces an affordance of wireless communication through a combination of phones that are small enough to be portable, buttons that respond to pressing, and a sufficient wireless infrastructure. Gaver suggests that these concepts promote exploration of systems to discover affordances rather than knowledge of systems leading to expectations of available affordances (Gaver 1991). This touches on technology use in practice by pointing to specific mechanisms that may facilitate the discovery of affordances in their use rather than the transmission of affordance knowledge through training and design documentation.

Stoffregen (2004) suggests that another reason why certain affordances are not acted on is due to the distinction between an affordance and a goal. Gibson (1979) theorizes affordances as a contrast to the Gestalt notion of demand character or valence, which bestows meaning on physical objects based on the needs of an observer. Gibson argues that, "The affordance of something does not change as the need of the observer changes. The observer may or may not perceive or attend to the affordance, according to his needs, but the affordance, being invariant, is always there to be perceived" (1979, p. 138-139). Stoffregen states that therefore, "Affordances are defined independent of the goals of the animal. The opportunities for action are what they are regardless of what we may want or desire" (2004, p. 82). This provides another explanation for why some affordances may be acted on while others are not. Stoffregen (2004) suggests that affordances that correspond to our goals will be of great interest to us while affordances that do not correspond to our goals will be of little or no interest. Therefore, the affordances that relate to our goals will be the most likely to be acted on while the affordances unrelated to our goals will typically be ignored. These conceptualizations help to extend our understanding of what leads users to act on particular affordances and this has important implications for the study of technology use.

2.3 Degree of Affordances

Other characteristics of affordances have also been investigated by scholars. Gibson tended to limit his conception of affordances to a binary state in which they either exist or they do not. However, other scholars have considered that affordances can be more nuanced based on the difficulty of acting on the affordance. Warren (1984) conducted a number of experiments on stair climbing and found that the affordance of stair climbing is actually based on a consistent ratio of riser height to leg length. Warren also identified two important points for affordances: a critical point and an optimal point. In his stair climbing experiments, Warren states that the "critical point is reached at which the stair is too high to afford bipedal climbing, and the climber must shift to a quadrupedal (hands-and-knees) gait" (1984, p. 686). Thus, the critical point is a boundary point at which the affordance no longer exists. Warren describes the optimal point as, "yielding minimum energy expenditure per vertical meter of travel - a candidate for the best fit between climber and stair" (1984, p. 686). In other words, the optimal point is where the least amount of effort is required to act on the affordance and therefore represents the best affordance fit for the user. McGrenere and Ho (2000) suggest that Warren's critical and optimal points bookend what they call "the degree of an affordance", the study of which has implications for technology design and use. They suggest that an understanding of affordances that exist between the critical and optimal points would be valuable.

2.4 Positioning of Affordances

Another challenge to Gibson's conceptualization of affordances regards his positioning of affordances in relation to the environment and the animal. It is never entirely clear in his writings whether an affordance is a property of the environment or a property of the relationship

between the animal and its environment. This ambiguity has led to an ongoing debate among scholars regarding the ontological nature of affordances. Initially, most scholars in ecological psychology took the position that affordances are properties of the environment (Heft 1989; Michaels 2000; Reed 1996; Stoffregen 2000; Turvey 1992). Turvey (1992), in fact, developed a formal definition of affordances as dispositional properties of the environment. Turvey's intention was to formalize the relationship between affordances and prospective control, which is the ability to perceive possibilities for action and then adjust behavior according to those possibilities. He believed prospective control to be an important component of an ecological ontology that espoused direct perception of affordances. Turvey theorized that perceiving affordances was to perceive real possibilities that exist independent of a perceiving animal. He equated real possibilities with laws, which he defined as, "an invariant relation between or among substantial properties of things" (Turvey 1992, p. 177). Based on these ontological premises, Turvey theorized that affordances must be dispositional properties of the environment because dispositions were possibilities for properties of things.

In addition to being possibilities for properties of things, dispositions, by their nature, must exist in pairs. Because affordances define the relationship between the environment and an animal, Turvey theorized the paired complement of a dispositional property of the environment to be an effectivity (property) of an animal. An added benefit of this conceptualization is that it provides a means for getting from the idea of affordances as simply action potentials to the idea that affordances are actualized under suitable circumstances because, "dispositionals never fail to be actualized when conjoined with suitable circumstances" (Turvey 1992, p. 178). Turvey thus provided a conceptual link between the potential and actual usage of material objects, which was never clearly articulated in Gibson's work.

However, Stoffregen (2003) points out that the use of dispositions for defining affordances is problematic if affordances always result in action when the necessary set of circumstances exist. He argues that this contradicts Gibson's view that affordances represent what an animal can potentially do, not what an animal must do, and therefore dispositions are incompatible with a Gibsonian view of affordances. Stoffregen argues that the problems in Turvey's formalization of affordances result from situating affordances solely as properties of the environment. He hypothesizes that instead, affordances should be conceptualized as emergent properties of the animal-environment system, which exists at a higher level than the animal or the environment. He further theorizes that placing affordances at the level of the animal-environment system allows them to be specified and detected prospectively and therefore preserves the concept of prospective control that Turvey was interested in establishing. Stoffregen goes on to suggest that the direct perception of affordances eliminates the need to perceive properties of the environment and animals separately. This would seem to complement Orlikowski's (2007) assertion that we gain analytical insight by focusing on the ways in which the social and material intertwine and emerge in ongoing, situated practice rather than treating them as distinct and independent concepts.

Chemero (2003) presents a somewhat different perspective on the specification of affordances. Like Stoffregen (2003), Chemero situates affordances independently of both the environment and the animal. However, instead of treating affordances as properties of an animal-environment system, Chemero postulates that affordances are relationships between animals and the environment. Specifically, he theorized that affordances are, "relations between the abilities of organisms and features of the environment" (2003, p. 189).

Chemero's reasoning for specifying affordances as relationships is based on Heft's (2001) argument that Gibson's ecological psychology is descended from William James's radical empiricism.

> To the radical empiricist, perception is direct because it is an act that includes the thing perceived. This leads to what James called the problem of two minds. Suppose you and I both perceive the same pint of Guinness. The pint, according to radical empiricism, is part of both my perception and yours. However, this leads to a problem of mereology: If the pint is part of both our perceptions, then our minds overlap. This, James thought, is in direct conflict with the to-him-obvious fact that our minds are private. The problem of two minds, then, is as follows: If perception is direct, and two individuals can perceive the same object, then how can their minds be truly separate? … The solution to this problem is apparent in another of the main tenets of Jamesian radical empiricism. According to radical empiricism, everything that is experienced is equally real. Among the things we experience are relations between things, so relations are real, with the same status as the things that stand in relations. To solve the problem of two minds, suppose that perceivables are relations between perceivers and aspects of situations. If that is true, you and I can both perceive the potability of the Guinness, without our perceptions overlapping. You will perceive the relation between you and the pint, whereas I will perceive the relation between me and the pint, and our perceptions can remain private. The key to this solution, though, is that what we perceive, the affordance potability, is not in the environment alone.

It is, instead, the relation between the perceiver and the environment. (Heft in Chemero 2003, p. 168)

In other words, among the things we experience are relationships between things and those relationships are as real as the things that stand in relation to each other.

Orlikowski and Scott (2008) situate affordances in the second research stream shown in Table 1. I would argue that Chemero's (2003) specification of affordances as relationships between environmental features and animal abilities place it in the third stream, based on that stream's logical structure of relationality. Stoffregen's (2003) view of affordances as emergent properties of the animal-environment system would also fit that third stream of research. However, Chemero's specification benefits from its capability to preserve the distinctions between social and material phenomena, which I argue are important to effectively theorizing the materiality of IT and enhancing the applied value of IS research. Therefore, what affordance theory provides to IS research is a theoretical construct that has the potential to balance treatment of social and material phenomena while maintaining the characteristics of those phenomena as distinct.

2.5 Affordances and Constraints

The relationship between affordances and constraints has also been debated by scholars studying and using affordance theory. Stoffregen (2003), for one, argues that affordances actually constrain behavior. He states that, "properties of the environment do not constrain behavior…affordances are the sole constraints operating on behavior" (2003, p. 127). Stoffregen uses this argument to support his assertion that affordances are emergent properties of the animal-environment system.

Norman (1988) was also interested in constraints of technology, but unlike Stoffregren (2003), Norman considers affordances and constraints as separate concepts. For Norman, affordances provide clues to how things work while constraints limit the possibilities for action. Norman's interest in constraints led him to identify four unique categories of constraints:

- *Physical Constraints*: These constraints physically limit possible actions. For example, a wireless phone system has a limited range within which the phones will function and no human agency will be sufficient to make the phone work outside the physical range of the system.
- *Semantic Constraints*: These constraints rely upon the meaning of the situation to control the set of possible actions. For example, a wireless phone will visually display its current signal strength to indicate when a user may or may not use the phone to make or receive calls.
- *Cultural Constraints*: Each culture has a set of allowable actions for social situations that constrain what is acceptable even if physically and semantically allowable. For example, a wireless phone system may allow nurses to engage in communication anywhere within the physical range of the system, but the social norms of patient privacy and confidentiality in healthcare may constrain nurses from using the phones when privacy and confidentiality may be compromised.
- *Logical Constraints*: These constraints typically correspond to natural mappings that take advantage of physical analogies to improve understanding (Norman 1988). For example, nurse call systems can display a graphical representation of the rooms on a patient care unit. A logical constraint would dictate that the graphical representation needs to match the physical layout of the unit. In other words, the rooms should be

represented as a floor plan of the unit and the graphical display should be correctly oriented based on its physical location.

Norman suggests that the use of constraints in technology design can actually help designers make technology affordances more perceptible to users.

Leonardi (2011) studied the relationship between organizational routines and technology and found that when users were unable to achieve their goals with their current set of routines and technologies they changed one or the other. The decision to change the routine or the technology is based on the user's perception of constraints and affordances. When a user perceives that the technology is acting as a constraint the user will look to change the functionality of the technology. When a user perceives that the technology offers an affordance, the user will look to change the routines to take advantage of that affordance. Therefore, when people evaluate technology they see either affordances or constraints based on how the technology fits with their current goals. Thus, affordances and constraints are distinct from one another even though they both originate in people's perception of technology.

2.6 Affordance Complexity

In the ecological psychology literature the focus of study has been primarily on simple actions like stair climbing (Warren 1984), passage through doorways (Franchak et al. 2010), or catching balls (Oudejans et al. 1996) in which the environmental features and animal abilities that compose the affordance are relatively limited (e.g. the affordance of stair climbing includes a flight of steps with features of riser height and run and an individual's lower extremities which must have the ability to move through a specific range of motion). However, some scholars have begun to address the complexity that exists with tools and technology. van Leeuwen et al. (1994) state that the study of tool use, "focuses attention on situations in which the organism

realizes its needs not immediately but by using environmental resources as a means to an end. In this sense, tool use represents mediated action … An organism uses tools to make environmental resources serve its needs. Also, however, the tool manifests the way in which the organism must tailor itself to environmental conditions" (van Leeuwen et al. 1994, p. 174). They postulate that tool use represents a higher order affordance structure in which there are three relationships between the actor and the tool, the actor and the target, and the tool and the target. Figure 3 is their illustration of this affordance structure.

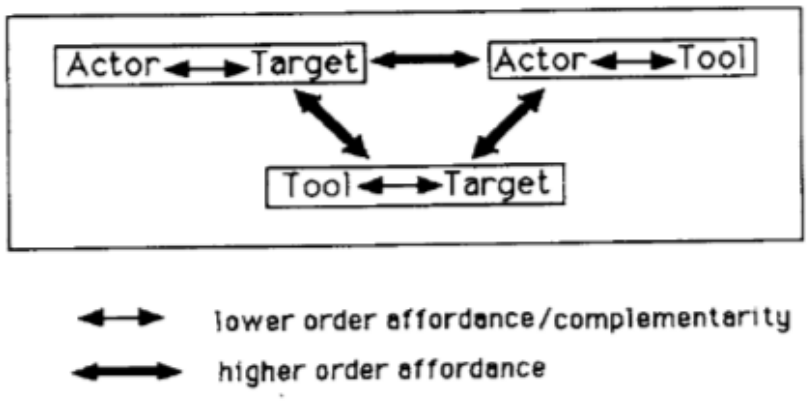

Figure 3. Higher Order Affordance Illustration (van Leeuwen et al. 1994)

The implication of this higher order affordance structure is that the affordance complexity expands from a single relationship to three interrelated relationships, suggesting that the tool used to accomplish a particular goal has both a direct and indirect effect on the user's achievement of the desired goal. van Leeuwen et al. (1994) studied these higher order affordance structures in the relatively simple context of a hook as the tool and a target object that could only be reached by using the hook. In a series of experiments they identified multiple second order affordances and even third order affordances in the use of a hook to reach a target.

These findings create challenges for successfully applying affordance theory to more complex technologies like information systems.

One way of dealing with the complex nature of technology affordances is to limit the scope of study. In HCI research the study of affordances has primarily focused on technology interfaces including telephone keypads and the arrangement of light switches (Norman 1988), scrollbars in computer programs (Gaver 1991), and visual signs in websites (Leung and Underwood 2007). This focus allows the complexity of affordances to be limited to discrete aspects of the technology. There is certainly value in understanding technology interfaces and our use of them, including the function of scrollbars in computer programs that require mouse movements and clicking activity (Gaver 1991). However, we also want to move beyond the study of isolated or discrete behaviors to understanding the influences and impacts of higher order affordances on more complex behaviors that are common to information systems research.

2.7 Social Affordances

With its origins in the psychology of visual perception, affordance research has traditionally focused on the influences of the material environment on individual behavior. This is true in both ecological psychology (e.g. stair climbing) and HCI (e.g. perceiving the function of scrollbars in computer programs). However, many of the opportunities for behavior made possible by affordances are related to social behavior and social interaction. Indeed, Gibson suggests that, "The richest and most elaborate affordances of the environment are provided by animals and, for us, other people. …They are so different from ordinary objects that infants learn almost immediately to distinguish them from plants and nonliving things. When touched they touch back, when struck they strike back; in short, they interact with the observer and with one another. Behavior affords behavior" (1979, p. 135). Gibson goes on to describe the affordances

of people and animals as reciprocal and mutual (i.e. you provide an affordance for me and I provide a related affordance for you). From this perspective, affordances remain specific to an individual, but are related to affordances for other individuals.

How does materiality relate to the social aspects of affordances? Gaver (1996) defines affordances offered by other animals and people as social affordances because they represent "the possibilities for action that people offer one another." He distinguishes social affordances from the affordances offered by material objects: "What I am concerned with here is the possibilities offered by the physical environment for social interaction. These are not social affordances, as defined above, but affordances for sociality. I believe they offer new opportunities for basic research and a powerful tool for design" (Gaver 1996, p. 113). This distinction between social affordances and affordances for sociality never caught on as researchers have used the term social affordance to mean both the opportunities offered by other people and the ways in which the physical environment in general, and technology specifically, supports social interaction (Bradner et al. 2002; Kozma 2003; Kreijns and Kirschner 2001). Bradner et al., for example, define social affordance as "the relationship between the properties of an object and the social characteristics of a group that enable particular kinds of interaction among members of that group" (2002, p. 154).

2.8 Information Systems Affordances

The affordance research described in the previous sections has resulted in refinements and extensions in the affordance nomological network first postulated by Gibson (1977; 1979). However, it is argued that further refinement is necessary to successfully use affordance theory in the study of information systems. A focused specification of information systems (IS) affordances is a starting point for bridging affordance theory and information systems research.

Based on the argument made earlier that there is value in maintaining the distinct characteristics of technology, Chemero's (2003) definition of affordances is suggested as the most appropriate foundation to construct a specification for IS affordances. Specifically, the use of affordance theory in IS research would be better served by distinguishing between information systems and other elements of the environment within which information systems operate. Therefore, it is proposed that in using Chemero's definition, features of the environment should be limited to those of the information system with the rest of the environment repositioned as the context within which features of information systems and abilities of organisms relate to produce affordances. This change in the specification of IS affordances maintains the influence of the environmental context while emphasizing the role of the information system and more distinctly theorizing the IT artifact.

A second change to Chemero's definition of affordances involves the organisms of interest to information systems. Since the only organisms that typically interact with information systems are humans, abilities can be narrowed to those of people. Therefore, the term individual will be used in place of organism. These modification to Chemero's (2003) version of affordances would result in a specification for IS affordance in which the relationship between the abilities of an individual and the features of an information system produce affordances within the context of the environment in which they function.

With this initial framing, we can begin to explore a more detailed view of technology affordances. An initial step in this process is to begin classifying affordances based on relevant criteria. In much of the affordance literature, affordances are described as enablers of behavior and a majority of the examples in that literature represent enabling relationships. However, throughout the literature there is often a pairing of affordances and constraints and some

researchers assert that the affordance concept should include both enablers of and constraints on behavior (Stoffregen 2003). Based on this assertion, a typology of affordances should distinguish between enabling affordances and constraining affordances. At one level, the characterization of enabling affordances and constraining affordances might be considered trivial, but the argument will be made that this distinction promotes the concept of paired affordances in designed technology.

The concept of a paired affordance is potentially useful in IS research because frequently technology design results in affordance pairs, one enabling behavior and the other constraining behavior. For example, a firewall provides an enabling affordance of security for users behind the firewall while simultaneously providing a constraining affordance for prospective intruders outside the firewall. In this case the paired affordances are recognized and desirable for the organization implementing the technology. However, in other situations paired affordances may not be recognized and could have undesirable effects. For example, an organization may chose to implement an ERP system to enable common business practices across the firm, but in the process constrain individual business units by limiting their ability to adapt to local opportunities. In this case the goal of improving organizational efficiency may actually result in reduced efficiency for certain units. Therefore, understanding the nature and consequences of paired affordances may be critical to the effectiveness of information systems in specific environments.

Constraining affordances are also important to recognize and understand because human agents may act to circumvent constraining technology. For example, Malato and Kim (2004) studied the implementation of a computerized medication dispensing system for use by Registered Nurses (RNs) in a public hospital. The system was designed to track and control the

dispensing of medications through use of a fingerprint scanner to reduce costs associated with undocumented medication dispersal and medication errors. An important feature of the system was that even though a nurse had to specify a particular medication for retrieval, once her fingerprint was validated she could access all the prescribed medications for her patients. The nurses were only supposed to take medications to be used at that moment and return later for additional medications as they were needed, but Malato and Kim (2004) found that the perceived inefficiencies of using the system in the way it was designed prompted RNs to circumvent the system by taking all the medications they would need for an entire shift or keeping a secret supply of medications to avoid using the system altogether. This is just one example of a specific association between affordances and human agency that will need to be considered and assessed in this research. This is not, however, a call to re-theorize human agency. There is an entire body of literature on agency concepts like reinvention, enactment, adaptation, etc. (Boudreau and Robey 2005; Johnson and Rice 1987) that have been developed, which may be used to inform and complement this research.

A special characteristic of information systems may also engender an important potential distinction in developing a theory of affordances for IS research. The environment, along with many technologies in the environment, provides direct affordances to individuals through their physical characteristics (e.g. cell phones and laptops have weight and size that afford varying degrees of portability). In contrast, information systems provide certain affordances by mediating between users and the environment. For example, air traffic control systems afford air traffic controllers the ability to manage airspace along with the airplanes in that space. Without the information system, the air traffic controller would have to observe the airspace directly. Instead, the information system provides a model of that airspace and its associated airplanes

with which the controllers can interact (Mathiassen et al. 2000). This mediating aspect of information systems means that a theory of IS affordances may need to distinguish between direct affordances and mediating affordances to adequately theorize the ways in which information system enable and constrain behavior.

