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Reflections on Risk-driven Design and Instruction

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ABSTRACT AND INTRODUCTION

Big problems need big solutions. We are building bigger and bigger systems and systems of systems that need system-level theories and tools that address how to increase the chances of these systems being a success. There are multiple issues so we will need multiple perspectives. The risk-driven spiral model provides a framework to approach this development process, and for discussions about the scale and scalability of theory in HCI as it applies to systems of all sizes.

We start by presenting the risk-driven spiral model of Boehm, Pew, and Mavor [4]. We then present an ontology of HCI research, which suggests work that is currently not being done. This model also raises several theory-based discussion questions, some of which remain unanswered. These questions include understanding the risks that are important in each domain, knowing how to teach and defend our work to managers and funders, and tracking current system development risks, sharing lessons across projects (so we will include a small exercise with the audience). We then reflect on the implications for HCI noting suggestions for revising our teaching and presentation of HCI, and then several discussion points about understanding current risks, including that we need to know the risks, and not teach small risks, and study big risks.

Author Keywords

Risk-driven spiral model; HCI theory; HCI examples

ACM Classification Keywords

D.2.1 Requirements/Specifications (D.3.1); D.2.5 Testing and Debugging; D.2.5 Testing and Debugging; D.2.10 Design [**] (D.2.2); H.5 INFORMATION INTERFACES AND PRESENTATION; K.4.1 Public Policy Issues; K.6.1 Project and People Management; Design; human factors; theory.

OVERVIEW OF RISK-DRIVEN DESIGN

Boehm and Hansen [2] argue that most systems development follows an iterative cycle, often represented as a spiral model. This model can be applied to small systems development projects [5] as well as to much larger projects.

Human factors issues have been explicitly incorporated into the spiral model by the US Committee on Human-System Design Support for Changing Technology [4]. The revised, Risk Driven Incremental Commitment Model (RD-ICM) encourages incremental development of systems in an ongoing spiral process comprising requirements specification, technical exploration, and stakeholder commitment. Movement around the spiral represents time and commitment and work on the project (see Figure 1).

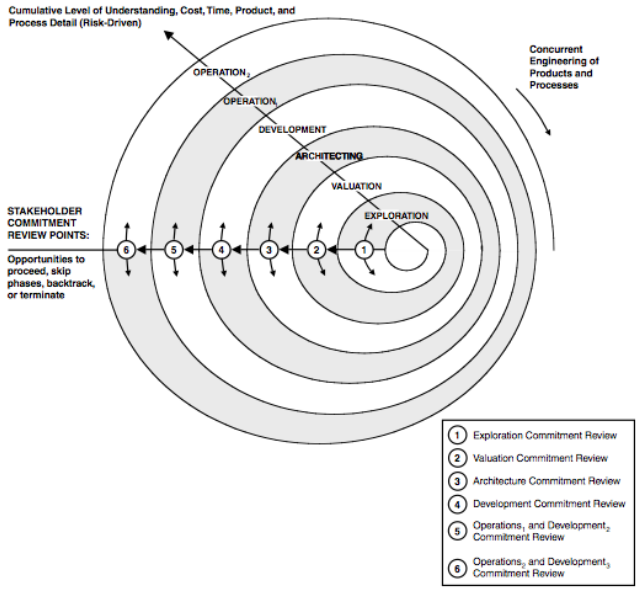

Figure 1. The RD-ICM Model as a spiral showing the important stages and cycles.

The spiral development process can also be viewed linearly (Figure 2). At each stage, the system development is assessed for risks to the system's success. The development process then focuses on managing these risks. Risks associated with technical issues (e.g., Can we build it? Can we build it for that price?) are reduced by increasing the understanding of those issues and how to deal with them. Other risks can arise from historical events, for example, which are harder to reduce; and from financial matters, which can often be reduced through fixed price contracts.

