Risk-Driven Design
a review of Pew & Mavor (2007)


- Offers a New look at HCl/HSI - It is risk-driven process
- Offers insights into HCl/HSI organising principles
  - A way of knowing
  - How to argue HCl
  - When to shut up

- 17% of my sabbatical
- Useful for teaching PSU (Stark & Kokini, 2010)
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- The committee
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Goals of this tutorial
- Provide an organizing framework for HSI/HCI/MP:
  - Ways of knowing
  - Teaching materials now on web for free
- Shorten To be taught about system design
- Provide you with tools to argue for better design
  - by reducing risk
- Discuss the application of user models that it represents
  - In offering it thought I wouldn’t need to be conscious!
  - Play with Pretzal.

Problems with (Future) Systems of Systems Development
- Lack of commitment by funders, managers to avoid HSI risks
- Lack of communication between system engineers and human-system experts
- Difficulties providing data about humans into the design process
- Thus, the study literature survey at the beginning of the book (also see Booser & Minninger, 2003)

Risk-Driven Design
a review of Pew & Mavor (2007)
- Offers a new look at HCI/HSI - It is risk-driven process
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- A way of knowing
- How to argue HCI
- When to shut up
- 17% of my abstractive
- Useful for teaching PSU (Stark & Kokini, 2009)

About the Spiral Model
- Continuous development of best criteria
- Spiral cycle due to objectives, constraints, alternatives, etc.
- Iterative, rework, and Commissioner for practice
- Lead of system drivers by risk
- Degree of detail drivers by risk
- The greater the lead, the greater the risk!
- Essential spiral model of process and high-level activities and conflicts

Symbiq IV Pump ICM Process
- Exploration Phase
  - Stakeholder needs: interview, field observations
  - Initial user interface prototypes
  - Competitive analysis, system mapping
- Commitment to proceed
- Validation Phase
  - Safety analysis and prioritization
  - Display viability/option prototypes and analysis
  - Top level life cycle plan, business case analysis
- Safety and risk assessment
- Commitment to proceed while addressing risk

Implications
A way to view
- Comparisons
- other applications
Risks related to seeing system engineers
- People need to develop, but data
  - Risks related to seeing system engineers
- Can/could
If no HSI risk
Goals of this tutorial

- Provide an organizing framework for HSI/HCI/HF:
  -- Ways of knowing
  -- Teaching materials now on web for free
    - Show/Learn how to leverage the results of the report
  -- Teach and be taught about system design
  -- Provide you with tools to argue for better design
  -- by reducing risk
    - Discuss the application of user models that it represents

- In offering it I thought I would not be co-chair!
- Play with Prezzi.com
Problems with (Future) Systems of Systems Development

- Lack of commitment by funders, managers to avoid HSI risks
- Lack of communication between system engineers and human-system experts
- Difficulties providing data about humans into the design process
- Thus, the study/literature survey at beginning of book (also see Booher & Minniger, 2003)
Pew and Mavor (2007) Charged to:

Work with a panel to

- Comprehensively review issues
- Evaluate state of the art in HSI (and engineering)
- Develop a vision
- Recommend a research plan
Starts with Boehm's Spiral Model

Boehm & Hansen (2001)

[Spiral] Process Model Principles

1. Commitment and accountability
2. Success-critical stakeholder satisficing
3. Incremental growth of system definition and stakeholder commitment
4, 5. Concurrent, iterative system definition and development cycles
[Spiral] Process Model Principles

1. Commitment and accountability
2. Success-critical stakeholder satisfying
3. Incremental growth of system definition and stakeholder commitment
4, 5. Concurrent, iterative system definition and development cycles
   Cycles can be viewed as sequential concurrently-performed phases or spiral growth of system definition
6. Risk-based activity levels and anchor point commitment milestones
Life cycle phases

- Exploration
- Valuation
- Architecting
- Development
- Operation

Phase steps

- Evaluate alternatives with risk analysis & prototype
- Develop/verify
- Plan/architect
- Review [with stakeholders]
- Cost
Essentials of the Spiral Model

- Concurrent development of key artifacts
- Each cycle does Objectives, Constraints, Alternatives, Risks, Review, and Commitment to Proceed
- Level of effort driven by risk
- Degree of detail driven by risk
- Use anchor point milestones
- Emphasis on system and life cycle activities and artifacts
Further insights:
- Why you start with KLM to look at built systems used to be given rational than
- Can look for missing methods
- Many HCI projects are not in small box, but cut across homogeneous.
- Many are constrains on things in the boxes, or ways to reuse the boxes, or ways to share results across boxes.
- Can choose method based on risk if you care about risk, or project if you care about method.
- Some work ignores this flow, and ends up being narrower, undefined set to process, and further from designers.

Small Example 1

Small Example 2

Implications for System Design
A way to view system design:
- Similar to waterfall (e.g., http://www.waterfall2006.com/)
- Other approaches in book

Other approaches in book:
- Risks related to humans (users) are often ignored by system engineers
- People naturally work on risks, so theory is not just normative but descriptive
- Risks related to hardware are ignored by HCI professionals
- Can/could/should bring in experts to advise

If no HCI risks, then nothing needed from HCI.
- See recommendations in book
- Other recommendations
- Can be used to classify HCI ways of knowing.
Incremental Commitment in Gambling

- Total Commitment: Roulette
  - Put your chips on a number
    - E.g., a value of a key performance parameter
  - Wait and see if you win or lose

- Incremental Commitment: Poker, Blackjack
  - Put some chips in
  - See your cards, some of others’ cards
  - Decide whether, how much to commit to proceed
Example risks

- Can't manufacture
- Can't deliver
- Performance does not match other stake holder requirements
- Wrong types of developers and HIS professionals
- Performance does not satisfy user requirements
- Mismatch of system to context (sand in tools)
- See Booher and Minniger (2003), Casey (1988), etc.
FIGURE 4-3 Steps in risk analysis.