These potential classifications of affordances along with the proposed theoretical specification for IS affordances represent a starting point from which to develop a more complete and useful theory of IS affordances. This theory development effort was carried out using the methodology described in the next section.

Chapter 3

Methodology

3.1 Philosophical Foundations

All research is guided, either explicitly or implicitly, by a set of philosophical assumptions about the nature of reality (i.e. ontological assumptions) and our ability to know and study that reality (i.e. epistemological assumptions). In the field of information systems, most research has been guided by either a positivist perspective or an interpretive perspective. The positivist perspective is "premised on the existence of a priori fixed relationships within a phenomena which are typically investigated with structured instrumentation. Such studies serve primarily to test theory, in an attempt to increase predictive understanding of phenomena" (Orlikowski and Baroudi 1991, p. 5). In contrast to positivism, the interpretive perspective assumes, "that people create and associate their own subjective and intersubjective meanings as they interact with the world around them. Interpretive researchers thus attempt to understand phenomena through assessing the meaning that participants assign to them" (Orlikowski and Baroudi 1991, p. 5). Although the use of the interpretive perspective has been growing (Mingers 2003; Walsham 1995), positivism continues to be the dominant perspective in information systems research (Chen and Hirschheim 2004). Orlikowski and Baroudi also include the critical perspective in their discussion of philosophies used in information systems research, although they identified no studies using that perspective. The critical perspective aims, "to critique the status quo, through the exposure of what are believed to be deep-seated, structural contradictions within social systems, and thereby to transform those alienating and restrictive social conditions" (Orlikowski and Baroudi 1991, p. 5-6).

More recently another philosophy, the critical realist perspective (Archer et al. 1998; Bhaskar 1978), not to be confused with the critical perspective, has been introduced and promoted in information systems research (Carlsson 2003; Mingers 2004; Smith 2006). Critical realism takes the ontological position that there exists a reality independent of our knowledge of it (intransitive objects) which contains mechanisms and structures with enduring properties (the real) that cause events (the actual) some of which we observe (the empirical). Critical realism asserts that the role of science is to theorize about that reality by taking the events we can observe and asking what the world must be like for those events to occur. Critical realism assumes, "a realist view of being in the ontological domain whilst accepting the relativism of knowledge as socially and historically conditioned in the epistemological domain" (Mingers 2004, p. 91). With regard to the positivist, interpretive, and critical perspectives, Mingers argues that, "critical realism subsumes all three of them. It points out the limitations of positivism and interpretivism individually whilst recognizing the contribution that research methods from these paradigms can make. It also subsumes critical theory, at least in its traditional Habermasian form, through the idea of the essentially emancipatory and transformative capacity of social science" (2004, p. 97). A few information systems scholars have taken the critical realist perspective in their research (Dobson 2001; Khoo and Robey 2007) and critical realism has been chosen to guide this dissertation research under the argument that it is an appropriate philosophical perspective for the study of affordances based on its unique ontological and epistemological tenets.

For Gibson (1979) and the rest of the ecological psychology field, affordances represent an important component of an ontological premise that meaning can exist in the environment separate from meaning that is internally or socially constructed. Klein (2004), for one, argues

that an interpretive perspective does not deny the existence of a reality apart from that which is socially constructed and would therefore likely suggest interpretivism to be just as appropriate for this research. However, the interpretive perspective's emphasis on the primacy of a socially constructed reality tends to result in research that marginalizes materiality. Because of this tendency, I believe there is value for the study of affordances in adopting a philosophical perspective that explicitly acknowledges the existence of an objective reality that can be studied and is worthy of attention from researchers while at the same time accepting that our ability to study and understand that reality is bounded by social and historical contexts. Furthermore, critical realism asserts, "that ideas, concepts, meanings and categories are equally as real as physical objects…and have causal effect both on the physical world (e.g., in the generation of technology) and the social and ideational world" (Mingers 2004, p.99) making it amenable to the study of concepts like affordances, which are argued to be relational in nature and for which those relationships are as real as the things which stand in relation to each other. Markus and Silver (2008) also suggest that critical realism is an appropriate perspective to take in the study of materiality because its approach to causality may prove effective in identifying the role information technology plays in the uses and consequences of the technology.

3.2 Research Design

Mingers (2004) suggests that critical realism supports the use of a variety of research techniques including both quantitative and qualitative methods, and the choice of which methods to employ will be contingent on the types of objects being studied. A panel session on Materiality and Organization Studies was held at the 2009 Academy of Management Annual Meeting that included presentations of research on affordances. During that session an audience member asked the panel, "Having defined affordances as a relational concept, how do you go

about studying it?" The responses from the panel were varied, but consistently referred to qualitative methods and fieldwork (e.g. "get rich descriptions first and then try to theorize around it", "code your field notes") as appropriate ways of studying affordances (Fayard et al. 2009). This study on affordances addresses the research question, *how do the material properties of health information systems enable and constrain the work practices of clinicians*? It is similar in nature to some of the affordance research presented in that panel session in that it seeks to understand how technology is implicated in user work practices. Therefore, as suggested by the AoM panel members, fieldwork using qualitative methods will be employed as part of the research design for this study.

Creswell (1998) defines qualitative research as, "An inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. The researcher builds a complex, holistic picture, analyzes words, reports, detailed views of informants, and conducts the study in a natural setting." Mason (2002) provides the following guidelines for qualitative research:

1. Be systematically and rigorously conducted
2. Be accountable for its quality and its claims
3. Be strategically conducted, yet flexible and contextual
4. Involve critical self-scrutiny by the researcher
5. Produce explanations or arguments, rather than just descriptions
6. Aspire to be generalizable
7. Be conducted as a moral practice

There are many different kinds of fieldwork that can be utilized in qualitative research including; ethnography, case study, and action research. For this research the case study has been chosen as the method of choice for investigating the influences of a health information

system on clinician work practices. Eisenhardt describes a case study as "a research strategy which focuses on understanding the dynamics present within single settings" (1989, p. 534) and Eisenhardt and Graebner state that, "Building theory from case studies is a research strategy that involves using one or more cases to create theoretical constructs, propositions and/or midrange theory from case-based, empirical evidence" (Eisenhardt and Graebner 2007, p. 25). Yin (2003) suggests that case studies are appropriate for studying phenomena in the context of social practice and that they can involve single or multiple cases at multiple levels of analysis.

The decision for this dissertation research was to focus on a single implementation of a health information system based on the argument that very rich data could be acquired from a single case and that studying multiple implementations would not guarantee additional insights into the phenomena I was interested in studying. Unlike quantitative research design which is driven by requirements for sample size and power, qualitative research design is driven by the potential for rich data and insights that a field site may offer and in fact the use a single case can be very effective for addressing exploratory research questions and building theory (Siggelkow 2007).

The selection of cases in qualitative research should be driven by theoretical concerns rather than random or stratified sampling. Eisenhardt and Graebner state that, "Theoretical sampling simply means that cases are selected because they are particularly suitable for illuminating and extending relationships and logic among constructs" (2007, p. 27). The particular system implementation that was chosen for this study was based on its anticipated potential for answering the research question and providing theory building insights. The nature of the system implementation that was selected for study was described to me in enough detail by my initial site contact that I was confident enough in its potential to pursue the site for my

research. I was told that the system had been implemented with almost no customization due to a very tight schedule knowing that they would have to eventually make changes to the system in order for it to fit their work practices. At the time I became aware of the study opportunity, the system had been in use for nearly two years, but was still being adapted and upgraded to meet the needs of the clinical users. This appeared to be a great opportunity for very rich data and insights on the influences that a health information system could have on clinician work practices.

With the initiation of data collection I had the opportunity to interview the Chief Nursing Officer who was part of the administration team that was responsible for the implementation and continued adaptation of the system. She provided much more detail on the background and circumstances surrounding this particular system implementation and I have decided to use her words, in addition to my own, to describe that implementation process in the Site Description section below as a more detailed justification for the site's potential as a case study as well as a lead in to the rest of the study.

3.2.1 Site Selection

This dissertation began by identifying the need for research on the enabling and constraining capabilities of information systems. This study could therefore have been conducted in any number of settings and was not constrained to a particular type of information system. The choice of healthcare as the contextual focus of this dissertation research is based largely on my background in healthcare both as a former clinician, as a registered Occupational Therapist, and as a vendor of health information systems. I have seven years of experience working with health information and communication systems in a variety of healthcare organizations including large urban hospitals, small rural medical centers, skilled nursing

facilities, outpatient clinics, and doctor's offices. The systems that I worked with as a vendor were primarily designed to support nurse's communication and information needs in clinical settings and therefore in my selection of a research site I was particularly interested in studying nurse's use of health information systems.

Prior knowledge of and extensive experience within the research context is not essential to the conduct of a successful research study. However, that kind of knowledge and experience can facilitate a better appreciation for the kinds of issues that exist in the context, issues that are nascent to an understanding of the phenomena under study as well as the potential challenges that can be expected in collecting data about the phenomena of interest. I believe my experience as a clinician and as a vendor of health information systems uniquely positions me to conduct a study that investigates the influences of a health information system on clinician work practices in a healthcare setting.

As a vendor of health information systems, my territory covered parts of three Midwestern states. In my search for an appropriate research site I engaged with contacts I had at various institutions in that region. Through those inquiries I was directed to a hospital that had implemented an electronic medical records (EMR) system throughout their entire facility in a very short period of time. The EMR system that had been implemented at this hospital was the EpicCare Inpatient Clinical System, which henceforth shall be known as "Epic"[1]. I contacted the Director of Clinical Informatics at the hospital, which henceforth shall be known as "Urban

[1] Epic Systems Corporation (Epic®) provides healthcare management software that integrates financial and clinical information across inpatient, ambulatory, and payer technology systems. Epic's software offerings include scheduling and registration tools, billing and managed care administration applications, inpatient and outpatient core clinical systems, electronic medical records applications, and applications for managing hospital pharmacy, emergency, surgery, radiology, laboratory, and intensive care departments. Citrix Consulting. 2005. "Epic Hyperspace Deployment on Metaframe Presentation Server Scalability Analysis," Citrix Systems, Inc., Ft. Lauderdale, Florida.

Hospital", to acquire additional details and ascertain the hospital's openness to a research study of their Epic system.

I explained to the Clinical Informatics Director my intentions for the research; that I was a doctoral candidate conducting my dissertation research with the intention of studying the influences of a health information system on the work practices of clinicians. After describing my intended research, including my interest in focusing on nurse's work practices, the Clinical Informatics Director agreed that the Epic system at Urban Hospital would provide an appropriate context for my study and consented to support the research[2]. She then initiated requests for study permission from the Chief Information Officer (CIO), since the study fell within his domain of information systems, and the Chief Nursing Officer (CNO), since the study would be focusing on nurse's use of the Epic system.

Upon approval from both the CIO and CNO for the study, I was informed that the hospital had its own Internal Review Board (IRB) that I would need to be in compliance with before I could begin data collection. I initiated the IRB process with both the hospital IRB and Georgia State University (GSU) IRB in April 2010, although the approval process had to be completed sequentially since the GSU IRB required approval from the hospital IRB before it would proceed. Approval from the hospital IRB was granted in May 2010 and final approval

[2] The Clinical Informatics Director specifically inquired about my background and experience in healthcare prior to agreeing to support the study. This same line of inquiry was raised by other Urban stakeholders and informants during the study and, although I may have been able to secure the site regardless of my background, I do believe that my healthcare experience was instrumental in both helping to convince the Urban stakeholders of my ability to conduct the research and in building relationships with informants.

On a related note, an earlier opportunity for a study site had been made available to me with a group of physician's practices that had implemented an EMR. In discussing that opportunity with the site contact I was asked how much experience I had with physician practice operations. When my contact realized that my experience was primarily in acute care settings I was told that, while they might be able to accommodate me, she felt it would be a burden on them to bring me up to speed on their operations, as it is quite different from acute care, and that it would be better if I pursued my research in an acute care setting where my background and experience would allow me to operate with minimal hand holding from the organization.

from the GSU IRB was granted in June 2010. Data collection was then scheduled for the following month.

3.2.2 Site Description

Urban Hospital is a 555-bed not-for-profit acute care facility located in the heart of a major metropolitan city in the Midwestern United States. It is a general medical and surgical hospital with one main campus and over 50 outpatient and physician practice locations. Urban has a staff of over 1,000 physicians and more than 4,000 employees' total. Since 2001, the hospital has been consistently recognized as one of the top 50 hospitals in the U.S. by *U.S. News and World Report*. In 2010 the hospital also achieved Magnet Recognition for Nursing Excellence by the American Nurses Credentialing Center (ANCC). The Magnet Recognition Program recognizes healthcare organizations that demonstrate the highest-quality patient care, nursing excellence and innovations in professional nursing practice.

At the beginning of 2007, Urban Hospital was part of an alliance of healthcare organizations that shared some common infrastructure including a clinical documentation system called IDX LastWord that was being used by the clinicians at Urban for part, though not all, of their clinical documentation. A significant portion of Urban's clinical documentation was still in paper form when LastWord was in use. In my interview with the CNO, she explained that in May of 2007 Urban made the decision to separate from the health alliance, which meant losing those common infrastructure components. Urban could have chosen to work directly with IDX to continue using LastWord, but the administration felt that LastWord would not take them into the future and therefore they decided to acquire a new system.

Urban brought in Accenture to help them select that new system. The CNO described the accelerated process they used to make their selection.

> "So we brought Accenture in and said you need to help us because we have literally one year to get ourselves separated and we need an entirely new electronic health record. So anyway, brought them in May of 2007 and said look we've got a very short period of time to get separated so you need to help us because at the time we didn't even have an IT department. I was the CNO, the chief nursing officer and we had a whole lot of things to get done in a year. So they helped us kind of look at what historically the industry would say would be best. So we picked out several vendors. We picked out Epic, we picked out Cerner, we picked out Soarian. We picked out those three and said which one of these can get us to the end game, because we wanted a system that could be fully integrated across the hospital and we wanted a system that we wouldn't lose any functionality in and would also position us for the future. So we brought the three vendors here, no RFP [Request for Proposal], none of that and said here is what we need. We have a six week time frame. You're going to come in once and we're going to tell you all about things and what the challenge is and you're going to come back two or three more times over the next six weeks and by the end of the summer we're going to have an answer. So we set up a steering committee made up of physicians, users, nurses, occupational therapists, physical therapists and some of the administrative team; and then Accenture and we were the selection committee. So we met with these vendors over the summer of 2007 and by August 31st we made a selection. We chose Epic and then we said okay you have thirty days and we need a contract and we need it signed because we need to get moving. So then we just worked through that process and then starting really, just about the day after Labor Day in 2007, Epic was actually on site beginning the process even before the contract was signed."

Accenture continued to work with Urban to implement the Epic system and functioned as their IT staff along with the people from Epic until they were able to put together their own IT department. The CNO went on to describe that implementation process.

> "It was a very aggressive timeline so that we spent the fall of 2007 starting to design the systems. Because not only was it the health information system, it was all the other 300 applications that attached to LastWord that we had to go back and a) decide if we wanted them, b) get them relicensed and repurchased and c) design them so that they would all be ready to be integrated with Epic, beginning on January 1. So we spent the fall in design sessions, negotiations with the other applications, getting contracts signed and building those systems as well. And then beginning essentially January 1 of 2008, all the testing started and all the infrastructure build was happening concurrently so that at the end of March in 2008 the ERP system went live. We chose Lawson which was our ERP system and that went live in March and then Epic went live across the house everywhere on June 1st of 2008."

That meant that the hospital was able to go live facility-wide with Epic exactly nine months after selecting the system. Epic is a major vendor of health information systems with

many EpicCare implementations around the world and the CNO said that this was the fastest implementation of the EpicCare Inpatient System of its kind.

> "[Epic] had never done it in the timeframe that we had done it in, no one had. It was the first ever. Now they had done whole hospital go-lives when it was a brand new hospital so there were no patients in the bed, but you're talking about a full service hospital running at full capacity and at midnight on that night when we flipped that switch, there was no going back. So it had to be right because there was no going back."

In addition to the accelerated system implementation, an appropriate training program for the staff had to be developed and conducted prior to go-live. The CNO described that process as well.

> "So we spent about six weeks in April, mid-April through the end of May training essentially at that time, thirty-two hundred people on Epic. Because Epic is live across the house, not just in the clinical areas but all the front end, registration, patient access, all of that is Epic and then all the back end is Epic as well. So everybody got retrained…the Epic training actually went from six in the morning until midnight, six days a week."

> "Epic provided super-super users and then our people became the super users and then the super users and the people from Epic were the trainers for the staff. So each unit, each department had one or more super users that were trained as well as their staff all got trained. So there were lots of layers of the ability for people to move in those leadership roles as the training commenced."

> "[Training time per staff was] anywhere from about sixteen hours to as little as, I think the least anybody received was ten hours. And then they were required after the formal training to play in the playground, because we had a mirror image of it set up and then they were required to do exercises in the playground. So again a good example would be during their shift, they had to, between a certain period of time, they had to do mirror charting. So they went ahead and did their patient care just like they normally would, but then they went to Epic and they said okay if Epic was turned on, how would I have charted in here? We had them practicing barcode med administration so our pharmacist prepared bags of medication and in the playground you could go in and you could simulate doing barcode med administration because they had never done that before."

> "[During the training period] our staff elected to work overtime and we paid them bonus pay to work overtime so they might come in on an extra four hour shift, or just some period of time, or they may elect to go and do their training from home because they could. So the training could be accessed from home or from here and some things you can only do from here. So if you go out and you're interviewing you'll hear on the different units and the different departments, they set up training rooms on their units all decorated in all kinds of fun ways and they provided exercises there in different ways so

> it was really kind of fun. And then Epic has a web-based training site which is very generic so it's enough to show you how the system may look but it's really not the full blown system. But it's very nice, it's interactive, it has speech in it so it talks to you and it's a really nice system."

Because of the tight schedule, the hospital was forced to implement Epic with minimal customization resulting in a system that was not specifically fitted to the needs of the hospital or the clinicians who would be using it. This situation provides a useful setting for the study of how a health information system can enable and constrain clinician work practices given that the clinicians had to deal with a system that was expected to initially be in some conflict with their existing work practices. At the start of data collection, the hospital was preparing for a significant upgrade to Epic and was continuing to make other adaptations to the system to improve the fit with their clinical work practices.

3.3 Data Collection

> "What is important about well-collected qualitative data? One major feature is that they focus on *naturally occurring, ordinary events in natural settings*, so that we have a strong handle on what "real life" is like. That confidence is buttressed by *local groundedness*, the fact that the data were collected in close proximity to a specific situation, rather than through the mail or over the phone. The emphasis is on a specific *case*, a focused and bounded phenomenon embedded in its context. The influences of the local context are not stripped away, but are taken into account. The possibility for understanding latent, underlying, or nonobvious issues is strong." (Miles and Huberman 1994, p. 10, emphasis included)

Data collection in qualitative research can be accomplished using a variety of methods with the three most common being qualitative interviewing, observing and participating, and the use of visual methods and documents (Mason 2002). Furthermore, the use of multiple methods provides the advantages of strengthening the triangulation of evidence (Eisenhardt 1989) and facilitating a broader set of opportunities for gathering relevant data. Eisenhardt also suggests that using flexible and opportunistic data collection methods can allow the investigator to "take

advantage of emergent themes and unique case features" (1989, p. 533). Upon these recommendations, a combination of interviews, observation, and document analysis were selected as appropriate methods of data collection for this research study.