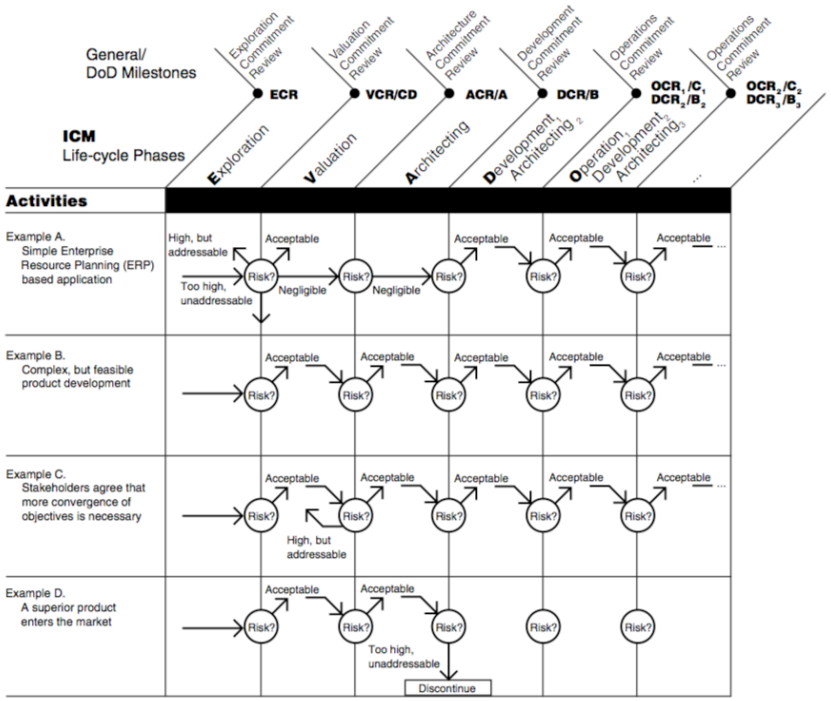

Figure 2. The RD-ICM Model laid out linearly, showing how different risk patterns yield different developmental processes.

Several of the many implications arising from the use of this model have already been addressed [4, 6], including its applicability to the development of systems of *all* sizes. Here, we would like to examine a few other particularly interesting implications where the HCIC audience can help influence the framework.

ONTOLOGY OF HCI RESEARCH

The spiral model can be used to create an ontology to characterize HCI research. This ontology can be used, for example, to help find areas that are little explored. We can suggest at least these initial categories of HCI research (there are no doubt others, and we believe that this is an important discussion point for the presentation):

1. Creating a new task capability or artifact, developing a new artifact, e.g., the Apple watch or web service.
2. Case studies of methods that are deemed useful in reducing important risks, e.g., applying or improving GOMS, or user modeling, or ethnographic studies.
3. Work to characterize particular user populations or task / application sets.
4. How the team organization can influence how design can be done

This list is built on assumptions about risk sizes and probabilities. It has little to say about measuring current risks. One theory-based suggestion that emerges from this ontology is that there should be further investigation of the risks that lead projects to fail, both during development and after delivery.

THE PSYCHOLOGY OF USER-RELATED RISK IN THEORY AND IN PRACTICE

Work on user-related risk has often been driven by the magnitude of the consequences, e.g., in aviation, where accidents can lead to the loss of hundreds of lives. In consumer products, however, there has been less research because the consequences, although more widespread, are often irritating rather than fatal.

Questions that remains are: how much do designers need to know about users? Does knowing the user really reduce risks to development? Is folk psychology good enough? Clearly it is not in some cases, but how would we judge it and how would we teach it? Where is folk psychology particularly dangerous, and can designers accurately judge when folk psychology will fail?

The examples we use to illustrate HCI problems need to be useful and applicable. The infamous double-handled door that you cannot tell whether to push or pull open is still sold and used. So maybe a double-handed door (perhaps we can call this a Norman door?) is not actually a risk to the success of any system if the door takes an extra three seconds to use. Where doors do matter, such as server doors and exit doors, the problems with the doors are

alleviated. Are we reducing the impact of our teaching and outreach by using examples of what are thus only trifling risks? And should we be searching for and documenting more important and compelling risks? (We believe we should.)

THE FUTURE OF RISK AND RISK MANAGEMENT AND RESILIENCE

As we become more reliant on technological systems that are increasing in size and complexity, the resilience of these systems becomes critical as a way to protect against unforeseen risks. In particular, we need to understand the four essential capabilities of resilience [3]: (a) knowing what to do; (b) monitoring the things that change; (c) anticipating future changes; and (d) learning from experience; and the risks associated with these capabilities as they apply to users. These risks will change over time as the system, broadly defined, evolves to meet changing demands, and perhaps interact and interoperate with other systems, and as the users evolve and become more experienced in using the system. The way that we manage these risks will also change, and we may need to develop new methods and tools to deal with new risks.

Car driving offers a good example of the changing face of risks and risk management. There is still the risk that a car can run out of fuel, but the risks associated with skidding in adverse road conditions have been mitigated by anti-lock braking systems. Driverless cars introduce a whole new set of risks, which will require different mitigation strategies and HCI methodologies to those used for smart phone apps. There are still a lot of unknown unknowns in the field of self-driving cars: e.g., how do we make them operate successfully alongside traditional cars on winding country roads with sharp, blind bends? What does the car do when it encounters a situation it has not been programmed to deal with? For example, Google's car currently passes control to the human driver. If the driver has not been kept in the loop and doesn't have awareness of the situation that led to the passing of control, this can lead to particularly unfortunate consequences.

This passing of control when automation can no longer manage the process has long been noted as an irony of automation by Bainbridge [1]. For these sorts of problems, the mitigation strategies will include user studies, but these are likely to be carried out in ways that are different to the way we currently do them. If we no longer allow the driver to manually drive, will that skill erode over time, so when it is needed to deal with a new situation, the driver can no longer take the actions that are required in a timely manner? We may have a usability study created where users are dropped into the middle of difficult driving situations, across the US.

CURRENT RISKS AND SPRINGBOARD TO DISCUSSION

To encourage discussion and as a springboard to discussion, depending on the format of the presentation, we will ask the audience to judge risks from a sheet, and to work in buzz groups to discuss what they think the largest risks are for several types of HCI development projects, from smart phone apps to autonomous cars.

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