A Complexity Theory Perspective for Defining the Digital Persona of HIT Usage

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Abstract
It is common for unintended consequences to arise after implementing health information technology (HIT). These consequences occur because HIT creates a digital chasm between the manner in which people conduct business processes pre and post-HIT. Human Computer Interaction (HCI) issues can provide meaningful insight about the digital persona in which people interact with HIT and how we can better design and evaluate HIT to mitigate the digital chasm. In this paper we use complexity theory to analyze HCI issues from the implementation of a perioperative information system. The insight from our analysis provides insight on how we can design HIT to support the digital persona of end users.

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Complexity theory; Digital Persona; Health Information Technology;

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Health information systems, evaluation, human factors

Introduction
Our ability to design and evaluate health information technology is often hampered by the complexity of the processes where HIT is used. More specifically, we automate processes without understanding their impacts on other processes. Yet it is often the situational contexts that define how a HIT works in specific settings [1]. Contexts shape the interactions of people, processes and technology, and often not in predictable ways [2]. A better understanding of
contextual fit would help us improve the design and evaluation of HIT [3].

A consequence of not having contextual fit between HIT and the situation where it is implemented are issues such as technology induced errors, communication issues and workarounds [4,5]. Complexity theory can help us understand contextual fit, specifically the interrelationships and degree of interrelatedness between processes [6]. Complexity theory has been used to study processes like discharge or handover that are complex and have a high degree of interrelatedness [6,7]. A key tenet of complexity theory is the non-linearity of processes and how behaviors and tasks emerge as a result of the non-linearity [8].

Figure 1 shows our perspective on the digital persona, which defines the activities and manner in which people engage with technology. Overall the persona is poorly understood and there is often a significant gap between the ostensive (i.e. ideal representation depicted through flowcharts and models) and the performance (i.e. what actually takes place in real settings) dimensions of a task [9]. We refer to that gap as the digital chasm.

Complexity theory has not been used to empirically study HCI issues. However we believe it can provide valuable insight on the complex and non-linear processes that spawn HCI issues. In this paper we use fig.1 as a framework to study HCI issues using complexity theory. Our objective is to better understand the digital persona and more importantly, to provide insight on how to design and evaluate HIT to overcome the digital chasm.

Figure 1. Digital persona and digital chasm as part of business process automation

Case Study
We conducted a study of a perioperative system called the Surgical Information Management System (SIMS). SIMS was implemented in April 2009 in a multi-campus hospital in an urban Canadian City across all perioperative areas (pre-admit unit (PAU), same day admit (SDA), surgical day care (SDC), operating room (OR) and post-anesthesia care unit (PACU)). The goal of SIMs was to bring common data and connectivity across the perioperative spectrum. From April 2012 to June 2013 we conducted over 130 hours of non-participant observations across all the perioperative areas and campuses. We also conducted 8 interviews and 3 focus groups with different categories of users including anaesthetists, nurses and managers. The observational notes were transcribed into written notes that documented users, activities and processes. The interviews and focus groups were transcribed verbatim. We analyzed the case study using four tenets of complexity theory: non-linearity, emergent behavior, connectivity and process variation, in order to identify HCI issues.
Results
We briefly discuss the analysis from each complexity tenet and how it helps us understand the digital chasm.

Non-Linear Processes
Changes in one area affect tasks in another area, often in non-linear ways. PAU is the patients first touch point and it is where the digital persona starts. In the pre-SIMS system anesthetists would highlight or bold patient issues that would be important in subsequent areas. This feature was not available in SIMS and it resulted in issues down the perioperative spectrum on the day of surgery and beyond. For example, patients with latex allergies are supposed to be the first surgery of the day to prevent exposure to latex. However because a latex allergy was not highlighted in PAU it resulted in a patient’s surgery being scheduled later in the day.

Emergent Behavior
HCI issues can result in emergent behavior caused by HIT. One emergent behavior was the ‘over automation’ paradox. It was identified that people were more than they needed to because of the ease of clicking on a field to enter data. Some fields only needed to be charted once per hour but nurses were charting them every time they assessed the patient. One nurse described this problem: “I think some people are documenting a lot more than they needed to document. I often found myself saying, "Did you do that on paper?" And they would say, "No." And I’m saying, "Well then, why are you doing it now?". Excess data presented a problem in that it swelled the perioperative reports making them excessively long but more importantly make it harder to find relevant data about a case as it was buried within unnecessary data.

Connectivity
Connectivity caused by HIT can lead to unintended issues. An example of a connectivity issue took place in the OR. During observations there were several instances where the anaesthetist would put a memo in SIMS to help patient care when the patient gets to PACU. An example could be a memo saying the patient’s blood pressure is prone to spikes. However, because there was no common protocol on where memos should be put, nurses in PACU may not see the memo. Another connectivity issue was assuming that module interoperability exists. Each perioperative area has a unique SIMS module. However there are variations in interoperability between different modules. In the OR Manager module nurses were charting in a particular field about an antibiotic given in the OR. However, that field did not transfer to the PACU module, so the nurses there could not see that the medication was given. A nurse in PACU commented ‘until last week, we did not know the OR nurses were giving anything [in the OR]...’ HIT mediated connectivity can be problematic. At best connectivity is unhelpful if not seen, and at worse, it could lead to medical errors or adverse outcomes.

Process variation
The manner in which different clinicians interacted with SIMS varied greatly across the perioperative areas. Data entry is an example of such a process. In PAU the objective is passive data entry about patient history. In the OR data entry is active real time entry about the patient’s surgery. Anesthetists described how a benefit of the paper based system is that writing down complex drug data helped them think about the data. In SIMS the data entry is a drop down menu which did...
not provide the same cognitive stimulation. Another process variation was the need for mobile data entry. In the pre-SIMS paper system an anesthetist could chart on the edge of the bed. In the OR the cart with the PC is about 15 feet away from the patient. As a result anesthetists may have to remember drug doses or other data to chart it later. As a work around one anesthetist wrote drug doses on his scrubs at the side of the bed and later entered the data into SIMS.

Discussion
This paper used the tenets of complexity theory to identify HCI issues from the implementation of SIMS. While existing research has acknowledged the complex nature of HIT we extended that work and identified specific HCI issues caused by complexity. These issues enable us to better understand the digital persona and how to close the digital chasm that exists between current and automated business processes.

It is essential that we focus on HCI issues at key interaction points. HCI issues at PAU led to a ripple effect down the perioperative spectrum that was not linear but exponential. We also need to pay attention to process variation as a driver of HCI issues. For example, the loss of charting mobility in the OR caused huge HCI issues for anesthetists and could pose safety risks by forcing anesthetists to remember essential data. Finally there were several emergent HCI behaviors that were spawned by HIT.

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References