If affordances are relationships between the features of an information system and the abilities of individuals, then a logical starting point for data collection would be the examination of the features of the information system selected for study to identify potential affordances that may result from a pairing of those features with individual abilities. Identification of an information system's features can come from an analysis of system documentation as well as interviews with individuals who have direct knowledge of the system[3]. Relevant documents for the study of system features would include white papers, product brochures, requests for proposals, and training manuals. Knowledgeable individuals would include system designers and developers, vendor sales representatives, installation and maintenance technicians, experienced users, and possibly competing vendors and administrative decision makers who have spent time investigating the system. Additional features could also be gleaned from a direct examination of the system itself.

The resulting set of identified features and their potential affordances primarily represent the intentional design of the system. This provides a baseline for assessing the actual use of the system in practice. Data collection can then shift focus to the users of the system, which can best be accomplished using interviews and observation. Semi-structured interviews with users form

[3] Even though I have extensive professional experience with a variety of health information and communication systems, I did not have any experience with the Epic EMR system. Therefore, I took the opportunity to learn more about Epic in preparation for formally studying its use at Urban Hospital. Information about Epic is available online, but the 2010 Healthcare Information and Management Systems Society (HIMSS) conference was also being held in Atlanta and the HIMSS conference includes a vendor exhibit hall where health information systems vendors can market their systems. I took that opportunity to attend the conference and was able to visit the Epic booth in the vendor exhibit hall. An Epic representative gave me a personal guided tour of their demonstration system of the EpicCare Inpatient EMR Module and provided me with several pieces of documentation that further explained the features and functions of the system. I believe this experience helped to better prepare me for the study I conducted at Urban Hospital.

the core data collection method in this stage of the study as user's perceptions of the system and their use of it are critical to understanding its influence on them, but observation is also be a useful tool to identify specific affordances in use that users are not necessarily able to articulate during an interview. The value of observation is further enhanced based on my background and experience in acute care settings, which favorably positioned me to recognize relevant content and behaviors in the activities and processes I observed. Observation sessions were an opportunity to see connections between features, abilities, and affordances that cannot be identified through interviews alone.

In preparation for data collection, I constructed an interview guide that would facilitate a semi-structured format for the interview sessions. Exploratory research necessitates that subjects be given latitude to express their thoughts and opinions while still guided to the topics of interest, and a semi-structured interview format provides that combination of freedom and structure. The initial interview guide for this study was constructed before the case study site was identified and therefore its questions were more generic to healthcare organizations in general rather than specific to the particular site that was studied. That initial interview guide is shown in Appendix A. Once the site was established and data collection was initiated, the interview guide was adjusted to include site specific details, and as data collection progressed it also evolved to incorporate new concepts and ideas identified during earlier interviews and observations. Appendix B includes a sample of some of the new/modified questions that were developed and used during the data collection process.

Another preparatory requirement for data collection was the decision of how to capture the interview content. I decided that I would need to audio record the interviews to both ensure the capture of all audible interview content and to free me from having to focus on writing or

typing everything during the conversations. I found that audio recording the interviews made it much easier to keep the conversation flowing and allowed me to more easily adapt my follow-up questions based on the subject's responses. Two of the nurses asked not to be recorded and I found the content from those conversations, as compared to the other interviews, to be somewhat limited. For the recordings, I chose to use an app on my iPod Touch for capturing digital audio rather than using a dedicated audio recording device. The reason for this decision was that I was already using my Touch to keep my calendar and detailed contact information and I wanted to minimize the number of devices I was using while on site. The one drawback to this arrangement was that a dedicated device would have had a physical start/stop button that was lacking on the iPod, and I found I needed to make a few adjustments before it functioned smoothly during the interviews. Initially I did not feel that video recording would be necessary for the interviews, but during the course of data collection I found that some of the nurses would bring their mobile computers with them into the interview and our conversations would sometimes include visual aspects of the computer (e.g. the structure of information displayed in the interface). I considered bringing a video recording device with me after the first interview where I realized it might have been useful, but the IRB approved consent form only included consent for audio recording so instead I made notes about those interactions to remind me of the visual information that was not be captured by the audio recording.

Hospitals are organized around departments that include a variety of patient care units. These units range from medical/surgical units where medically stable patients stay prior to and after undergoing medical/surgical procedures to intensive care units where patients with life threatening conditions are cared for by specially trained staff and monitored and supported by specialized equipment. This research study was focused on an electronic medical records system

(Epic) implemented in a single hospital, but that hospital contained a mix of different units each with unique characteristics and a certain level of autonomy in how they chose to use the Epic system. In order to further focus the data collection process and ensure a rich set of data that was both diverse and cohesive, I decided that data collection would focus on a specific set of units with some diversity between the units selected. Through a process of negotiation with hospital administration I was given access to two medical/surgical units, a geriatrics unit (3 West) and a beriatrics unit (5 South), and one intensive care unit, the cardiovascular ICU (CVICU), to conduct my data collection. In addition, the hospital has an electronic intensive care unit (eICU) which provides remote monitoring to all of the other intensive care units in Urban Hospital, and I was offered the opportunity to visit that unit and interview two of its nursing staff. Nursing care in a hospital is also a 24-hour process, and the work practices of nurses on night shift differ from the work practices of nurses on day shift. Therefore, I also negotiated access to the patient care units on both day and night shifts to interview and observe nurses working in each environment.

Onsite data collection began on June 29, 2010 and ended on July 29, 2010. During that time period I spent 14 days at Urban Hospital engaged in data collection efforts and interviewed a total of 53 subjects using both group and individual interviews. Specifically, my interviews with the Information Technology (IT) team and the Clinical Informatics (CI) team were conducted as group interviews while all other interviews were conducted individually. Table 2 lists the research subjects by organization role and system role as well as the interview format used. In addition, nurses are listed by the unit in which they worked and whether they were on day or night shift.

Table 2. Subject Roles and Interview Format

Organization Role	Epic Role	Unit	Shift	Interview Format
Nurse Manager	Administration	3 West	NA	Individual
Nurse Manager	Administration	5 South	NA	Individual

Nurse Manager	Administration	CVICU	NA	Individual
Vice President and CHO/CNO	Administration	NA	NA	Individual
Registered Nurse - Charge Nurse	Clinician User	3 West	Day	Individual
Registered Nurse - Charge Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Day	Individual
Registered Nurse	Clinician User	3 West	Night	Individual
Registered Nurse	Clinician User	3 West	Night	Individual
Registered Nurse	Clinician User	3 West	Night	Individual
Registered Nurse - Coordinator	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Day	Individual
Registered Nurse	Clinician User	5 South	Night	Individual
Registered Nurse	Clinician User	5 South	Night	Individual
Registered Nurse	Clinician User	5 South	Night	Individual
Registered Nurse	Clinician User	5 South	Night	Individual
Registered Nurse - Coordinator	Clinician User	CVICU	Day	Individual
Registered Nurse	Clinician User	CVICU	Day	Individual
Registered Nurse	Clinician User	CVICU	Day	Individual
Registered Nurse	Clinician User	CVICU	Day	Individual
Registered Nurse	Clinician User	CVICU	Night	Individual
Registered Nurse	Clinician User	CVICU	Night	Individual
Registered Nurse	Clinician User	eICU	Day	Individual
Registered Nurse	Clinician User	eICU	Day	Individual
Clinical Informatics Analyst	Support	NA	NA	Group - CI
Clinical Informatics Analyst	Support	NA	NA	Group - CI
Clinical Informatics Analyst	Support	NA	NA	Group - CI
Clinical Informatics Analyst, Senior	Support	NA	NA	Group - CI
Clinical Informatics Analyst, Senior	Support	NA	NA	Group - CI
Educator - Clinical	Support	NA	NA	Individual
Educator - Clinical	Support	NA	NA	Individual

Educator - Unit	Support	NA	NA	Individual
Infrastructure Support	Support	NA	NA	Individual
IT - Data & Systems Team Lead	Support	NA	NA	Group - IT
IT - Director of IT	Support	NA	NA	Group - IT
IT - Inpatient Clinical Team Lead	Support	NA	NA	Group - IT
IT - Outpatient Clinical Team Lead	Support	NA	NA	Group - IT
IT - Revenue Cycle Team Lead	Support	NA	NA	Group - IT

Based on my belief that the data collection process should begin with an analysis of the features of the information system and its intended purpose, my initial interviews were conducted with hospital administrators and system support personnel. Hospital administrators included the Chief Nursing Officer, who at the time of the interview was also the Chief Hospital Officer, and the nurse managers of each unit that I was granted access to studying. Interviews with the nurse managers served the dual purpose of identifying their expectations for and perceptions of the use of the system by the nurses on their unit as well as establishing procedures for interviews with the unit nurses and observation of activity on the unit. System support personnel included the Information Technology team which provided backend support to Epic and its integration with other related systems, and the Clinical Informatics team which provided direct support to the clinical users of Epic. In addition, three educators who provided ongoing system education and training to clinicians were interviewed for their perspectives on user abilities related to Epic's features.

Nurses, as the clinician users of interest in this research, formed the core of the data collection effort with a total of 33 nurses interviewed across the three primary patient care units included in the study along with two nurses in the eICU[4]. In addition to interviews, 22 of the

[4] The eICU is an advanced telemedicine solution at Urban Hospital which uses computers and private, high-speed data lines, located in one of the hospital's ancillary buildings to enable critical care nurses to remotely monitor ICU patients 24 hours a day, seven days a week. I was given the opportunity to visit the eICU and interview two of the staff nurses on their use of the system. However, that data was not used to develop the theoretical insights in this document and no findings from those interviews are presented.

nurses were observed as they engaged in their daily work practices of providing patient care and interacting with physicians and other clinicians on the patient care unit. Observation sessions always took place after the nurses had been interviewed and had consented to their participation in the study.

I was also given full access to both the Epic production system and the Epic sandbox environment during my time at the hospital, which allowed me to test some of the system functions for myself and to evaluate certain features that were discussed during the interviews. This combination of data collection opportunities provided a richer set of data and a more comprehensive understanding of the case study than I could have obtained using other methods of data collection.

3.4 Data Analysis

Eisenhardt argues that, "Analyzing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process" (1989, p. 539). Therefore, a critical step in the research process is the identification and use of an appropriate set of principles and guidelines for conducting an effective case study analysis that allows raw data to be transformed into a usable theory. Miles and Huberman (1994) provide detailed guidance for analyzing qualitative case data and their suggested approaches were used in the analysis of this research data.

Miles and Huberman state that, "Coding is analysis. To review a set of field notes, transcribed or synthesized, and to dissect them meaningfully, while keeping the relations between the parts intact, is the stuff of analysis" (1994, p. 56). Coding is an important part of the process of data reduction, which they describe as "the process of selecting, focusing, simplifying, abstracting, and transforming the data that appear in written-up field notes and transcriptions"

(1994, p. 10). Miles and Huberman assert that data reduction occurs even before fieldwork commences through the research questions and conceptual framework from which the researcher operates and through the site selection and initial data collection choices that are made. This form of data reduction was followed in this research through the initial formulation of a theoretical framework for studying affordances along with the site selection and data collection decisions described in the previous sections. Those choices helped to focus the data collection process and reduce the potential data to be included in the study.

I chose nVivo 8 as the data analysis tool for coding the data collected in this research. Audio recordings of the interviews were first transcribed using a transcription service, and the transcribed documents were then loaded into nVivo along with observation data and other notes that were already in document format. Transcripts and other documents imported to nVivo are called sources. nVivo allows codes, which it calls nodes, to be assigned to any block of text, from single words to entire sections, and the codes can be maintained independently (free nodes) or in a relational tree structure (tree nodes). Text assigned to a particular code can then be grouped and displayed across all sources in which it originates, making it easy to review and evaluate all interview transcripts and field notes associated with a particular code. nVivo also provides basic node statistics on the number of sources in which the code has been assigned as well as the total number of references coded in each source.

An initial round of coding to identify what Miles and Huberman (1994) call descriptive and interpretive codes resulted in a total of 87 unique codes. nVivo's tree node structure was utilized to facilitate a code hierarchy with descriptive codes organized under specific interpretive codes. Miles and Huberman argue that this coding process is designed to summarize segments of data without necessarily drawing any inferences from the data and that the assignment of

descriptive and interpretive codes is meant to provide an initial round of data reduction in preparation for a second round of coding.

My initial coding scheme was based my research question, *how do the material properties of health information systems enable and constrain the work practices of clinicians*, and my definition of IS affordances as relationships between the abilities of individuals and features of an information system within the context of an environment. That question and definition focused my early analysis on work practices, individual abilities, system features, and environmental characteristics. With those broad categories in mind I took each transcript and looked for instances of the categories in the conversations with my subjects. Although nVivo allows coding at the word level, I was interested in the context of the conversation surrounding the descriptive and interpretive codes I was assigning. Therefore, I coded entire sections of the transcripts that were associated with each code I identified. This also meant that I often coded whole transcript sections or overlapping sections with multiple codes since practices, abilities, features, and the environment were all interconnected and woven into the interview conversations and field notes. nVivo also allows adding notes to transcripts and memos to code categories which enabled me to capture my thoughts related to particular conversations or categories as I was working my way through the coding process. These notes were helpful in organizing my thinking throughout the analysis process and preparing for the next round of coding. The descriptive and interpretive codes and their structure also evolved as I progressed through the coding process when new information suggested the need to merge some codes or break codes into sub-categories. This process was very iterative with periods of coding separated by periods of reflection on both the data analysis process and the results of that analysis.

The first round of coding continued until all of my data had been analyzed and I was sufficiently certain that all relevant text had been coded and no new descriptive or interpretive codes were forthcoming in the data. At that point a second round of coding was initiated. This second round of coding was meant to produce what Miles and Huberman (1994) call pattern codes or meta-codes, which are more inferential and explanatory in nature than either descriptive or interpretive codes. Miles and Huberman suggest that pattern coding "helps the researcher elaborate a cognitive map, an evolving, more integrated schema for understanding local incidents and interactions" (1994, p. 69). This second round of coding was conducted to elaborate the influences of the Epic system on nurses work practices at Urban Hospital.

nVivo groups all text assigned to particular codes allowing the analysis of that text as an interrelated set of data across transcripts. In this second round of coding I focused on the codes which contained the most references in my data. This was not meant to be a quantitative analysis, but rather a concentration on the categories that were given the most attention in this particular context with the expectation that these categories would provide richer, more extensive, data for the development of robust pattern codes. Through this process of analyzing the data assigned to descriptive and interpretive codes and the assessment of my notes and memos I iteratively developed the theoretical concepts and relationships which are discussed in Chapter 5 to extend the nomological network of affordances.

Chapter 4

Results

> "In a single-case study, the challenge of presenting rich qualitative data is readily addressed by simply presenting a relatively complete rendering of the story within the text. The story typically consists of narrative that is interspersed with quotations from key informants and other supporting evidence. The story is then intertwined with the theory to demonstrate the close connection between empirical evidence and emergent theory. This intertwining keeps both theory and evidence at the forefront of the paper." (Eisenhardt and Graebner 2007, p. 29)

Urban Hospital provides both inpatient and outpatient care services. Inpatient care is defined as the admission of a patient for treatment that will require at least one overnight stay in the hospital, while patient services that do not require an overnight stay are considered outpatient care. The focus of this study was on the work practices of nurses as they provide inpatient care services on patient care units.

Hospitals organize their inpatient care around patient care units and patients admitted to the hospital for inpatient care are assigned to a room on a particular unit. These units may occupy a wing of the hospital or an entire hospital floor and have a dedicated staff of clinicians that include registered nurses, henceforth known as nurses, and nursing assistants, henceforth known as techs, who provide 24-hour care for the patients admitted to the unit. Hospitals have a mix of patient care units with each unit configured for the care of a particular type of patient or condition or set of conditions. For example, most hospitals have a maternity unit that specializes in the care of expecting mothers and healthy newborns and at least one medical surgical (med/surg) unit that provides care for a range of patients who have been admitted to the hospital for various medical conditions and/or surgical procedures. Other types of patient care units found in hospitals include neonatal units, pediatric units, intensive care (ICU) units, oncology units, and neurology units, among others. Figure 4 shows a floor plan for a typical patient care

unit with patient rooms around the outside of the unit and a core that includes a nurse's station, supply storage, staff lounge, staff lavatory, clean utility, and soiled utility.

Figure 4. Example Patient Care Unit Floor Plan

Patients admitted to a patient care unit spend most of their hospital stay on the unit and therefore the nurses and techs assigned to the unit become primarily responsible for their care under the authority and direction of physicians. Because the patients admitted to the patient care units require continuous monitoring and care, the units are staffed 24 hours a day on rotating shifts. On the units that I studied at Urban Hospital, nurses and techs work 12-hour shifts from 7 a.m. to 7 p.m. (day shift) or from 7 p.m. to 7 a.m. (night shift). Each unit is headed by a nurse manager who may have an assistant, a clinical coordinator, and one nurse per shift is normally designated as the charge nurse who functions as the shift supervisor.

The focus of my research is nurse's work practices on patient care units and the influence of health information systems on those work practices. The remainder of this chapter will provide an account of the work practices of nurses on three patient care units (3West, 5South, and CVICU) at Urban Hospital and the influence of the Epic system on those nurses and their work practices through the lens of affordances.

- 3West is a geriatric med/surg unit which specializes in the care of geriatric patients, but provides care to a range of patients who have been admitted to the hospital for various medical conditions and/or surgical procedures. Figure 5 is a picture of one of the hallways on 3West.
- 5South is a bariatric unit which specializes in the care of patients undergoing medical weight loss treatment, although they too provide care for other medical surgical patients.
- CVICU is a cardiovascular intensive care unit that provides care for patients experiencing acute heart conditions or undergoing cardiothoracic or vascular surgeries.

Figure 5. 3West Hallway

All three units share some similar characteristics, particularly 3West and 5South, but there are also significant differences, particularly in CVICU, that will be pointed out to highlight affordances of the Epic system and their enablement and constraint of nurse's work practices on these units. The activities that nurses engage in during their shift include, but are not limited to, handoff, medication pass, patient assessment, orders, patient education, care plans, admissions, and discharges. Descriptions and discussions of a selection of these activities will be made that explore the affordances available to clinicians both prior to Epic and after Epic's implementation.

Prior to the implementation of Epic the nurses at Urban Hospital were using some electronic documentation (e.g. LastWord), but the majority of their clinical documentation remained paper-based. Paper-based clinical documentation on a patient care unit is typically afforded through a patient chart like the one in Figure 6. All of the clinical documentation about a particular patient during the patient's hospital stay is kept in that chart and pages are added to it as necessary for the addition of new orders, notes, etc. The chart is organized into sections (orders, MAR, progress notes, care plans, etc.) so that information can be more easily located and documented. Clinicians who need to view the contents of the chart or add information to it, like writing a progress note, must get access to the physical chart. For inpatient care the chart is kept on the patient care unit unless the patient is transported off the unit, in which case the chart typically accompanies the patient (e.g. patient is taken to radiology for an MRI). On the unit the patient chart will have a designated storage location either at the nurse's station in a chart rack or in a chart holder located just outside the patient room door. However, clinicians do not always return the chart to its designated place so other clinicians who need it later often end up having to

search for it[5]. A nurse on 5South described a particular affordance of a paper-based chart that was lost to her with the implementation of Epic.

