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Real World Constraints for Actualizing Human Factors Findings for Healthcare Systems

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ABSTRACT

While theoretical and applied research findings recommend methods to optimize human-computer interaction, using them in a real-world scenario requires understanding and accommodation of constraints not normally included in experiments. This study describes steps to include research findings to incorporate interoperability requirements in the use of commercial-off-the-shelf products. The focus of this study is on a satisfactory and productive user experience.

Keywords: Commercial-off-the-shelf, Constraints, Healthcare, Human-computer interaction, Interoperability, User experience, Project management

INTRODUCTION

The U.S. Office of the National Coordinator for Health Information Technology, as part of the 21st Century Cures Act (2016), supports seamless and secure access, exchange, and use of electronic health information. This has significant implications for those who deploy healthcare information systems, as it mandates interoperability between organizations as part the exchange. Information systems make this exchange timelier, more reliable and consistent. The Healthcare Information and Management Systems Society (HIMSS) organization, in response to the 21st Century Cures Act, has defined four levels of interoperability to allow different information systems to access, exchange, integrate and cooperatively use data in a coordinated manner (HIMSS, 2022). The first three levels of their interoperability, Foundational, Structural and Semantic, mostly address technical alignment. The fourth level, Organizational, includes considerations such as governance, policy, social, legal, and organizational to achieve integrated end-user processes and workflows. The four levels of interoperability ideally combine to create a satisfying and productive user experience.

While human factors research has recommended principles and processes to use to improve end user experience, its focus is usually on a single system design. Achieving interoperability implies the use of multiple information systems and it is likely the systems are already designed, developed, and in production both in the organization and elsewhere. This paper presents the scenario where a single individual requires interaction between multiple, commercially available information systems to complete a task. Ideally, this

investigation takes place prior to deployment of additional systems, so that is the scenario presented here. It highlights difficulties healthcare organizations may encounter, for example when medical devices interact with an electronic health record (EHR), sharing patient data in real time, or checking whether funding for medical supplies is available. It proposes a process that incorporates research results and real-world constraints, to accommodate real-world constraints imposed by commercial products.

BACKGROUND

Research into healthcare information system interoperability acknowledges the benefits of it and the difficulty implementing it. Research also shows the importance of human factors in making useful systems and reducing risk to patient safety (Lowry et al. 2012, Ratwani et al. 2018). Specific recommendations include aligning technology protocol and system use, and governance (Collautt et al. 2010). Documented concerns include data sharing within the same EHR at different locations (Fennelly et al. 2020) and interoperability between different systems and different organizations.

Our investigation found no research recommendations for designing the end user experience when multiple systems interact. For example, how to notify users that a response to a request for information was received? How do systems set expectations for response time, or do systems set expectations for response time, knowing the margin of error is large?

Once these questions are answered, what constraints exist in the multiple commercial off-the-shelf (COTS) system environment to realize those decisions? A COTS product is a software system that has defined functions available as a package. A notable example is Microsoft Office. Organizations purchase it, on contract, as an existing package for installation and use. The contract might specify the number of concurrent users or an overall number of users. It would also specify availability of upgrades and levels of support. Of course, any modifications to the software or the standard contract increases the cost. The essential criteria for evaluating a contract for a COTS product are (CGI Group, Inc. 2018):

- Functionality – does the out-of-the-box product meet organizational needs?
- Flexibility – what is involved with changing the standard configuration or the code?
- Auditability – what controls are in place to reduce the risk of audit findings?
- Sustainability – what levels of support are available and what is the associated cost?

It is possible that when an organization contracts for a COTS product, it may not know future interoperability requirements. When they are known, meeting them may require contract modifications.

When an organization has a contract for a COTS product that requires an interface with another COTS product, how are the design decisions made with consideration for human factors made? This involves consideration for

the Iron Triangle of project management; scope, cost, and schedule (Ebbesen and Hope, 2013, Pinto, 2010, Pollack et al. 2018). This interaction describes the trade-off between the constraints. For example, with enough money and time, the organization can find staff or consultants to incorporate needed functions and features and vice versa. Depending on the contract specifications, either the software can change, or a new overlay may provide the functionality. However, modifications rely on agreement between the two parties in the contract.

Another consideration is compliance with various regulatory authorities. For example, if users want more frequent feedback from a medical device than is provided, and the device was purchased with embedded software, the organization is not likely to persuade the vendor to make changes, especially if it requires additional U.S. Food and Drug Administration approval. If a user's group lobbies the manufacturer with sound evidence, that may have results but would take time. The Iron Triangle constraints of project management again apply.

The authors have witnessed examples of how companies have responded to requests for software modifications. It varies, possibly based on corporate culture. Some may offer to accommodate for a price, some may cite that requested modifications would require unacceptable changes to the appearance of their product. Examples are the appearance of buttons on a screen, or text changes on buttons. Others are more willing to consider changes, especially it makes their product more marketable.

Another constraint organizations encounter is having access to technical resources. Some configurations require both systems and technically savvy staff to create and use complex features. An example is Smart infusion pumps, used for intravenous therapy. They have settings specific to certain drugs, as a safety feature. To configure the pump to use this requires staff knowledgeable on the pump library, the nursing infusion list and the pharmacy files in the EHR.

APPROACH

The following process steps …

1. The first step is to conduct an environmental scan. This has two parts. The first is to ask the software supplier how other customers have interfaced to their system. The second part is to ask other users to identify what they do to integrate systems. In a competitive healthcare environment, both these groups may have reluctance to reveal solutions. of – figure out what users of the systems do currently. Negative transfer. Wasted resources – duplicate efforts. If we frame this as a before-deployment scenario, we would need to understand from the vendors how other instances interaction takes place. *That's what I did for the iFAMS and DMLSS products and had very strange responses.*
2. Identify possible solutions, based on human factors heuristics, etc. and minimal end user involvement (minimal to not get their hopes up). List of methods to deploy needed here.

3. Document changes to each system needed for each possible solution.
4. Present options to contracting department, to gauge whether needed changes are possible with current contract or extent of changes needed.
5. Engage with system providers to understand effects on functionality, cost and schedule.
6. Evaluate options to arrive at a realistic solution from a project management perspective.
7. Use the overall project constraints to design / prototype options for end user evaluation.
8. Present options to end users (need help here with terms to use)
    a. Take care to comply with contract constraints established by project leadership
    b. Attempt to get representative sample of users
9. Rank options and document pros and cons of each for presentation for leadership evaluation and selection
10. Engage in leadership discussions as requested
11. Deploy leadership selected method of providing end user experience as a standard, likely custom, deployment

DISCUSSION

The process proposed in this paper infuses real-world constraints into the effort to provide a satisfactory user experience when task completion requires multiple COTS products. It applies those constraints in a manner that incorporates research findings that acknowledges the integrated nature of individual and organizational goals.

CONCLUSION

While providing a productive and satisfying user experience appears high on the list of interoperability priorities, too frequently that goal is overshadowed by resource constraints.

NEXT STEPS

Human Factors consideration for information system use has historically focused on aspects of the task, the technology and end users or people (…). Decades of research has culminated in best practices and …

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