

A Summary of Human-System Integration in the System Development Process

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Abstract

In a recent book, Pew and Mavor and the Committee on Human-System Design Support for Changing Technology (2007) proposed a revision to Boehm's Spiral Model for system development. This revision encourages considering the user within a system as a source of risk. Where these risks are significant, this approach suggests ways to reduce the risk through appropriate studies of the user. This tutorial provides a summary of this model and some of the insights and extensions of this model based on teaching it. These insights are related to learning: learning by the field through using this approach to organize methods and techniques, learning by system development managers that there are sometimes risks related to humans using their systems (and implications for how to teach this), learning about designers as stakeholders, and learning by designers as lessons from one design are applied to later designs. These insights and extensions suggest the importance of shared representations such as cognitive models for educating team members and for the system development process.

Keywords: Human-system design; user models; representation

Introduction

In a recent book, Pew and Mavor and the Committee for Committee on Human-System Design Support for Changing Technology (2007) propose a revision to Boehm's Spiral Model for system development. I present here a summary of this model for system design. This report argues that not understanding aspects of the user can be a risk in system design. Thus, where there are no user related risks, system designers do not need to worry about users. In other cases, where there are risks, the book presents approaches for reducing these risks. User models are a way to share knowledge about users across the design process.

Intended audience. This tutorial will be of interest to people interested in using models in industry as a shared representation, modelers interested in applications of models, and those interested in understanding the Committee's report as edited by Pew and Mavor.

Prerequisite knowledge: This tutorial does not presume any prerequisite knowledge. Attendees may wish to have skimmed the book (which is available on the web page-at-a-time for free), or have examined other work on system design.

The Spiral Model

The spiral model is an approach to system design that encourages increment development of systems in a spiral of requirements specification, technical exploration, and stakeholder commitment. The spiral model is shown in

Figure 1, where movement around the spiral represents time and commitment and work on the project.

At each stage in development, the system development is accessed for risks to the system's success. The process is then targeted at reducing these risks. Some risks may be technical, can we build it or can we build it for that price? In these cases, technical work is performed to reduce the risk through technical understanding. Other risks can arise from historical events, which are hard to reduce, and from financial matters, which often can be reduced by setting up contracts at a known price. Risks can also occur due to not understanding user, their tasks, or their interaction with the system, which the report and this tutorial address.

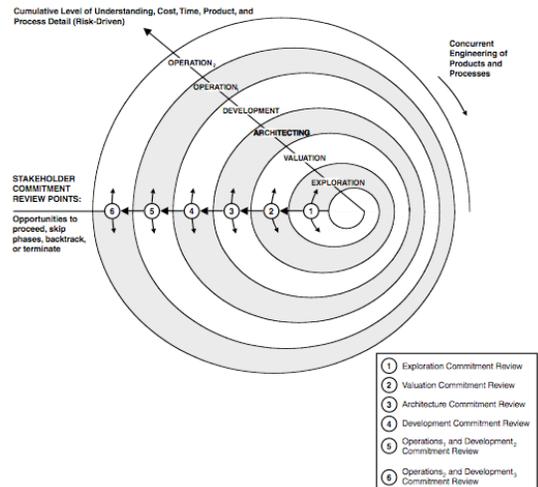


Figure 1. The basic spiral model (Pew & Mavor, 2007).

This revised system design model in Pew and Mavor (2007) has several key features, as noted in the book: (a) Systems should be developed through a process that considers and satisfies the needs of stakeholders. This step is done in the Exploration and Evaluation stages.

(b) Development is incremental and performed iteratively. These related aspects are shown in Figure 1 by the multiple loops representing the increasing resources committed to design and implementation, and through the five stages (Exploration, Valuation, Architecting, Development, and Operation). These stages are incremental because movement from one stage to another depends upon a successful review

(c) Development occurs concurrently, that is, multiple steps may be performed simultaneously. Designers may implement one part of the system while testing another.

(d) The process is mindful of risks during system development and deployment. The level of risk is accessed repeatedly at milestones between stages. Risk is used to manage the project—the level of effort and level of detail of work are driven by the level of risk. Where there is no risk to system development, there is no need for effort to reduce risk. For example, if the system being developed is similar to a known product, there may be no reason to explore further how to support users or how to manufacture it.

Insights

The committee did not set out to create human-system integration (HSI) teaching materials, but the resulting book can be used to teach about HSI, human-computer interaction (HCI), and human factors. In teaching this material, the students and I found several extensions and insights.

(a) The revised spiral model provides a framework for organizing much of HCI and HSI. Most HCI methods can be cast as ways to reduce various types of risks, and most design processes cast as steps in the spiral.

(b) The revised spiral model is not just normative, it is also descriptive. That is, managers may already be working to reduce risk; it is just that they do not see the risks related to users because they do not understand users. This insight suggests that it is likely to be more important to create materials to teach about incipient risks than it is to teach about the revised spiral model process itself.

(c) Designers are stakeholders too. Tools and approaches to reduce risks must support their understanding. They are users of the process and their needs and capabilities are part of the development process.

(d) One of the major results of using shared representations and analyses of systems while being designed may be learning of the design team and application to later designs. Thus, work on creating shared representations should not just include integration across the team and across the design process for a single project (which the book calls for), but also across designs over multiple projects.

Summary

The risk-driven incremental concurrent development model, the later version of the spiral model, provides a useful and safer way to create systems. As a study aid, the model provides a new way to view HSI and HCI methods, design approaches, and development theories, and how to include them in system design.

So, in this new view, the decision to do user research, review, or studies is based on system design risks. If the system development is predicted to be smooth and not novel, then little or no usability studies are required, and little or no should be done. Where there is more risk, more work should be done given the resources. But, the user-related risk has be balanced against other risks. The technology may in fact be riskier, and thus require more resources. Or, as is often the case, the managers understand the technical risk.

There are several corollaries to this. The managers often must be educated about user risks, and we will need books and tutorials like this to help educate system designers about where and when their theories of users mismatch the world.

We will need improved representations of users (shared representations) to use in the design process, similar to how blueprints are used in buildings.

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References

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Frank Ritter currently teaches at the College of IST at Penn State, previously he has worked at BBN Labs and taught at the U. of Nottingham, where he was the Director of the Institute for Applied Cognitive Science. He earned his PhD in AI and Psychology and a MS in psychology from Carnegie-Mellon. He has a BSEE from the University of Illinois at Urbana/Champaign. He was a member of the committee that helped prepare the book the tutorial is based on.£