> "If you wanted to make sure you saw the doctor, you kept the chart with you, because they would have to have the chart to get the progress notes for the right orders. So if you really wanted to get them you would make sure you had the chart on you." (5South Nurse)

Figure 6. Paper-based Patient Chart

4.1 Epic – The Information System and All Its Parts

With the implementation of Epic, the patient medical record became digital and the paper charts were no longer used for clinical documentation. The decision was made to use mobile workstations as the primary means of access to Epic on most of the patient care units. These workstations are known as COWs (computer on wheels) and WOWs (workstation on wheels). Figure 7 shows one of these mobile workstations. It includes a computer base with WiFi, a flat

[5] When I was working as an Occupational Therapist in an acute care hospital I provided therapy services to patients either on the unit or in the Rehab department. If the patients were brought to the Rehab department their chart was brought with them. If I had to provide therapy on the patient care unit I would have to locate the chart to check for current information on the patient before starting a therapy session. I would also typically talk to the patient's nurse to find out if there was anything going on with that patient that I needed to know that might not be in the chart. After the therapy session I needed to get the chart again to add my note on the session. There were times when the chart was being used by another clinician and I would have to wait to use it and other times when I had to go searching for the chart because it wasn't at the nurse's station.

screen monitor, a keyboard and mouse, a barcode scanner for scanning patients and medications, and a battery pack, all built on a rolling frame that can be height adjusted within a range. There is also a wire basket that can be used to hold supplies and a desktop surface on which to set objects or to write.

Figure 7. Epic Mobile Workstation - WOW

In addition to the WOWs, desktop computers were also installed in hallway alcoves around the unit and at the nurse's station, giving the clinicians additional options for accessing Epic on the unit. However, since nurses were required to use the barcode scanners to administer

medications to the patients in their rooms they primarily used the mobile workstations for their access to Epic. The CNO described the hospital's hardware configuration decisions for the Epic implementation and their impact on the clinicians.

> "Medication passes are a big deal so truly you need to have the ability for every nurse to have computer access during medication administration times. So [medication passes] are preset in hospitals, they're pretty standard. So we said where do you have the most nurses? Mostly on dayshift, so we said, on every unit count the number of nurses, the maximum number of nurses that you would have on the dayshift. Let's just say that number is fifteen. They minimally got fifteen mobiles and we said okay, how many physicians do you traditionally have rounding at one time? Okay add that number and give them a couple of extra. So it was pretty close to five hundred mobile carts that we bought. I would tell you that we grossly underestimated it on the dayshift. Once evenings and nights come, there's no problem. It's the dayshift time between about seven in the morning and maybe one in the afternoon that is really the crunch time. Because you have physicians rounding, you have all your nurses here, you have the residents rounding, you have OT, PT, respiratory therapy. So the maximum number of people who need those things, and gosh of course it's always all at the same time, is really the crunch time. People used to fight over charts because if one person had the chart, you couldn't chart. Well now they fight over the COWs."

The mobile workstations became the preferred way to access Epic by most of the physicians and other clinicians, although many of them could have used the desktop computers in the hallways or at the nurse's station for their Epic access. Urban was a teaching hospital so in the mornings when the physicians and residents came to the unit to see patients, and they each wanted their own WOW for rounding, there would inevitably be more clinicians wanting WOWs than were available on the unit. To ensure that the nurses had access to the mobile workstations to complete their medication passes, some units came up with ways for their nurses to stake claim to the WOWs.

> "We have Velcro laminate stickers with people's names on them and they get them first thing in the morning and they put their sticker on their COW, and I've had physicians pull the stickers off and throw the stickers on the table and take the COW away. But in general I think people respect that the mobile cart has somebody's name on it. That's the process we came up with because nurses cannot do anything without their computer. Nothing, they can do nothing!" (5South Nurse Manager)

The intensive care units (ICUs) did not experience the same mobile workstation issues seen on other units. This was because on all of the ICUs, including CVICU, a desktop computer was installed in each patient room and those computers included an attached barcode scanner for medication pass. The CNO explained that this hardware configuration originated from the implementation of another documentation system for the ICUs that was started before the need to implement Epic hospital-wide was identified. The plan for that system had included computers in every patient room. The ICUs also has WOWs, although not as many as on the other units, and there are still computers at the nurse's station and in the hallways, but having computers in the patient rooms allowed the nurses to use the in-room computers instead of the WOWs to pass medications. This difference significantly altered some of the dynamics of Epic's use on those units.

Login to Epic was one issue that has had a varied impact on nurse's work practices across the units. Accessing Epic, whether through a WOW or a desktop computer, required the clinicians to go through a particular login procedure. Specifically, Urban Hospital enabled access to Epic through a thin client interface that runs under Citrix[6], which also provides single sign on and authentication for hospital systems other than Epic. Nurses and other clinicians have to first log into Citrix by typing in their username and password for authentication. Citrix then enables access to Epic on the clinician's computer through the Epic Hyperspace® user interface. This multi-step login is not instantaneous and because the process is heavily dependent on the network and its performance capabilities, it can take even longer to get Epic up and running when the network is slow. Nurses reported that logging into Epic could take a minute or more and one nurse on 5South said, "It takes a while to log in, I mean a good five minutes I would

[6] Citirx provides desktop virtualization and software as a service through networking and cloud computing technologies to approximately 230,000 organizations around the world including many healthcare organizations, www.citrix.com.

say." When asked about issues with Epic, a nurse on 3West commented, "The only thing that I hate, hate, hate about it is logging in! It takes forever!" Whatever the real times were for login to Epic, the common perception of nurses across all three units in this study was that it takes too long.

Wireless network access on the WOWs also meant that WiFi signal strength was an issue when accessing Epic on the mobile workstations. Nurses on both 3West and 5South reported that Epic sometimes froze on them when working in a patient room and they had to take the WOW outside the room to regain network access. A member of the infrastructure support group explained that those issues were decreasing because of network upgrades as well as better diagnosis and correction of root causes, but that hardware and network issues were still a problem that they continued to address on the units.

The nurses on CVICU reported a different set of Epic login issues than the nurses on 3West and 5South. Due to presence of computers in the patient rooms and fewer WOWs, CVICU nurses primarily used the computers in the patient rooms instead of the WOWs for medication pass and bedside documentation. This meant they had to log in and out of Epic as they moved from patient room to patient room. This amplified their frustration with the login process and altered their work practices in various ways including addressing the computer before addressing the patient.

> "The logging in now is ridiculous. As soon as I walk in my patient's room I log in and then I address the patient. It's just something that you have to get going or otherwise you're standing there and not accomplishing anything while you're waiting for it to log in." (CVICU Nurse)

With computers at the bedside, nurses were expected whenever possible to chart as they worked to improve the timeliness of documentation. However, some nurses found the Epic login

process so slow that they deliberately chose to postpone their documentation to reduce the number of times they need to login and out of the system.

> "I find the logging in and out very tedious and aggravating…When I have two patients, rather than logging in and out, except to give meds which you have to scan, I tend to chart everything at the same time. I'll just go out to a computer and chart the patient's assessments and any other little things at the same time so that I don't have to log in, in one room, log out when I go to the next room and log in and log out." (CVICU Nurse)

The lengthy login times affected the nurses as well as the other staff members who assisted them in providing patient care on the unit. The ICU Clinical Educator occasionally helped the CVICU nurses with certain patient care tasks and often found it easier to leave handwritten notes for the nurses rather than waiting on Citrix to complete the login to Epic.

> "It's very tedious using Citrix. The nurses have to go to one room, log off, go back in, log on. You have a lot of down time just waiting on the computer to boot up so you can put your information in. I'll find when I'm helping people, if I'm going in to empty someone's catheter, rather than go in and type that they had 300 of urine out, I'll take a piece of scrap paper, I'll put the date, time and my initials and just lay it there and I'll move on to the next task." (ICU Clinical Educator)

As mentioned earlier, the ICUs did have some WOWs available and these could have been used instead of the bedside computers and so I asked the nurses why they didn't just use the WOWs, if logging in and out of the bedside computers was so onerous. The response was that many of their WOWs had a tendency to automatically scroll on Epic windows that were longer than a single screen, which made it so difficult to use the WOWs that most nurses chose not to use them.

> "The computer on wheels, you know a lot of them you'll start scrolling and it will just keep on scrolling, so the computers on wheels are just useless most of the time." (CVICU Nurse)

In contrast to CVICU, nurses on 3West and 5South primarily used the mobile workstations and just kept their WOWs with them during their daily activities. This allowed

them to stay logged in for most of their shift, which reduced the impact of the login process on their use of Epic.

> "I try to keep myself logged in and if I'm going to be away from the computer for a time I'll log out. But I'm literally with the computer all day so we usually can stay logged in unless we go off to lunch or we're in the middle of a really extensive procedure." (3West Nurse)

However, the lengthy logon times did have the effect of leading some nurses on 3West and 5South to stay logged into their WOWs even when they stepped away from the computer, which was contrary to proper procedures for maintaining information security.

> "Well I try not to [log out], I mean I minimize my thing [Epic window] because obviously you don't want all that information sitting out there." (5South Nurse)

In addition, the practice of keeping the WOW always with them created both a self-perception of attachment to the computer and a perception by the patients that the nurses were tied to their computers.

> "I always feel like I have to have that computer attached to me. That's the only thing that I don't really like. I feel like that takes away the moment with the patient. And I know patients feel like that too, they have mentioned that before." (5South Nurse)

> "I'll get comments. Sometimes patients say, "here comes the computer", "you always have the computer", that kind of stuff. But nothing negative. It's always all in good humor." (3West Nurse)

The use of both the WOWs on 3West and 5South and the bedside computers on CVICU also had an effect on the relationship between the nurses and patients. Some nurses reported a change in their bedside behavior when using the computer and how that change in behavior altered their relationship with the patient.

> I feel the biggest impact it has on me is that it has turned me from a health care provider to a data collector…You're turning your back to the patient because you're data inputting. You're inputting all this data into this computer and into this system, and you're turning your back on your patient." (CVICU Nurse)

> From a patient aspect I think that there are negatives because of the wrist band, they feel like they're an item in K-Mart. You know let me scan your band and see if you are who

> you say you are. It's much more structured because it cuts down on med errors, it cuts down on nursing error, it cuts down on a lot of that, but you're looking at a screen, talking to a patient and a lot of times the screen is between you and the patient if you're not really careful. Whereas with a paper chart, when you brought in a chart you needed to put it on something, so nurses were more inclined two or three years ago to sit down at the bedside and talk to the patient and then assess them and sit there and chart what they saw. Or to interact with the patient directly, step outside the room, drop down the drop down box, and chart outside the room after they were done. Here you're bringing a computer directly into the room and there are now three people in the room, you the patient and the computer. (3West Nurse)

These examples of nurse's experiences with Epic are testament to the fact that, for good or bad, nurses on patient care units adopting electronic documentation systems are more tightly connected to and dependent on information technology than ever before in the conduct of their work practices.

4.2 Handoff – Maintaining Continuity of Care between Nurses

> "Continuity of care is concerned with the quality of care over time. There are two important perspectives on this. Traditionally, continuity of care is idealized in the patient's experience of a 'continuous caring relationship' with an identified health care professional. For providers in vertically integrated systems of care, the contrasting ideal is the delivery of a 'seamless service' through integration, coordination and the sharing of information between different providers. As patients' health care needs can now only rarely be met by a single professional, multidimensional models of continuity have had to be developed to accommodate the possibility of achieving both ideals simultaneously. Continuity of care may, therefore, be viewed from the perspective of either patient or provider." (Gulliford et al. 2006, p. 248)

Continuity of care is necessary for the effective delivery of health services. For inpatient services the need for continuity of care is based on the requirement that patients receive care on a 24 hour basis while clinicians can only work on shifts. Therefore, patient care units must have procedures designed to facilitate continuity of care from one shift to the next. At Urban Hospital the specific procedures used on each unit were at the discretion of the unit's nurse manager, but on all units the expectation was that the nurses ending their shift would remain on the unit until the nurses starting their shift had been sufficiently advised on their patients. The

procedures for maintaining continuity of care on patient care units at Urban Hospital were collectively referred to as "handoff".

A nurse on a patient care unit at Urban begins her shift by getting her patient assignments for that shift. The assignment of patients depends on a variety of factors which are not germane to the discussion of handoff except that a nurse can be assigned patients that were assigned to multiple nurses on the previous shift. In other words, handoff is not necessarily a one to one exchange between incoming and outgoing nurses, and this can add to the complexity of the handoff process, particularly when certain methods of handoff are used. With her list of assigned patients, the nurse can begin identifying relevant information about each patient that will enable her to provide appropriate care for them during the course of her shift. Relevant information can be obtained from the patient chart, but the outgoing nurses typically possess additional knowledge that is not in the patient chart or is not readily apparent in the chart. Therefore, the outgoing nurses are always required to "give report" to the incoming nurses on the current state of the patients in their care. Prior to the implementation of Epic, giving report on 3West and 5South was either done verbally or by tape recording.

Verbal report means that two nurses sit down face-to-face and discuss each of the patients being handed off. The outgoing nurse typically has notes that she wrote over the course of her shift which remind her what to tell the incoming nurse. The incoming nurse writes down important pieces of information that the outgoing nurse is telling her and asks for clarification when necessary. Patient care units might have special "report" rooms where nurses can have some privacy to give report, or a common room, like the nurse's break room where all the nurses will congregate at the same time, might be used for verbal report.

> "We were face to face for half an hour before and after shifts and it just seems archaic now the way we used to do it. In fact we laugh about how we all used to get together in

> one room and shout over one another and I don't know why we did that either. We had a whole floor but we'd all be in the break room trying to shout over each other. In fact we were just talking about it the other day, can you believe how we used to give report? That was so crazy!" (5South Nurse)

One of the challenges with verbal report is that it can be a very time consuming process, especially when the handoff is not a one to one exchange of patients between individual nurses. One nurse on 5South reported that she had to handoff to as many as five other incoming nurses, "because we have so much turnover on the floor and they usually try to make assignments geographically, so if I lose a few patients in my group then I will pick up others." Another nurse on 5South described the challenge of conducting verbal reports with multiple nurses.

> "It's harder to give verbal report as far as getting out on time because the team I have, the next nurse that comes on, she won't necessarily have every one of my patients. So I might have to give report to more than one nurse and if I'm talking to one nurse and the other nurse is taking report from another night shift nurse, if I'm done and they're not, I've got to wait, just sit and wait. And everybody has to go through that. So that's kind of an issue of waiting and not getting out on time." (5South Nurse)

An alternative method for giving report, which addresses some of the issues with verbal reporting, is the use of tape recorders. The outgoing nurse sits down before the end of her shift and audio records her report on each patient using a tape recorder, and then the incoming nurse listens to the taped reports on her assigned patients when she arrives for her shift. The advantage to tape recording is that the outgoing nurse only needs to provide a few verbal updates and clarifications to the incoming nurse, which reduces the time required to verbally handoff between shifts. The incoming nurse is also able to listen to the recording at her own pace and refer back to it if necessary.

Unlike 3West and 5South, CVICU had used a written communication sheet for their handoff report. The communication sheet was developed to include all pertinent patient information for the unit's nurses and a separate sheet was maintained on each CVICU patient

during their stay on the unit. The CVICU nurses updated the communications sheets during their shift and used them to handoff to the incoming nurses.

With the implementation of Epic, some of the nurse managers decided to change their unit's handoff procedures to make use of the new EMR system. Handoff reports, in whatever form they take, are not kept as a part of the patient's permanent record because they are meant only to facilitate continuity of care and often contain "off the record" comments. Epic did not have a specific handoff function, but it did have a built-in function called "Dear Staff" which was a freeform textbox that, unlike the rest of the documentation system, did not become part of the patient's permanent medical record. The Dear Staff function was designed to afford all medical staff the ability to share information that is "off the record" with each other through Epic. For example, a nurse might want to note that a patient's family is belligerent so that other staff members would be prepared when they interacted with those family members. The Dear Staff function allowed that kind of communication, but there was a 2,000 character limit on the information that could be stored in the textbox, and only one instance of the textbox is available per patient for the length of the patient's stay. Therefore, all staff wishing to use the function shared that space and deleted, modified, or reused information previously entered.

Some of the nurse managers decided to use the Dear Staff function on their units as a way to enable the handoff process through Epic even though it was not specifically designed for that purpose. The expectation was that anything that would have been exchanged in the verbal report or included in the tape recordings could safely be included in the Dear Staff textbox, since it would not become part of the patient's permanent record.

> "I had a guy that wouldn't get out of bed and in my electronic handoff I said you know, I've used every skill that I have to get this man out of bed other than dynamite! And I can use words like that because it's not part of the permanent record." (5South Nurse)

The Dear Staff textbox feature therefore was transformed from a space designed for general "off the record" communication between all medical staff to a tool that specifically supported the unit nurse's needs for handoff reporting.

> "We really utilize the Dear Staff. That's our ongoing shift hand off so that things are kept track of, because otherwise there's really not a way to keep track of significant events easily over a period of time. You can go through and you can look at everybody's notes, but just because they have a note in there doesn't mean that it's pertinent to what you need to know right then." (CVICU Nurse)

This appropriation of the system had several effects that both enabled and constrained the work practices of the nurses using it.

The Dear Staff textbox could be modified as often as necessary, so as relevant information was identified during the course of a shift, the nurses could update the content of each patient's Dear Staff textbox to serve as their handoff report for the following shift.

> "I usually start my reports around one o'clock updating them. And then, after I make that first update, if anything new, any new orders or anything else comes up, then I will immediately update my report after I get those." (5South Nurse)

Because it was a freeform space, the Dear Staff textbox provided functionality similar to the tape recordings where nurses had the freedom to structure their information as they saw fit. However, one significant difference was that information in the Dear Staff textbox was carried over from shift to shift and could therefore be reused. With tape recording the expectation was that a nurse started from scratch and included the patient's entire history in each recorded report, but with the Dear Staff textbox that history could be kept from shift to shift and only new information needed to be updated as necessary.

> "You never have to go through the same story over and over again. You just have to update. Maybe you just have to add a couple of sentences at the end of your shift instead of having to go through the whole thing. Just putting updates in instead of going through the whole story of why they came in and their whole history. I mean tape recording would sometimes take 45 minutes and now updating a handoff takes a few minutes." (3West Nurse)

Use of the Dear Staff textbox also overcame the issue of waiting to get verbal report from an outgoing nurse.

> "It's nice to know, I've got rooms this, this and this. I go straight to my computer, I pull those people up and put them in my little team cluster on Epic and I just go right to town and I do my thing. I don't have to come in like old times and say oh man you know, where's this nurse? I can't find her so I guess I can't start report, I've got to wait, because that's happened before. I've been ready to get report and they were in another room doing a dressing change or giving pain meds or whatever so you have to sit and wait. [With handoff in Epic] I can get the ball rolling and at least get the information about my patients. There's been some times where I've had some questions that I've needed to ask the nurses. If they've been a little busy, at least I've got the gist of what's going on with my patients. It's not like I'm sitting there, I don't know a thing about them. I got the report but there's maybe one or two questions I need answered. But for the most part I've got my report, I can pretty much get started if I needed to, you know what I mean? I think I can speak for everyone and say that we're all pretty satisfied with handoff." (5South Nurse)

Of course reuse also had its downside if nurses did not edit the existing information to keep it all current. With tape recording or verbal report the incoming nurse knew that the information was current because it was either just recorded or just told to her. With the Dear Staff textbox the incoming nurse did not necessarily know what information was current and what information was out of date because the textbox didn't track changes.

> "People don't update the report as thoroughly or as appropriately as they should, because they say, "today had an x-ray and had two units of blood" and that was on day shift. Then it goes to evening shift and they don't change it, so it's saying this shift got two units of blood and you're thinking okay they just had the blood and then you find out no that was close to 24 hours ago. So the thing about "today", "tomorrow", words like that don't get changed and then it can get confusing. (5South Nurse)

The 2,000 character limit also became a problem for the nurses when patients were in the hospital for some time and the information in their Dear Staff textbox reached the character limit.

> "Once you have a patient that's been here so long it gets hard to go into much detail on the hand off because you have to go back and figure out what to delete so that you can keep going. You try to delete things that aren't necessary or try to abbreviate things, but then that gets to be a hassle because you've got other things you want to do and instead you're just trying to figure out how to write in your update." (3West Nurse)

A final challenge that nurses experienced using the Dear Staff function for handoff was that the organization of information in the textbox varied by nurse depending on the nurse's preference for representing the handoff information and some nurses did not provide the same type of information in the Dear Staff textbox that they would have provided in a verbal or taped report.

> "It's not that this is Epic's problem, this is the user's problem. They don't put in the same information that they would be giving us if it was an oral or tape report. They would go down and say okay they have an IV, this is what the IV is, this is where it is. Half the time now they don't even tell us [in the handoff report]. They'll leave that out or they'll say they have a foley but they won't say what the foley put out. They won't give us I's and O's which is sometimes important. Yeah, you can go and click on I's and O's and see it, but when you're getting report sometimes you like to have all that information right in front of you so you know right away where your problems might be." (5South Nurse)

These issues prompted some of the units to move toward a standardized template for the handoff report in the Dear Staff textbox, although that had not yet been fully implemented on the units I was studying.

> "We're actually working on a template to standardize our report system because when you have a patient who's been here for a long time, we have 2,000 characters which is all you can write in that box. So if a patient has been here for a month, you probably have already hit your 2,000 characters, so what would you delete. There's got to be some way to standardize, so we're working on a template." (5South Nurse)

These various issues have resulted in a procedure that most agree has improved the handoff process over previous methods, but which could still benefit from improvements both in the way the function works and in how it is used by the nurses.

4.3 Medication Pass – Nurses, Their Patients, and Epic

Following handoff, the incoming nurses would begin the performance of their shift duties on the patient care unit. One of the primary patient care tasks assigned to nurses on inpatient care units is the administration of medications to their patients. As assistants to the nurses, techs

may perform many of the same tasks as nurses on the patient care units, but the administration of medications is a task that only registered nurses may perform. At Urban Hospital this procedure is known as "medication pass" and, as the CNO mentioned in her description of the WOW distribution process, medication pass is performed at four-hour intervals during the day which are fairly standard for most hospitals: 9am, 1pm, 5pm, 9pm, etc.

Doctors give various orders for the treatment of their patients and medications are frequently ordered. When an order is placed for a medication, the medication is added to the patient's medication administration record (MAR) and the order for that medication is sent to the hospital pharmacy. It is the pharmacy's job to verify the medication prescribed by the physician and then deliver it to the unit for administration to the patient. Figure 8 shows an example screen from the Epic MAR that includes current medications in white and discontinued medications in yellow. It is the MAR that nurses use to guide their medication passes.

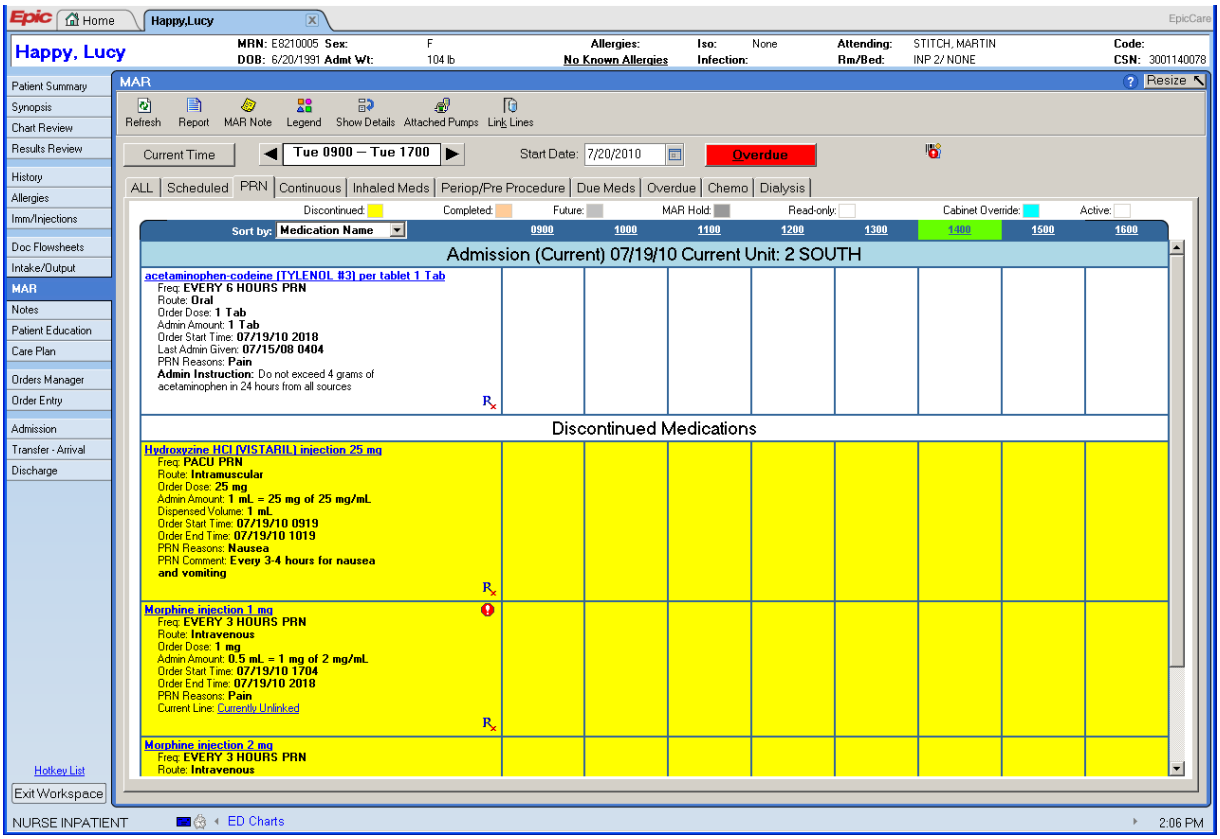

Figure 8. Epic Medication Administration Record Screen

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) sets standards for healthcare practice and certifies healthcare organizations for compliance with those standards. JCAHO standards for medication management require that all medications be secured either in a locked container or locked room or kept under constant surveillance at all times (Rich 2004). The hospital pharmacy is a secured environment, but medications must also be stored on patient care units to facilitate timely administration of those medications to patients on the unit. Typically a medication cart or cabinet is used for this purpose and Figure 9 shows a picture of one of the medication carts used on 5South. The carts on 3West and 5South used a keypad access system for security and both units had multiple carts that were each configured to provide medication storage for a set of patient rooms on the unit. For each patient room serviced by a

medication cart, one drawer on the cart was assigned to that patient room and the pharmacy filled the drawers with the prescribed medications for each patient.

Both 3West and 5South used medication carts, but prior to Epic and the introduction of the WOWs they used them in different ways. Specifically, on 5South the nurses took the medication carts with them into the patient's room to pass their medications. They got the patient's chart, which contained the MAR, and set it on top of the cart along with any additional supplies they needed to administer the medications and then pushed the cart into a patient's room. This allowed the nurses to dispense the medications directly from the cart drawer and provided them a desktop surface to keep the chart and write in it while passing their medications.

> "The medication carts had ten drawers in them for all your supplies and medications and they'd push their cart everywhere, but that's kind of indigenous to 5South. And they used to push the cart to the bedside because joint commission requires, for patient safety, that there can't be any interruption between preparing the medication and giving the medication to the patient. So you have to be at the bedside, but that cart was so big it was really difficult entering a room and getting to the bedside." (5South Nurse Manager)

Figure 9. 5South Medication Cart

In contrast, the nurses on 3West did not take their medication carts into the patient rooms. Instead, the nurses took the patient chart to the medication cart and from the MAR determined which medications and supplies to take with them into the patient room for that particular medication pass. They then carried the chart, medications, and supplies by hand to the patient's room and set everything on a table or tray in the room. An irony regarding this arrangement was that the medication carts on 3West were smaller than the carts used on 5South so it would have actually been easier to take the 3West carts into the patient rooms for medication pass. Figure 10 shows a picture of one of the carts used on 3West.

Figure 10. 3West Medication Cart

Before passing medications a nurse had to confirm that five criteria were present: right patient, right medication, right dose, right route[7], and right time. The right patient was determined by the identification bracelet that all patients wore on their wrist during their hospital stay. Prior to Epic the nurse was supposed to visually check the bracelet to confirm the patient's identity before passing any medications. The labels on the medications in the medication cart were visually checked against the information on the MAR to confirm the right medication, right dose, right route, and right time. Once a match on all five criteria had been confirmed, the nurse could then safely administer the medication to the patient.

[7] Route is the mode of medication delivery (e.g. orally, intravenously, etc.)

With the implementation of Epic, the hospital moved to an electronic verification system for medication pass. Specifically, Urban began using barcodes to uniquely identify both medications and patients and the MAR became part of the Epic electronic documentation system. The patient identification bracelets were printed with a barcode and the pharmacy began applying a barcode to all medication doses that it dispensed. As described earlier, the WOWs included barcode scanners that were to be used for medication pass and no computers were installed in the patient rooms, except in the ICUs. This configuration required the nurses on 3West and 5South to take a WOW into the patient's room to perform their medication passes. Because the medication carts were bulky by themselves, this made it impractical for nurses on 5South to bring the medication carts into the patient rooms along with the WOWs, although they certainly could have done so.

On both 3West and 5South the nurses shifted their work practices to accommodate the WOWs and their barcode scanners and in doing so the process of medication pass on both units became more like each other. Specifically, on both units the nurses began taking their WOWs to the medication cart to collect the medications for their medication pass. They put the medications on their WOW along with any necessary supplies and took the WOW into the patient room to pass the medications.

Once at the bedside, the new procedure for medication pass required the nurse to first scan the barcode on the patient's identification bracelet, which automatically opened that patient's MAR in Epic. The nurse then scanned a medication barcode and Epic confirmed that the scanned medication had been prescribed to be given for that patient, at that dosage, through that route, and at that time. If any of the criteria were inaccurate, Epic was designed to display a flag to warn the nurse of the discrepancy. The nurse had the ability to override the flag in order

to continue with the administration of that medication if she determined that it was appropriate, but the flags often identified genuine errors that needed to be addressed.

> "I remember when we first went up on Epic. I went to give a medication, I looked at the medication, it sounded like, looked like, acted like, but it was the wrong medication. I went and scanned it and [Epic says] there is no medication for this and I'm like looking at it and it was Prozac and something else and they were real similar and I mean there was just a couple of letters that were different. It was really weird. This is what they call a near miss! It was a new thing that had come out and it was like oh okay that's interesting, the computer just saved me from making a med error." (3West Nurse)

The nurse was also required to scan her own identification badge on an RFID reader on the WOW to confirm her identity as the clinician passing that medication to the patient. This set of procedures was meant to reduce human error in the administration of medications and provide better tracking of medication pass activities, which it did according to the nurse managers.

> "We used to have a lot of medication errors on 5South. We'd probably have about fifteen a quarter which really isn't that many when you give over 30,000 medications in a very short time, but now it's maybe one every once in a while because the system stops you." (5South Nurse Manager)

The 3West Nurse Manager also indicated that medication errors on her unit had decreased from around 10-15 per quarter prior to Epic to one or less after they started using Epic for medication pass.

This set of procedures became the standard for medication pass at Urban Hospital, and nursing administration was able to keep track of nurses' compliance in following the correct procedures through Epic's data capture of system events. The CNO explained the hospital's policy on compliance with the medication pass procedures.

> "I'm alright if they work around something as long as it still promotes safety, it's legal and it gets to the same end point. But there's only one way to do barcode med administration and the policy says you have to do it at the bedside, so people who don't do that are automatically in the discipline system. Now there are some exceptions to that in a code situation or if the scanners are down, but every month I get a report and so does every manager and every director. And I can tell every nurse in this hospital how many doses of medication they gave, how many times they bar-coded the medicine and how many times they bar-coded the patient. So if people are in what I call the 50/50

> club, we have a very different conversation than the 95/5 club. Meaning 95% of the time I did it versus 50%. We gave them some leeway in the beginning, they were learning. But now, if you're in the 50/50 club, you're probably not going to have a very long tenure at [Urban] Hospital." (Chief Nursing Officer)

The goal of 95% compliance described by the CNO conceded that there would be occasional circumstances that necessitated a deviation from the ideal standard of 100% compliance, but that exceptions were to be limited. This meant that the nurses had the ability to override warnings from Epic and give the medications in spite of those warnings or to bypass the scanning procedures entirely when necessary (e.g. cardiac code situations), but those actions were tracked and nurses were required to explain specific deviations from normal procedures.

> "You go in and you scan the medicine and if you haven't scanned the patient first it pops up a little box. If you scan the patient at that time then that still reports you as not scanning the patient on their reports. So they write you up over it. So my scanning percentages were way down because I would do that, I would do the med and then the patient. I'm scanning and I don't know why it's coming up like this and they said 'are you scanning the patient first'? And just that little thing made a huge difference. I mean it was 60-70% scanning versus, after they told me, 92-93%. The other 7% is if you're doing something that's an emergency you just give the med, you don't worry about the scanning. You take care of the patient before you do the computer." (CVICU Nurse)

In addition to these issues, there were more serious deviations that occurred when the barcode scanners were first introduced. Some nurses made copies of the patient's identification bracelet and conducted their barcode scans at the medication cart so that they could just pass the medications to the patient without taking the WOW to the bedside. This was a major violation of hospital policy that was not tolerated by nurse management.

> "We've taken a very strong line about that and in the beginning we did have people who took them and printed out arm bands and stuck them on a sheet of paper and those people no longer work here. And so if people get caught violating the system intentionally, they are terminated immediately." (Chief Nursing Officer)

In addition to the required procedures for medication pass at the bedside, there were also standards and guidelines for the handling of medications in preparation for administering them to the patients. JCAHO required that medications be either locked in a container or under

surveillance by an authorized clinician at all times. The medication carts provided a locked container, but the nurses were taking the medications out of the cart and placing them on the WOW to take them into the patient room. The nurses on 3West had already been working this way prior to Epic, since they never took the medication carts into the rooms, but the nurses on 5South found that with the WOWs they had to adjust their work practices to keep the medications secure between the medication cart and the bedside while maintaining a level of efficiency in how they conducted medication pass.

> "I don't know if it's the right way or wrong way but this is what I do. I baggy all my patient's meds and label the bag that this is this particular patient's meds. I write the med down and get it out and baggy it and label it that it's that patient so I have all my patients' meds for all five of my patients and I just start with one and then when the bag is empty I put it away. That's the way I do it to keep myself organized. I know some nurses go individually, run in and out of the rooms. It just saves some time." (5South Nurse)

> Some people will take the whole drawer, but because it's kind of a double check for me, I will sit at the computer and pull out what's on the Cardex and take only the medications they need at that time in with me. That's how I do it. (5South Nurse)

This challenge was compounded by the fact that medication pass typically required certain tools and supplies (e.g. syringes, alcohol swabs, tape, etc.) that weren't kept with the medications but had to also be retrieved before going into the patient's room.

> "Sometimes you think you've got everything, but you're missing the right kind of syringe and you don't realize it until you're in their room and if they're in isolation you're all gowned up and then you have to go back out just to grab another syringe. Or you think you have enough alcohol swabs and then you realize that you didn't." (3West Nurse)

Because the WOW had a desktop surface and a storage bin, the nurses often kept some of these supplies on their WOW to keep from having to run back and forth from the patient's room to the supply storage areas during medication pass. Figure 11 shows a picture of one of the WOWs with various supplies on the desktop and in the wire storage basket.

Figure 11. WOW with Supplies

For example, the use of the WiFi antenna to hold medical tape (see Figure 9 just below and to the left of the monitor) was a common sight on the units, and the wire baskets were used to hold all sorts of things. In Figure 11 the wire basket includes a box of latex gloves, syringes, a stethoscope, and a bottle of Lipton iced tea. Infection control guidelines called for minimal exchange of items between patient rooms, which included the supplies seen on most WOWs, but it was a common practice on both 3West and 5South for nurses to load up their WOWs with

supplies needed for medication pass and other patient care activities. The WOWs, in fact, became a sort of mobile office space for many of the nurses during their shift.

4.4 Orders – The Physician/Nurse Relationship

Nurses on inpatient care units had an important and unique relationship with physicians. This relationship was quite different from the peer-to-peer relationship between nurses that enabled continuity of care on patient care units. Physicians were ultimately responsible for the treatment of their patients admitted to patient care units and therefore their relationship with nurses was a hierarchical one, with the physician in the position of authority. Because physicians spent relatively brief periods of time on the unit, they delegated responsibility for patient care to the unit nurses who were able to provide round-the-clock care for those patients. That delegation of responsibility came officially through written orders from the physicians, but physicians also engaged directly with nurses both in person, when they come to the unit to see their patients, and over the phone when necessary. These interactions allowed the physician and nurse to coordinate their efforts to maximize the effectiveness of the care prescribed and carried out for the patient.

> "I've always been one that when the physicians come around I make sure that I get up, go in the room with them, discuss any issues that we may have and come up with a plan and go with it. Some of the younger staff, they're still afraid of the doctors and they have a hard time talking to them so they kind of shy away, but then stuff gets missed." (CVICU Nurse)

There are many types of orders that physicians made for their patients including medication orders, activity orders, dietary orders, nursing orders, and consult orders, among others. Figure 12 shows a patient summary screen in Epic where nurses could view a list of

current orders for a particular patient. Some orders were written for other clinicians and hospital services but many were directed to the nurse for action.[8]

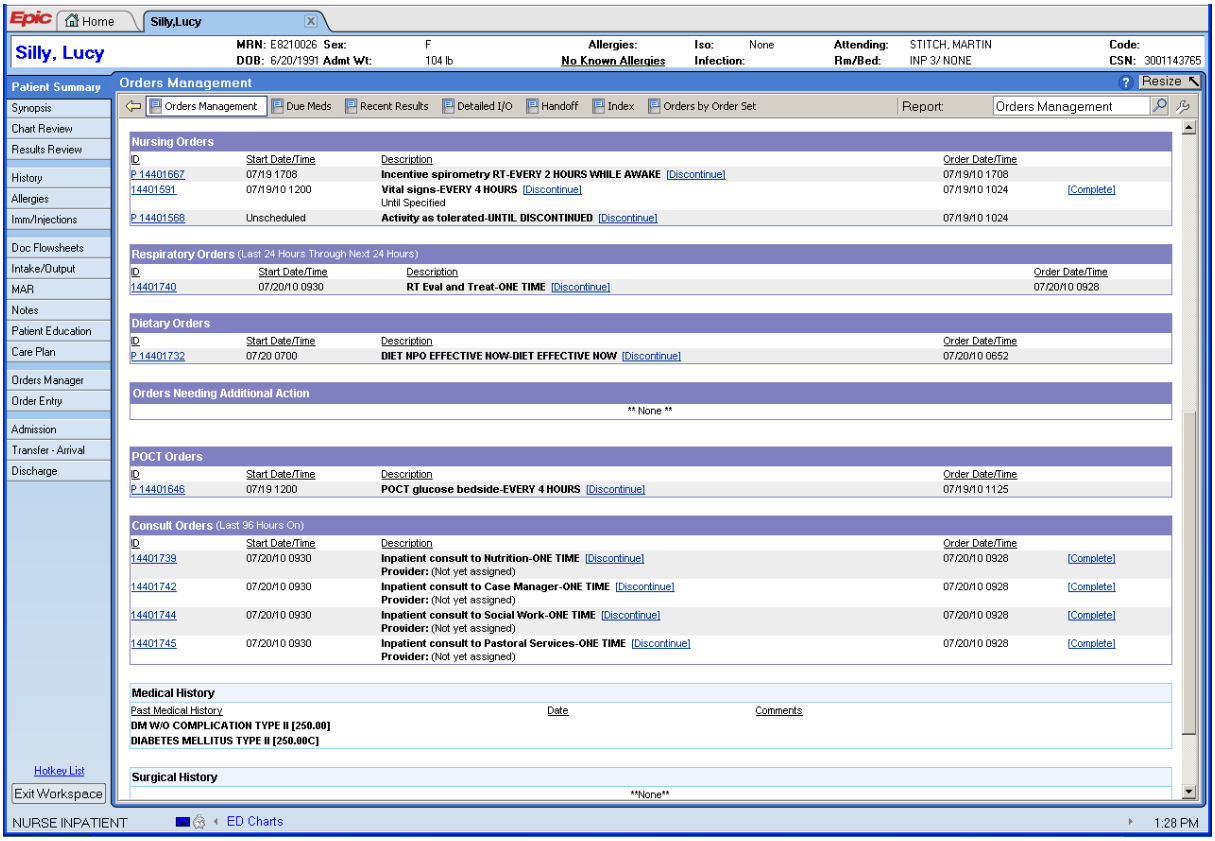

Figure 12. Epic Orders Summary Screen

Orders needed to be documented in the patient chart before they could be carried out and they were often added directly by the physician. However, they could also be given to the nurse verbally who then verified the order and added it to the chart on the instruction of the physician. When paper-based documentation was in use, the orders had to be written into the physical patient chart, which was only available on the unit, and therefore when physicians were not able to come to the unit they had to verbally relay their orders to the unit nurse who wrote the order

[8] As an Occupational Therapist in an acute care hospital, my orders to provide therapy services came directly from the patient's physician, although I typically coordinated with the patient's nurse on the unit before starting my therapy sessions.

into the chart. This process was difficult for the nurse, especially when the physician wanted to give multiple orders over the phone.

> "When you talk to a physician on the phone and you get an order from a physician on the phone, you're supposed to write it down, read it back and verify it before you put it in [the patient record]. They are not going to wait around for that. They really get very frustrated with us when we try to do the process correctly. And when you're giving somebody ten orders, that's a lot to write down, read it back and then verify it. They're not very patient." (CVICU Nurse)

While this need to add orders to the patient chart for the physicians was time consuming, the nurses did gain the advantage of knowing when new orders were added to the chart and they were also more likely to be able to read the orders. Legibility of orders written by physicians in a paper-based environment was often an issue. Physicians are notorious for having poor handwriting and nurses reported spending considerable time trying to figure out what the physicians had written in the chart.

> "We used to walk around with order sheets trying to see if somebody could make this word out and sometimes we'd have to end up calling the doc." (5South Nurse)

Another characteristic of the paper-based patient chart was that clinician notes were not all kept in the same section of the chart. All clinicians wrote notes in the patient chart that detailed their interactions with the patient and the patient's status and progress from their perspective.[9] The paper-based chart was organized so that physician notes were in one section and nursing notes were in another, which meant that the physicians would consciously need to go to the nursing notes section if they wanted to read what the nurses documented on their interactions with the patients. Many of the nurses felt that, because of this chart structure, the physicians would rarely read the nursing notes, which meant that they could not rely on it as a way to share information with the physician. If they wanted to communicate with the physician

[9] As an Occupational Therapist I would write notes in the patient's chart describing the therapy activities I performed with the patient along with my assessment of their progress since our last session and my recommendations for additional therapy needs.

they would need to leave a note on the cover of the chart that the physician would hopefully see and read, or they would have to call the physician or wait until the physician came to the unit to see their patients and talk to them at that time.

> "Nursing notes are in one section and physician notes are in a completely other section of the chart. Physicians may never even look at the nursing chart when they were doing paper charting. We had a little tri-fold chart and we'd do our stuff. They may have never even looked at it for all I know. They did their own assessment, they did their own progress note, they had their soap note and that was their thing. When you were doing paper charting you left a note in the front of the chart, a little yellow slip in the front of the chart. So if you missed the physician he may have put an answer right there on the paper chart to your question. But I think if you had any additional questions after that it may be difficult to get a hold of them." (3West Nurse)

With the implementation of Epic, physicians were given the ability to access the electronic patient chart, not only from any computer in the hospital, but also from anywhere they had a computer with internet access. This gave them tremendous flexibility in their access to the patient chart and allowed them to have more direct control over the input of orders whether onsite or away from the hospital.

> "The wonderful ability that physicians have to view from home, put in orders from home, put in orders here on different floors, you know that's huge. That's huge for a physician not to have to leave one floor to come to another floor to address a situation. Or to wait on a phone while one nurse gets the orders and another nurse verifies the orders." (3West Nurse)

The nurses felt this improved access to the patient chart by the physician was beneficial to both their relationship with the physician and to the relationship between the patient and the physician. One nurse described how the physician could be anywhere in the world and still place orders and maintain an awareness of what was happening with her patients.

> "On weekends, you used to be pretty sure when they rounded you'd have orders and then you wouldn't see them until next morning. Now they're looking at it all day, all night and from overseas. And you'll get a call or you'll get an order placed and you go, 'I thought she was in Italy?' Well she is but she wants them to have potassium or something. That's amazing! And that's a big positive to the patient because they'll say 'I haven't seen my doctor since 5:00 this morning and I was so sleepy' and I can tell them, 'well he's reading everything that I'm doing today so don't worry about that.

> He's following what's going on and he knows exactly what's going on. If you've got a question I can put it in the chart and he'll pick up on it today.'" (5South Nurse)

Another nurse described how the perception of her work and her relationship with the physicians changed once the physicians were able to add orders from anywhere and at anytime.

> "I feel like overall it helps things happen quickly in terms of the doctors being able to put in orders and us being able to follow through with the orders. Sometimes a little bit too fast because you're just barely getting done with one thing and all of a sudden you'll look at your computer and there's three new orders on patients. And if it's the end of a shift and say an order was put in at 6:30, you'll think 'I don't have time to do that,' but then you feel bad for the shift coming in and you don't want to look like a slacker. It used to be in the old days you just had to check their chart every two hours to make sure there weren't new orders. But you know I think instantly is good. Overall I feel that things get done faster and I don't mind that. But sometimes you'll feel in your mind I have my next hour booked and then you get another new order and you're like when am I going to do this?" (3West Nurse)

This interaction with the electronic patient chart by the physicians also extended to other parts of the chart. A nurse on 5South reported that some physicians actually read the Dear Staff handoff report because they commented on things the nurse had written there, and she felt this provided them with better insights on the nurse's interactions and concerns with the patients.

> "I think maybe they've got a better idea what's going on with the patient because we do the electronic handoff and I noticed, although it's meant to be a nurse-to-nurse shift thing, I notice the doctors read that and they might comment to me about something …. I had a guy that wouldn't get out of bed and in my electronic handoff I said you know, I've used every skill that I have to get this man out of bed other than dynamite…in my staff to staff I can say something like that, but then I'll have the doctor saying to me hey, maybe I'll have to write for that damn dynamite that you want." (5South Nurse)

With Epic, all clinician notes were kept in the same section of the chart which made it easier for any clinician, including the physicians, to notice notes from other clinicians and take the time to read them. The nurses therefore felt that it was now much more likely that the physicians would read their nursing notes and in doing so improve their understanding of the interactions between the nurse and their patients.

> "I think they see more of our nursing notes that we put in Epic or interdisciplinary notes because they'll say to me if they come in and look at the person's stuff, they'll go oh I

saw you put this note in about Mr. Jones and talk about it…before they wouldn't have saw my note that Mr. Jones was trying to climb out of bed and acting all crazy." (3West Nurse)

One other improvement in the relationship between the physician and nurse was that with access to Epic on their WOWs the nurses could more easily reference information in the patient record when communicating directly with the physician.

"Before when a doctor would call you back you'd have to go to that patient's chart and if you're in someone else's room you'd have to stop what you were doing. But now I always have my computer with me so when you're communicating with a physician all of your information is right there for every patient." (3West Nurse)

I was observing on 5South one day and saw a nurse come out of a patient room with her WOW. She turned and saw a physician down the hall and proceeded to push her WOW down the hall to the physician. The nurse and the physician then engaged in a conversation in the middle of the hall that included information the nurse was pointing out in Epic.

To the nurses these were all very positive changes in their relationship with the physicians. However, not all changes in the nurse/physician relationship following the implementation of Epic were positive and even though the physicians had gained greater access to the electronic patient record that did not mean they all made use of that access. Some of the physicians initially refused to learn to use Epic and one of the nurses described how that had affected the nurse's initial use of the system.

"A lot of the physicians did not attend the training sessions that they were supposed to so they expected the nurses to pick up the slack. We were struggling to keep our part afloat and at the same time trying to figure out their part of it." (CVICU Nurse)

The physician's reliance on the nurses for help with Epic also included asking them to enter orders in the system, even though the physicians were no longer supposed to ask the nurses to do that now that they could enter orders from anywhere.

"A lot of the veteran doctors who have been here for a while, they just wash their hands of Epic. A lot of them as soon as they sit down they will call a nurse over to sit with

them to help them navigate through or they'll just give them the order to do it because they don't know how to navigate." (5South Nurse)

"They like to do the drive by of 'okay I want this to happen, this to happen, this to happen but I don't want to take the time to sign in and put that there.' So that does still happen." (CVICU Nurse)

This had the effect of increasing the work load for the nurses. They had the right to tell the physicians to enter the orders themselves, but in most cases the nurses found it easier to just comply with the physician's requests.

"I would say that there were a lot of nurses that felt that they were still doing work that they thought would not be theirs. Their perception was that it was going to become physician workload and it took quite a while for us to get to the point where that decreased, I believe significantly. And what I mean by that, is the understanding that physicians would put in all orders, they would reconcile all medications, etc., etc. and in fact they weren't, they didn't do that consistently. So work that needed to be done many times was being done by nurses." (Clinical Educator)

"Every now and then we'll get verbal orders from the doctors and sometimes I find it easier if they give us a verbal order for a medication, just to put it in because usually they're giving us a verbal order for medications because the patient wants it right then and they're having pain or they're having nausea. So I find it easier if they tell me what they want, verify that with them and then put it in under their name and scan it, which we're allowed to do, although they prefer that the doctors do that. I don't like it when the doctor comes in and says 'oh I've got this new patient, here's all the orders that I want you to do.' I know there are a couple of doctors where we've wanted to say you need to put the orders in. We all argue about it, you should tell them they need to put that in there, but sometimes it's easier not to mess with it and just put the orders in." (5South Nurse)

Earlier it was noted that some doctors read and acted on the Dear Staff contents, which had been appropriated for handoff reporting by the nurses. Epic also included another textbox directly under the Dear Staff textbox called Dear Doctor that was meant for "off the record" communication to physicians. Some nurses found this to be an effective way to communicate with the physicians, but most reported that the physicians did not read the contents of the Dear Doctor textbox and no longer used it. The Dear Staff and Dear Doctor functions were not as directly accessible through the physician's normal Epic use as the nursing notes were, which

may explain its mixed use. Many physicians probably did not realize it was there or forgot that it was there.

> "Some of them do use it. I hate to say the really good ones, but the ones that are probably the most well-versed with Epic. They're going through their patient list each day and the good ones, I hate to call them the good ones, but they're the ones that will look and say, 'hey so and so hasn't had a bowel movement in four days so we need to give them this.' Well we ask for it so that's what we write in dear doc, 'hey will you please address this issue,' whatever it is, and they will usually even type a note back if they're really good. If not they'll at least put in an order and we know it was addressed." (3West Nurse)

In general it was mixed results like this that were evidenced across physicians and system functions. The general consensus was positive and many nurses had positive impressions and experiences in their relationships with physicians under Epic, but many others had negative feelings and experiences that seemed unlikely to be easily resolved. The discussion that follows will attempt to make sense of the results described in this chapter through the lens of affordances.

Chapter 5

Discussion

Gibson (1979) postulates that affordances represent environmental opportunities for behavior, which Stoffregen (2004) defines as all of the possible things that an animal can do in an environment or situation. The ontological position of affordances has been debated, with this dissertation taking the perspective that an affordance is a relational concept. Specifically, the theoretical arguments made by Chemero, who postulates that affordances are "relations between the abilities of organisms and features of the environment" (2003, p. 189), are taken as the basis for this research on affordances. In this dissertation on information systems research, an IS affordance has been further theorized as a relationship between features of an information system and abilities of an individual within the context of an environment. As an example from this study, an affordance for clinicians of the Epic EMR system is the behavioral opportunity to view and edit a patient's medical record. Access to Epic to view and edit a patient's medical record is an affordance that requires a combination of hardware, software, and network infrastructure along with the abilities to use those features correctly (e.g. the input of valid login credentials and knowledge of system navigation).

It can be argued that this affordance of access to Epic, as with all affordances, either exists or it does not exist (i.e. a nurse can either view and edit the patient record through Epic or she cannot). For example, if the hospital's network is down, then the affordance does not currently exist for the nurses at Urban Hospital because there is no way for them to access Epic without the network. Existence or non-existence of an affordance therefore represents a starting point for theorizing the affordance concept. Indeed, Gibson treats affordances as binary in nature because of his focus on environmental perception. Stoffregen uses this binary perspective of

affordance to argue how affordances are bounded in their scope when they encompass all action potentials. "If affordance includes all the things that an animal (or set of animals) can do in a given situation or environment, then it excludes the uncountably large number of things that the animal (or set of animals) cannot do in that situation or environment" (2004, p. 84). In other words, affordances represent a concept that, while broadly inclusive, is also focused on only those things that represent opportunities for behavior. Given that affordances represent all behavioral opportunities available to an individual, the existence of a particular affordance does not guarantee the opportunity will be acted on and the behavior completed by the individual. This raises the question of why some affordances are acted on and others are not, and this question is the basis for the concept of an "affordance threshold" discussed in the following section.

5.1 The Affordance Threshold

In Chapter 2 it was described how the perception of affordances and the goals of the individual provide reasons for why certain affordances are acted on while others are not. There is another reason why certain affordances are not acted on, even if they are perceived and even if they relate to the perceiver's goals. Specifically, the difficulty of acting on an affordance is a determining factor in whether or not it is used. As stated earlier, Gibson tends to treat affordances as binary (i.e. they either exist or they do not exist). However, other scholars recognize that an affordance exists within a range based on the degree of difficulty in acting on the affordance and this range becomes important for both technology design and technology use and relates to a technology's usability. In terms of the difficulty of acting on an affordance, Warren's (1984) critical and optimal points are at opposite ends of a continuum that McGrenere and Ho (2000) call the degree of the affordance, but which I call the affordance range. The

affordance range is a continuum of difficulty to act on an affordance between the critical and optimal points inclusively. Figure 13 provides a graphical illustration of the affordance range.

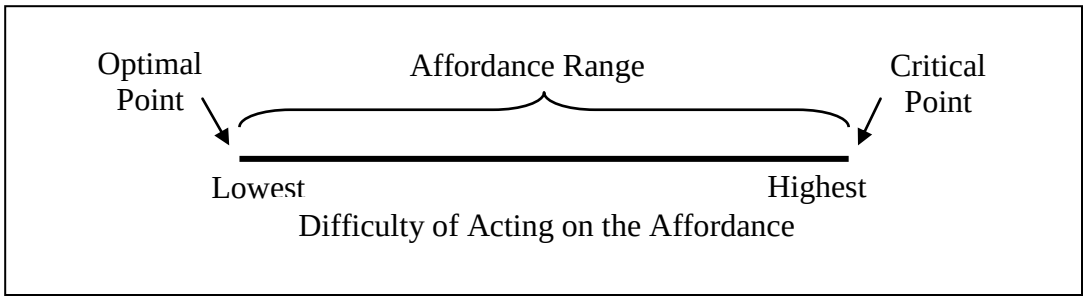

Figure 13. Affordance Range Graphical Illustration

McGrenere and Ho (2000) argue that understanding this affordance range is important and that we would benefit from developing language to describe affordances that exist between the critical and optimal points that Warren identifies. I suggest that within the affordance range there exists another important point; a point I call the "affordance threshold". The term "affordance threshold" has been used in other studies, but not in the way I am using it here. The term has thus far been used by a handful of scholars to refer to a point just short of Warren's critical point at which the affordance is still available, but just barely available. For Ishak et al. (2008) it was the smallest aperture that research participants could fit their hand through on 50% of trials; for Adolph et al. (2010) it was the steepest slope infants could walk down without falling; and for Franchak et al. (2010) it was the narrowest doorway research participants were able to pass through on 50% of trials.

In this research, I define the affordance threshold as a point within the affordance range at which important behavioral changes regarding an individual's use of the affordance are expected to occur. First, I argue that, if an affordance is optional for an individual, then, all other things being equal, as the difficulty of acting on an affordance increases, an individual will exhibit a

corresponding decrease in acting on that behavioral opportunity. However, I propose that the correspondence between difficulty and action is not constant across the entire affordance range. Specifically, I postulate that when the level of difficulty exceeds the affordance threshold the individual will be significantly less likely to act on it. In other words, the likelihood that an affordance will be acted on significantly decreases when the difficulty of acting on that affordance increases beyond the affordance threshold. Figure 14 provides an illustration of the affordance threshold and the theorized change in use expected beyond that threshold of difficulty.

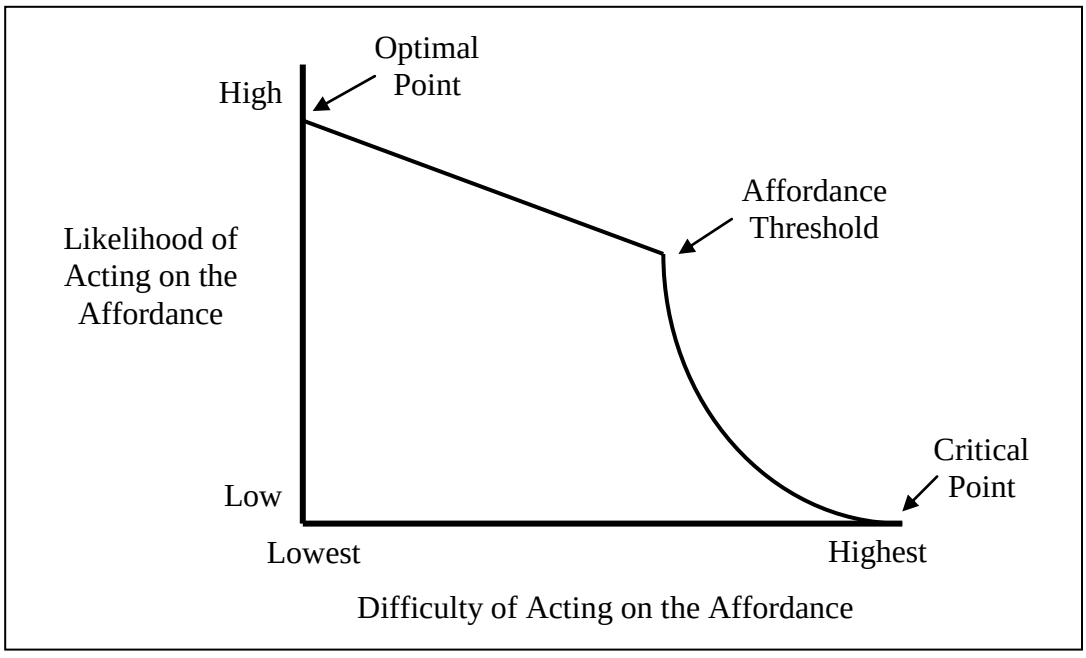

Figure 14. Affordance Threshold Graphical Illustration

The following is an example of this phenomenon from my study. The nurses at Urban Hospital were required to use Epic for their clinical documentation and in particular they had a specific set of procedures for medication pass that required them to use the barcode scanners attached to the WOWs or the bedside computers in the ICUs. Because there were both bedside

computers and WOWs in CVICU, the nurses on that unit had the option to use either one for medication pass as well as other clinical documentation. Given the login issues with Epic that were described in the results starting on page 58, I would have expected the nurses on CVICU to use the WOWs instead of the bedside computers so they could remain logged into Epic as they moved from patient room to patient room. However, because of the scrolling problem with the CVICU WOWs, which are described in the results on page 60, the nurses rarely used the WOWs on that unit. It is suggested that while the login problems increased the difficulty of using Epic, the scrolling issues with the WOWs increased the difficulty even more, to a point that the difficulty of using the WOWs was above the affordance threshold. This resulted in the CVICU nurses using the WOWs rarely or not at all. Figure 15 provides a graphical illustration of how the scrolling malfunction changed the use of the WOWs relative to the impact of the login issues effect on the use of the bedside computers.

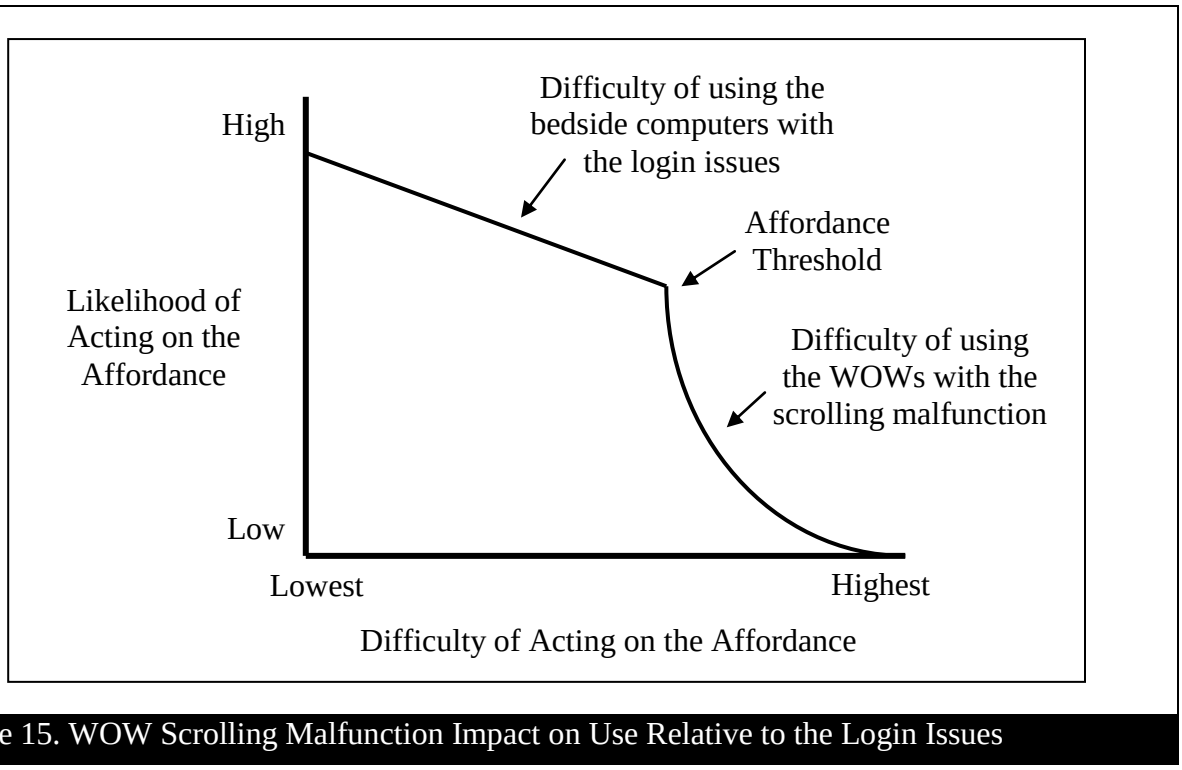

Figure 15. WOW Scrolling Malfunction Impact on Use Relative to the Login Issues

Another example comes from the use of the Dear Staff function for handoff reporting described on page 65. 3West, 5South, and CVICU had all decided to use the Dear Staff function for handoff and the nurses were expected to update the Dear Staff textbox on each of their patients before the end of their shift. However, one of the problems with the Dear Staff function was that it had a 2,000 character limit and, when a patient had been on the unit for a long time, that limit was often reached. Once the limit was reached a nurse wanting to add new information would have to either select existing content to delete or rewrite the existing content to make room for the new information. This problem, described on page 67, increased the level of difficulty of using the Dear Staff function for handoff reporting and prompted some nurses to provide handoff information to the incoming nurse verbally rather than spend the time trying to get it into the Dear Staff textbox. From the perspective of the affordance threshold, the difficulty of editing the Dear Staff textbox would, at times, move beyond that threshold, which would result in the nurse choosing not to use the function for that patient and switch to verbal reporting instead. This is also an example where the user's abilities are more at play in the positioning of the affordance in the affordance range. With the CVICU WOW scrolling problem, the user's abilities seemed to have a marginal impact on mitigating that problem. In the Dear Staff case, however, the nurse's typing ability and computer self-efficacy would be expected to play a role in the difficulty experienced in using the Dear Staff function for handoff reporting. Nurses less adept at typing and using computers would be expected to be closer to the affordance threshold already and would therefore be more likely to switch to verbal reporting when the character limit became an issue.

A third example was seen in the medication pass procedures on 5South. Prior to Epic and the introduction of the WOWs the nurses on 5South took their medication carts into the

patient rooms to pass medications. It was described in the results on page 74 how the use of Epic required the nurses on 5South and 3West to take a WOW into the patient room to pass medications because of the need for the barcode scanner that was only available with the WOWs on those units. This resulted in the nurses on 5South no longer taking the medication carts into the rooms with them. The medication carts were the same as they had always been and could still have been taken into the patient rooms, but the increased difficulty of maneuvering both a WOW and a medication cart into a patient room moved the affordance of doing so beyond the affordance threshold and from that point forward none of the nurses on 5South took a medication cart into the patient room.

So far the discussion has focused on affordances that are voluntary in nature (e.g. the CVICU nurses are not required to use the WOWs since they have the bedside computers for passing medications). Ontologically it could be argued that all affordances are voluntary since they represent behavioral opportunities rather than the behaviors themselves. Stoffregen (2003), in fact, used this argument to invalidate Turvey's (1992) assertion that affordances are dispositions, an argument discussed on page 17. However, there are certain affordances which, while voluntary in an ontological sense, may be mandated by work policies. For example, it was described in the results on page 75 how the procedures for medication pass were mandated and, while some exceptions were possible, nurses were expected to be at 95% compliance with those procedures. The CNO made the consequences for non-compliance quite clear when she stated that, "if you're in the 50/50 club [50% compliance], you're probably not going to have a very long tenure at [Urban] Hospital." Therefore, because of the potential consequences, the dynamics of use for mandated affordances are expected to differ from those of voluntary affordances. Specifically, an increase in the difficulty of acting on a mandated affordance

beyond the affordance threshold will not necessarily result in a significant decrease in the use of that affordance. Instead, an increase in difficulty will produce changes in other behaviors associated with the affordance.

For example, the nurses at Urban Hospital were required to use Epic for their clinical documentation. No matter how difficult and time consuming it might be to access Epic, the nurses were expected to use it. However, if the difficulty of accessing Epic moved beyond the affordance threshold, the nurses could be expected to change their behavior in other ways. One behavioral change that was associated with the issues regarding the logon process for Epic was discussed on page 61. When nurses perceived that the process of logging onto Epic was too time consuming they were less likely to follow proper security procedures and logout each time they stepped away from the computer. It was, in fact, not uncommon to see WOWs in the unit hallways that were logged into Epic with no clinician in sight. Figure 5 shows a WOW sitting in the hallway logged into Epic, but no one is at the computer. I argue that the lengthy login times increased the difficulty of using Epic beyond the affordance threshold for these nurses. However, since their use of the system was mandatory they instead compensated for that increase in difficulty caused by the login process by remaining logged into the system even when they should have logged out.

Another example of a change in behavior related to the login process was the decision by CVICU nurses to postpone their documentation to reduce the number of times they needed to login and out of the system, which was described on page 59. The expectation for clinical practice was to document as care was delivered whenever possible to reduce the potential for reporting errors. But even though the nurses recognized the value of that practice, the login issues with Epic constrained them to the point that they felt the need to compensate for that

constraint by postponing their documentation. Again, the nurses continued to use Epic, but they changed their use of the system in ways that differed from suggested practices.

A third example can be seen in the relationship between physicians and nurses in the dissemination of orders. A major part of a nurse's job is to carry out orders given by physicians. When paper-based patient records were still in use the physician's handwritten orders were often difficult to read. However, no matter how difficult they were to read and understand, the nurses were obligated to carry out those orders and therefore, rather than disregard the affordance of the order, the nurse would find ways of interpreting the order either by asking other nurses for help or by calling the physician and asking for clarification.

The concepts of affordance range and affordance threshold presented here are expected to facilitate a better understanding of both the design of information systems and the use of those systems. One consideration is the relationship between design and use of information systems and how the affordances of those systems exist within their affordance range. I suggest that information systems are designed to include affordances that lie much closer to the optimal point than those same affordances lie when the systems are in use. This discrepancy is due to the complex nature of information systems and the contexts in which they operate, where any number of features or environmental factors may influence the difficulty of acting on an affordance. Also, the range of user abilities that exist in practice is not always fully considered during design and yet that will often be a contributing factor in the difficulty of in situ affordance use. These issues are expected to be manifested through IS affordances which are much closer to the affordance threshold than they were intended to be in the design of the system. The consequences for use are that it becomes more likely that IS affordances will cross the affordance threshold and at that point their usage will drop significantly.

5.2 IS Affordance Complexity

The complexity of information systems that was just noted is a significant challenge for studying IS affordances and for understanding the relationship between their design and use. In the ecological psychology literature the focus has been primarily on simple actions like stair climbing, which involves a flight of stairs and an individual's physical climbing abilities. This is contrasted in the study of information systems where the IS affordances we are typically interested in understanding can be highly complex in nature (e.g. viewing and editing an electronic medical record requires a combination of hardware, software, and network resources along with multiple user abilities to operate the system correctly). van Leeuwen et al.'s (1994) study of affordance complexity in tool use described in the literature review provides an example of how challenging the study of affordances can become when dealing with technology. With IS affordances the magnitude of complexity is greater and therefore the challenge in using affordances to study information systems is even more daunting.

Some scholars have introduced concepts that could facilitate the study of complex technology affordances. Gaver (1991) proposes the concepts of nested affordances and sequential affordances to better conceptualize how affordances relate to one another and enable specific behavioral opportunities through combinations of individual affordances. He argues that, "In general, the affordances of complex objects are often grouped by the continuity of information about activities they reveal. …The role of a good interface is to guide attention via well-designed groups of sequential and nested affordances" (Gaver 1991, p. 82).

Nested and sequential affordance may be useful concepts for design, but from the perspective of a researcher studying affordances they can be problematic when investigating complex information systems like electronic medical records systems. Specifically, there is a

decomposition problem. This problem of decomposition is not the same as that found in theories of indirect perception that Gibson was opposed to, which decompose perception down to very low-level variables like light and sound (Michaels and Carello 1981). The decomposition I am referring to is related to the argument made by DeSanctis and Poole against a "progressively finer, feature at a time evaluation of technology" in the study of IT artifacts (1994, p. 124). The difficulty, they argue, is that there are "features within features" and therefore when does one stop decomposing the technology to achieve "consistent, meaningful results" (1994, p. 124). Markus and Silver (2008) make this same argument in their proposed use of technical objects and functional affordances as replacements for structural features in Adaptive Structuration Theory. To understand a nested or sequential affordance it becomes necessary to decompose the affordance into its component parts. From Gaver's (1991) sequential affordance example of the Macintosh scrollbar, that means decomposing the affordance of grabbing the scrollbar by using the mouse to click and hold the scrollbar from the affordance of dragging the scrollbar with the mouse once it has been grabbed. That may work with relatively simple system features, but for complex information systems the affordances of interest may be composed of multiple nested and sequential affordances, and at what level do we stop unpacking those affordances?

An alternative solution is to look at how users perceive affordances of the information systems they use and then study affordances and their influences from that level of perspective. We may find that, in practice, users perceive and act on higher order affordances, and this approach would alleviate the need for excessive decomposition of affordances to understand their use. For example, when the nurses at Urban Hospital described their use of Epic they talked about how long it took them to log into the system before they could use it to do their work. They did not, however, go into detail describing the steps in that process, which included

clearing the screensaver if it was active, then clicking an icon to launch Citrix, then entering their username and password and clicking enter, and so on. Although this series of sequential affordances was required for nurses to log into Epic, nurses were not focused on that level of affordances. Rather, they were focused on the goal of getting logged in so they could access their patient records. Therefore, what was relevant from a system use standpoint was the time to log in. The specific procedures that were used to accomplish the log in process were only relevant to the extent they impacted the login time. This did not mean, however, that the nurses only paid attention to higher order affordances. The scrolling malfunction on the CVICU WOWs, for one, focused the nurse's attention on a finer grain of detail, because that particular system affordance of screen scrolling became a problem for their higher order affordance of using Epic to view and edit patient records. The nurses could also focus on detailed aspects of the system when asked to do so, but the point is that attending to whatever level of affordances the users of a system tend to focus on will facilitate a useful view of the system for understanding its use or non-use.

This focus on the user's level of perspective of affordances also resonates with Gibson's idea of holistic perception, in which the organism directly perceives the behavioral opportunities offered by objects in the environment rather than the individual properties of environmental objects.

> Orthodox psychology asserts that *we perceive these objects insofar as we discriminate their properties or qualities*. Psychologists carry out elegant experiments in the laboratory to find out how and how well these qualities are discriminated. The psychologists assume that objects are *composed* of their qualities. But I now suggest that what we perceive when we look at objects are

> their affordances, not their qualities. We can discriminate the dimensions of difference if required to do so in an experiment, but what the object affords us is what we normally pay attention to. The special combination of qualities into which an object can be analyzed is ordinarily not noticed. (Gibson 1979, p. 134, emphasis included)

5.3 Affordances and Constraints

In Chapter 2, starting on page 25, I introduced a potential relationship between affordances and constraints. Specifically, I suggested that affordances could constrain as well as enable behavior, and therefore it might be valuable to develop further the idea of paired affordances, in which both enabling and constraining affordances offer opportunities for behavior to the actor. This conceptualization was primarily inspired by Stoffregen's theorizing on the ontology of affordances in which he asserts that "affordances are the sole constraints operating on behavior" (2003, p. 127). I went into my study with that conceptualization in mind, but after evaluating it in the context of nurses' work practices at Urban Hospital; I believe that this is not an effective way to think about affordances and constraints. I now argue that affordances do not themselves constrain behavior and, therefore, neither constraining affordances nor paired affordances can exist, as I earlier suggested. Instead, I argue that constraints are a product of the component parts of an affordance and other environmental characteristics. In other words, it is the features of the information system and the abilities of the individual within a particular environment, not the affordance relationship, which constrain behavior. Leonardi (2011) takes a similar position on the relationship between affordances and constraints. He suggests that when people evaluate technology they see either affordances or constraints based on how the technology fits with their current goals. Thus, affordances and constraints are

distinct from one another even though they both originate in people's perception of technology. This characterization of affordances and constraints contradicts Stoffregen's (2003) arguments, but I believe my data supports this view.

Before describing examples from my data, it is useful to clarify the origins of Stoffregen's assertions regarding constraints, which are part of his arguments against Turvey's (1992) positioning of affordances as properties of the environment as well as his conceptualization of affordances as emergent properties of the animal-environment system. Since I take the position that affordances are a relationship between environmental features and individual abilities, not emergent properties of the animal-environment system, it becomes unnecessary to characterize constraints as part of the affordance relationship. This position is consistent with my arguments that Chemero's specification of affordances is valuable because it preserves the distinctions between social and material phenomena. Here, we preserve an understanding of specific features and abilities to produce particular constraints instead of assigning constraints to the affordance itself.

My position is also premised on the assumption that constraints are not absolute conditions regarding action. In his arguments for defining constraints in terms of affordances, Stoffregen states that, "It is not meaningful to suggest that the height of a stair constrains stair climbing… Behavior is constrained by relations between properties of the environment and properties of the animal" (2003, p. 127). I argue that this statement is only true if constraints necessitate a particular action or deterministically prevent an action from occurring (e.g., that the height of the stair must be sufficient to prevent an individual from climbing it). If, however, a constraint simply inhibits behavior, than I believe it is more meaningful to suggest that the height

of a stair can constrain stair climbing because stair climbing becomes more difficult as the height of the stair increases, relative to the animal.

One example of the relationship between constraints and affordances is the handoff process used by the nurses at Urban Hospital. Prior to Epic, the nurses on 3West and 5South conducted handoff either verbally or through tape recording. CVICU, by contrast, used a written communication sheet to facilitate their handoffs. After the implementation of Epic, all three units adopted the Dear Staff function in Epic to enable handoff reporting through the EMR. This meant that the affordance of handoff was enabled, at various times, in four different ways across the units I was studying. In each case the affordance was related to a different set of features and abilities, which imposed different constraints on the nurses in each case. Those constraints can be attributed to specific system features, individual abilities, and/or environmental characteristics associated with the affordance of handoff.

In the case of verbal handoff described on page 63, one of the problems mentioned by the nurses was the overlap required between shifts. Overlapping time was a function of the nurses' need to discuss each patient face-to-face, which I would consider a feature-based constraint in the choice of a synchronous communication mode, which requires both parties to be present in the conversation at the same time. Switching to an asynchronous communication mode with tape recorded handoff removed that constraint. Another problem with verbal handoff was the need for space in which to conduct the handoff. The handoff conversations typically included confidential information about specific patients that was not to be broadcast to other patients and visitors on the unit. This necessitated the use of spaces that could be closed off to provide privacy, but there were few such spaces available on the patient care unit as shown in the unit floor plan in Figure 4. I characterize this as an environmental-based constraint because of the

unit's physical limitations on useable spaces for confidential conversations. This constraint was the basis for the comment on page 63 that the nurses used to congregate in the break room and shout over each other. Tape recording had its own set of problems related to the need for recording equipment for each nurse, a feature-based constraint, and a space to conduct the recording in privacy and with limited environmental noise, an environmental-based constraint.

The switch to using the Dear Staff function in Epic alleviated some these issues, but created others for handoff reporting. Like tape recording, the Dear Staff function enabled asynchronous communication, thus reducing the constraining requirements for shift overlap that were a function of verbal handoff. As described on page 66, tape recording required the nurse to restate everything about a patient at each handoff, which could take considerable time. This was a feature-based constraint, because it was not feasible to reuse old recordings and just update them with new information. The Dear Staff function, on the other hand, could be updated while retaining existing information that did not change from shift to shift, thus eliminating the tape recording constraint. However, the character limit in the Dear Staff textbox described on page 67 became a feature-based constraint that made it more difficult to update the handoff report once the character limit had been reached. The Dear Staff function also constrained nurses who were not proficient at typing, an ability-based constraint. These various constraints associated with handoff reporting support the argument that the features and abilities that form the affordance relationship, along with environmental characteristics, produce constraints for behavior in a given situation.

Beyond the desire for ontological precision, a clear understanding of constraints is important for the study of affordances because constraints increase the difficulty of acting on affordances. Therefore, constraints are fundamental to an understanding of technology use. As

the discussion on the affordance threshold argues, shifts within the affordance range are primarily a product of constraints. For example, both the scrolling problem with the WOWs on CVICU and the login issues with Epic in general were constraints on the nurse's use of the system which led the nurses to reduce their use of the WOWs and altered their use of Epic, respectively. Therefore, I argue that an effective understanding of technology use requires an understanding of both affordances and constraints. The study of affordances offers an understanding of what behaviors are possible in relation to a particular information system while the study of constraints offers an understanding of how those potential behaviors are likely to be inhibited.

5.4 Social Aspects of Affordances

It was described in the literature review that other people and animals could offer affordances just as objects in the environment do. Gaver (1996) described these as "social affordances" and distinguished them from affordances of technology which facilitate social interaction. I believe it is useful for the study of information systems to differentiate between the affordances of people and the affordances of technology and therefore I use Gaver's (1996) term "affordance for sociality" to refer to the possibilities offered by technology for social interaction. These affordances offer the potential for a better understanding of the affordance range and affordance threshold.

For example, on page 67 I discussed how the character limit of the Dear Staff function led some nurses to switch to verbal report when it became too time consuming to edit the existing content in the Dear Staff textbox. In other words, that character limit constraint shifted the difficulty of acting on the affordance of the Dear Staff function beyond the affordance threshold. However, not all nurses experienced the same difficulties because some were better at

editing the Dear Staff content. If those nurses were able to teach their techniques to the nurses having problems, then the difficulty of using the Dear Staff function for handoff could be shifted further to the left of the affordance threshold for the nurses experiencing difficulties with the character limit, reducing the practice of switching back to verbal handoff.

The Dear Staff function itself also acted as an affordance for sociality in its facilitation of handoff between nurses, resulting in a different set of issues. The Dear Staff function allowed individual nurses to compose handoff reports as they wanted due to the freeform nature of the Dear Staff textbox. However, this affordance caused difficulty for some nurses because they had to hunt for information in the handoff report that had been added by another nurse. This difficulty on the part of the readers of the handoff reports prompted the units to explore the possibility of enforcing a structure on those reports through a standardized template that nurses would be asked to follow in organizing their handoff information. The affordance of freeform input in the Dear Staff textbox would not change, but the implementation of such a template would be expected to alter the use of that affordance through the development of social norms and if necessary through mandated work policies.

Epic's affordances for sociality also influenced the relationship between nurses and patients. As described on page 61, the use of the WOWs on both 3West and 5South and the bedside computers on CVICU affected the bedside interactions between the nurse and patient. Most nurses said that their primary role was the caregiver relationship with their patients. Prior to Epic, the objects that were part of the bedside interaction between nurses and patients were essentially non-interactive (e.g. paper chart, medications, etc.) and therefore did not interfere with that caregiver relationship, at least in the perception of the nurses. With Epic, the WOWs and bedside computers became something almost 'alive' and very much a perceived part of the

nurse/patient interaction that could interfere with that relationship. Some nurses reported the perception of a three-way interaction between the nurse, the patient, and the computer, while others felt that they were becoming less of a caregiver and more of a data collector. Other nurses reported minimizing their use of the computers at the bedside to reduce the potential impact on their caregiver role. These perceptions were not universal, but they do show how the material properties of Epic and its component parts were influential in the social interactions between the nurses and their patients.

The relationship between nurses and physicians represented another opportunity for Epic to have an influence on clinician relationships. The relationship between physicians and nurses and the role of orders in that relationship were described in the results, starting on page 79. Prior to Epic, the nurses frequently entered orders for physicians because of the need to write them into the physical patient chart and the physician's infrequently visits to the unit. With the implementation of Epic, the affordance of medical record access for the physicians was enhanced. Now they could directly access their patient's charts from anywhere they had computer access instead of being limited to a physical paper chart located on the patient care unit. With this enhanced access, both administrators and nurses expected that the nurse's role in entering orders would be greatly reduced. However, as noted in the results, that was not always the case. Some physicians continued to ask the nurses to enter orders for them, although other physicians made use of their new access to enter their own orders and to engage with the nurses through Epic. In fact, the range of physician behaviors described by the nurses at Urban Hospital following the implementation of Epic provides excellent examples of the variety of influences of materiality on user relationships without being deterministic. It also points to the complexity

that affordances of sociality add to the study of materiality where one party in a relationship can undermine the affordances of a system like Epic for the other parties in the relationship.

5.5 Discussion Summary

In the introduction, I argued that IS research lacks an effective understanding of how the materiality of information technology enables and constrains the people who interact with that technology. I then proposed that affordance theory could provide an effective theoretical lens for studying the material aspects of IT. Robey et al. (2011) suggest that the need to define the theory's conceptual building blocks is of primary importance for theorizing the materiality of information technology, and this dissertation represents an effort to address that need. I began this process by taking the perspective that affordances are a relational concept (Chemero 2003), and more specifically, that an IS affordance is a relationship between the features of an information system and the abilities of an individual with the context of an environment. This conceptualization, I argued, maintains the balance between human agency and material properties of technology while preserving the unique characteristics of both. In this chapter I have defined and described several affordance concepts and positioned them within the nomological network of affordances. I have provided evidence from my research data for their salient characteristics and distinguished them from other concepts in the literature in order to more precisely theorize the ontology of affordances.

Critical realism was the guiding philosophical perspective in this research. Critical realism takes the ontological position that there is an objective reality with intransitive objects which exist independent of humans. The production of knowledge (i.e. science) is a human endeavor which seeks to improve our understanding of this objective reality through the use of transitive objects (e.g. theories, concepts, models). Mingers suggests that this is accomplished

when, “we take some unexplained phenomenon and propose hypothetical mechanisms that, if they existed, would generate or cause that which is to be explained” (2004, p. 94-95). The affordance threshold represents one of these hypothetical mechanisms. I started by defining the affordance range as a continuum of difficulty to act on an affordance which includes Warren’s (1984) critical and optimal points at either end of that continuum. All affordances exist somewhere within this range and I argued that an increase in difficulty along the affordance range results in a decrease in likelihood of action on the affordance, but that the correspondence of difficulty to act is not consistent across the entire affordance range. I then proposed the affordance threshold as a point within the affordance range at which important behavioral changes regarding an individual’s use of the affordance are expected to occur. These behavioral changes are theorized to differ based on whether the use of the affordance is optional or mandated from a work practice perspective. Specifically, when the difficulty of acting on an optional affordance increases beyond the affordance threshold, the likelihood of the individual acting on that affordance should decrease significantly. This conceptualization is illustrated in Figure 14. In contrast, when the difficulty of acting on a mandated affordance increases beyond the affordance threshold, the likelihood of action may not change significantly. Instead, other behaviors related to that affordance will be manifested.

The concept of constraints has been closely linked to the concept of affordances throughout the literature. Most recently, Leonardi (2011) proposes that when people evaluate technology they see either affordances or constraints based on how the technology fits with their current goals. I have argued that, ontologically, constraints are not a product of affordances as suggested by Stoffregen (2003). Instead, constraints are a product of the component parts of an affordance and other properties of the environment. In other words, system features and

individual abilities along with environmental characteristics, not the affordance relationship, constrain behavior. I suggested that another way to conceptualize the relationship between affordances and constraints is through the affordance range. Specifically, shifts within the affordance range are primarily a function of constraints and therefore the use of technology is shaped by this interrelationship of affordances and constraints. The study of affordances offers an understanding of possible behaviors in relation to a particular information system, while the study of constraints offers an understanding of how those potential behaviors are likely to be inhibited. Together they are expected to provide a more complete understanding of technology use.

These conceptualizations of affordances and constraints have potential value for IS research. However, the complexity of information technology presents a challenge to their application. My proposal to focus on user perspectives of affordances, as a solution to the problem of repeated decomposition, stands in contrast to the reductionist approach to affordances taken in much of the HCI literature. Critical realism supports a user perspective of affordances in that social structures are considered to be as real as natural phenomena, and yet those social structures do not exist independent of the activities they govern or the conceptions of the individuals engaging in those activities. To be sure, individual perspectives are incomplete views of reality, but when combined with the perceptions of others and the researcher's own knowledge of the study context, a more complete picture of the phenomena being investigated is produced. In this study that picture was comprised of both in situ and retrospective accounts, which enabled a longitudinal contrast between present and past work processes and the influence of the material characteristics of information technology on those work processes. The inclusion of accounts from multiple patient care units within the hospital also allowed distinctions to be

drawn between work practices and technology configurations that varied from unit to unit. My own experience with healthcare and inpatient hospital care was described and I believe that knowledge enhanced the data gathering and analysis processes.

Nurse's work practices in the context of inpatient care include multiple relationships which information technology can both enable and constrain. The caregiver relationship between nurses and their patients, the relationship between nurses for the continuity of care, and the hierarchical relationship between physicians and nurses are three of the more important relationships in that environment. Various aspects of each relationship were described and supported with data. I argued that information technology supported these relationships through affordances for sociality, which are contrasted with social affordances that are behavioral opportunities provided directly by other people. Affordances for sociality offer additional opportunities for conceptualizing the influences of information technology on the work practices users while at the same time adding to the complexity of studying materiality.

These insights into the ontology of affordances of health information technology comprise the core contribution of this research. Conceptual clarification about the nature of affordances in healthcare can provide groundwork for future studies on clinical work practice and potentially inform the design and implementation of systems that work effectively within the context of clinical practice. In the following chapter, I develop the implications of the present research and look ahead to possible future research opportunities.

Chapter 6

Conclusion

In this dissertation I have utilized a qualitative case study to investigate the use of an electronic medical records system by nurses on three inpatient care units of a large urban hospital to understand how the material properties of health information systems enable and constrain the work practices of clinicians. Critical realism was the guiding philosophical perspective in this research and affordance theory provided the theoretical basis for the investigation. An account of selected nurse's work practices on inpatient care units was presented from the perspective of the nurses and related stakeholders. Through that account several insights regarding the ontology of affordances were developed which have the potential to inform both research and practice regarding the design and use of information systems.

6.1 Implications for Research

This research is an exploratory study of the IT artifact as well as its usage and potential impact on work practices through the lens of affordances and therefore constitutes what Benbasat and Zmud (2003) would suggest is research that reinforces the central identity of the IS discipline. The value of this research for the IS field is that it provides a more nuanced understanding of the nature of the IT artifact and its relationship to the users of that technology. Benbasat and Zmud (2003) support theory borrowing from reference disciplines as long those theories are used to investigate the IT artifact and its nomological network. This research borrows affordance theory from the field of ecological psychology, but it does so in order to theorize the IT artifact and its nomological net through the specification of IS affordances and concepts like the affordance threshold. It is hoped that the theoretical contributions made to

affordance theory in this research will provide opportunities for other IS researchers to extend and refine the theory in other contexts and with other types of information systems to further our understanding of the IT artifact and its usage and impacts.

This was an exploratory study to build theory and to add to our knowledge about the nature of affordances and their relationship to information technology and its use. I have theorized the affordance range and the affordance threshold and their ontological nature regarding the likelihood of action in relation to the difficulty of acting on the affordance. These concepts were drawn partially from the literature, but are primarily a product of my qualitative analysis of original data. As with most research, the concepts and theoretical insights are an extension of existing ideas and do not represent a beginning or an end to knowledge. The ideas presented in this research require further refinement and validation to enhance their usefulness in the study of information technology, a task which may be undertaken by other IS scholars.

In addition to information system research, two other disciplines in particular may find this study relevant to their research; organizational behavior and healthcare. The organizational behavior community seeks to understand the role of technology on the social practices of people and organizations. Leonardi and Barley (2008) suggest that the role of materiality in organizational change has, to date, been under theorized and this research has relevance to their call for better theories of materiality, information technology, and organizational change. One of the goals of the healthcare research community is to understand the practices of healthcare providers and organizations. This study with its focus on nurse's work practices could provide that community with new insights into the role that information technology plays in healthcare practice.

6.2 Implications for Practice

At nearly 18% of GDP and growing (CMS 2011), national health expenditures represent a significant drain on the resources of governments, organizations, and individuals and many are concerned that these growing costs will severely limit our personal and societal fiscal options in the coming years. Inefficiencies and other problems in the delivery and management of health services account for a sizable portion of these expenditures and the promises of information technology as a solution to these issues have led many healthcare organizations to implement health information systems and the federal government to establish mandates for their ongoing adoption and use (Obey 2009). This has elevated the need for research on health information technology to more effectively determine its value and the impacts of its use in reducing healthcare costs and improving the efficiency and effectiveness of health services management and delivery.

This study has investigated the use of an electronic medical records system by the nurses on inpatient care units at a large urban hospital. Most IS studies in healthcare organizations have focused primarily on physicians and their use of health information technology (Davidson and Chismar 2007; Kohli and Kettinger 2004; Reardon and Davidson 2007). This is one of the few that has centered its investigation on the practices of nurses on inpatient care units. The account of work practices on those units and the influences of the EMR from the nurse's perspective may offer unique insights to other healthcare organizations in their adoption and use of similar systems.

The theoretical insights on affordances and constraints also have practical implications for the implementation and use of health information systems. Specifically, the insights regarding the affordance threshold and the nature of information systems affordances may assist

healthcare administrators and clinical decision makers in their evaluation of new information systems for their organizations and the policies they implement regarding the use of those systems. Taking an affordance perspective will lead to an evaluation of what behavioral opportunities the system offers in conjunction with the skill sets of the organization's clinicians and have practical implications for both system implementation and training.

While this study was based on an electronic medical records system in a healthcare organization, the concepts developed from the data are not specific to either the system or the setting and may be broadly applicable to any information system in a wide range of contexts. Therefore, many of the same insights from this study that would benefit healthcare organizations would be equally applicable to other organizations in their selection and use of information technology.

6.3 Research Limitations

As with any research, there are limitations to the methods and the extent to which the research findings can be generalized. Regarding generalization, critical realism takes the perspective that all social science research is limited in its ability to generalize to other contexts due to the fact that social structures, unlike natural laws, are localized in time and space and do not exist independent of the activities they govern. However, social structure still operates on an intransitive domain of generative mechanisms and therefore generalization of theories and concepts are certainly possible (Mingers 2004). The goal of this study was to extend and refine the theory of affordances for information system research. The concepts and other theoretical insights that came out of this research are generalizable to the extent that they are not specific to a particular technology or context. They were, however, developed from data collected on a

specific technology within a particular context so some of the insights drawn may prove to be distinctly local rather than general.

Regarding methods, the data for this study was collected during a one month time period and relied on retrospective accounts for the work practices and other activities occurring prior to the data collection period. Some of the relevant activities occurred as many as two years before the period of data collection. Leonard-Barton suggests that, "studies have shown that the participants in organizational processes do not forget key events in these processes as readily as one might supposed" (1990, p. 250). However, longitudinal research can result in more accurate accounts of events since significant events may not be recalled in retrospect if they were not recognized as significant when they occurred (Leonard-Barton 1990). The use of multiple informants in retrospective research may help to mitigate that issue, but future research could benefit from a longitudinal approach to track changes in information technology and work practices over time.

6.4 Future Research

This was an exploratory theory building study designed to contribute to the body of knowledge about the nature of affordances and their relationship to information technology and its use. I have presented a set of literature-based and data-derived concepts and assertions regarding affordances and constraints. This research represents a starting point for further refinement and extension of these ideas and insights. The data presented in support of the arguments made in this research represent only a part of the data that was collected in this study. I plan to continue working with that data to further develop and refine the affordance concepts and theoretical assertions presented here and to potentially identify new concepts and relationships for the theory of affordances.

I believe the study of healthcare is vitally important at this time in history and I plan to continue working in this area to further our understanding of the use of information technology in healthcare and how it can help solve some of the seemingly intractable problems plaguing that field. Understanding how information technology can more effectively support the work practices of clinicians and their relationships with their patients and each other will go a long way to improving healthcare practice and the delivery of health services. I hope that this research will contribute toward that goal.

Appendix A

Initial Interview Guide

Interview Guide for the Research Project Entitled:

Health Information Systems Affordances: How the Materiality of Information Technology Enables and Constrains the Behavior of Clinicians

Note: The following represents the initial set of questions that may be asked of sources in this study with questions grouped by source type. This interview guide will provide for a semi-structured interview format with question selection based the flow of the interview. In addition, the iterative nature of data collection and analysis that will be used in this study will make it likely that questions will need to be modified, deleted, and/or added to adequately address changes in the developing theory.

Clinician

Source Demographics

- What is your job title?
- What are your work roles and responsibilities within the organization?
- How many years of clinical experience do you have within this organization?
- How many years of clinical experience do you have with other organizations?
- What types of non-clinical work experience have you had?
- What is your academic background?

System Knowledge and Experience

- Describe the current system.
- Describe your use of the system.
- How much experience have you had with the current system?
- Have you had experience with similar systems? What systems? How much experience?
- How does the current system compare to other similar systems you have used?
- What kind of training have you received on the current system? Was it sufficient?
- How well do you think you know the current system?
- What features or functions do you use the most?
- Are there features of the system you are aware of but don't know how to use?

System Satisfaction

- Are you satisfied with the current system? Why or why not?
- Does the system function in the way it is supposed to? If not, what functions do not work properly?
- Are there features not currently available that you would like to see in the system?
- How has the implementation of this system affected work on the patient care unit?
- How has the implementation of this system affected the users?
- How has the implementation of this system affected patient perceptions of the unit?

Hospital Administrator

Source Demographics

- What is your job title?
- What are your work roles and responsibilities within the organization?
- How many years of administrative experience do you have within this organization?

- How many years of administrative experience do you have with other healthcare organizations?
- What other types of work experience have you had?
- What is your academic background?

System Selection

- Why did you purchase a new system?
- Describe the process that was used to select the current system.
- What systems did you consider when making the selection?
- Why did you choose the current system? Where there any features which were particularly important in the selection process?
- How important was system ease of use and training requirements in the selection decision?

System Satisfaction

- Are you satisfied with the current system? Why or why not?
- Are the users satisfied with the current system?
- How has the implementation of this system affected the patient care unit?
- How has the implementation of this system affected the users?
- How has the implementation of this system affected patient perceptions of the unit?

System Support

Source Demographics

- What is your job title?
- What are your work roles and responsibilities within your organization?

- How many years of experience do you have with your current organization?
- How many years of experience do you have with other organizations in the same industry?
- What other types of work experience have you had?
- What is your academic background?

System Knowledge

- What kind of training have you received on the installed system?
- How would you describe your understanding of the system?
- Describe the system.
- Describe the installation of the system.
- Describe the user training for the system.
- Describe the current maintenance of the system.
- What features of the system are most important for users to know about and use?
- Are there particular features that users typically have more difficulty understanding and using?
- Does the system have any recurring problems?
- Are there features the system does not have that users have asked for?

Appendix B

Adapted Interview Guide for Nurses

- Years at [Urban]
- During that time have you always worked on this unit? If not, what other units?
- Did you work as a nurse before coming to [Urban] Hospital? Where?
- Where did you go to nursing school? When was that?
- Documentation training in nursing school. Paper chart experience. EMR experience.
- Describe the difference between paper charting and using an EMR?
- How would you describe your typing proficiency?
- How comfortable are you using computers in general?
- Describe the training you received on the Epic system? How could it have been better?
- How well do you think you know the Epic system for your work?
- Describe a typical shift using Epic.
- How does the Epic system affect the way you care for patients? Interact with your teammates? Interact with doctors?
- How does the Epic system affect patient perceptions of the unit?
- What features or functions do you use the most? Any issues with those features?
- Are there any features of the system you are aware of but don't know how to use?
- If you could change the system to better fit your work practices how would you change it?

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