1. Define analysis method
2. For candidate risks & executed risk mitigation plans, determine:
   - Likelihood & consequence
   - Risk level
3. Assess impacts to program
4. Prioritize & denote significant risks
# ICM HSI Levels of Activity for Complex Systems

<table>
<thead>
<tr>
<th>Activity category</th>
<th>Levels of activity</th>
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</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
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<tr>
<td>Envisioning</td>
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<tr>
<td>opportunities</td>
<td></td>
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<tr>
<td>System-scoping</td>
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<tr>
<td>Understanding</td>
<td></td>
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<tr>
<td>needs</td>
<td></td>
</tr>
<tr>
<td>Goals/objectives</td>
<td></td>
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<tr>
<td>Requirements</td>
<td></td>
</tr>
<tr>
<td>Architecting and</td>
<td></td>
</tr>
<tr>
<td>designing solutions</td>
<td></td>
</tr>
<tr>
<td>a. system</td>
<td></td>
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<tr>
<td>b. human</td>
<td></td>
</tr>
<tr>
<td>c. hardware</td>
<td></td>
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<tr>
<td>d. software</td>
<td></td>
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<tr>
<td>Life-cycle planning</td>
<td></td>
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<tr>
<td>Evaluation</td>
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<tr>
<td>Negotiating</td>
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<tr>
<td>commitments</td>
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<tr>
<td>Development and</td>
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<tr>
<td>evolution</td>
<td></td>
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<tr>
<td>Monitoring and</td>
<td>Legacy</td>
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<tr>
<td>control</td>
<td></td>
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<tr>
<td>Operations and</td>
<td></td>
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<tr>
<td>retirement</td>
<td></td>
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<tr>
<td>Organizational</td>
<td></td>
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<tr>
<td>capability</td>
<td></td>
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<tr>
<td>improvement</td>
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</tbody>
</table>
FIGURE 2-2 Different risks create different ICM processes.

(From: Sillars and Wehner 2015.)
HUMAN-SYSTEM INTEGRATION IN SYSTEM DEVELOPMENT

General/DoD Milestones
- ECR
- VCR/CD
- ACR/A
- DCR/B
- OCR/C
- DCR/B
- OCR/C
- DCR/B

ICM Life-cycle Phases
- Exploration
- Valuation
- Architecting
- Development
- Operation

Activities

Example A.
Simple Enterprise Resource Planning (ERP) based application
- High, but addressable
- Acceptable
- Too high, unaddressable

Example B.
Complex, but feasible product development
- Acceptable

Example C.
Stakeholders agree that more convergence of objectives is necessary
- Acceptable
FIGURE 2-2 Different risks create different ICM processes.

(e.g., see Baumer & Silberman, 2011)
Small example: Scalable remotely controlled operations 1 of 2

Total vs. Incremental Commitment – 4:1

Total Commitment
- Agent technology demo and PR: Can do 4:1 for $1B
- Winning bidder: $800M; PDR in 120 days; 4:1 capability in 40 months
- PDR: many outstanding risks, undefined interfaces
- $800M, 40 months: "halfway" through integration and test
- 1:1 IOC after $3B, 80 months

Incremental Commitment [number of competing teams]
- $25M, 6 mo. to VCR [4]: may beat 1:2 with agent technology, but not 4:1
- $75M, 8 mo. to ACR [3]: agent technology may do 1:1; some risks
- $225M, 10 mo. to DCR [2]: validated architecture, high-risk elements
- $675M, 16 mo. to IOC [1]: viable 1:1 capability
- 1:1 IOC after $1B, 42 months
Total vs. Incremental Commitment – 4:1
RemPilotVeh 2 of 2

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Small Example 2

Example HCI Application:
Symbiq Medical Infusion Pump
Winner of 2006 HFES Best New Design Award
Described in NRC HSI Report, Chapter 5

Symbiq IV Pump ICM Process - I

- Exploration Phase
  - Stakeholder needs interviews, field observations
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Symbiq IV Pump ICM Process - II

- Architecting Phase
  - Modularity of pumping channels
  - Safety feature and alarms prototyping and iteration
  - Programmable therapy types, touchscreen analysis
  - Failure modes and effects analyses (FMEAs)
  - Prototype usage in teaching hospital
  - Commitment to proceed into development

- Development Phase
  - Extensive usability criteria and testing
  - Iterated FMEAs and safety analyses
  - Patient-simulator testing; adaptation to concerns
  - Commitment to production and business plans

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  - Can/could/should bring in experts to advise
If no HCI risks, then nothing needed from HCI
  - See recommendations in book
  - Other recommendations?
Can be used to classify HCI ways of knowing:
Methods for Reducing HSI Risks

Three major periods of use
- Define context of use
- Define requirements and design solutions
- Evaluate

All fit back into spiral
All used to reduce risks using previous approaches
We have bags of these methods!
Classification to period is somewhat arbitrary
Not exhaustive, illustrative lists to follow
Model building tools: MBT, constraints
ABCS of HCl and Psi: up to coding
How to run a study: reviews, benchmarks
CaffeineZone, dismal: all as implementer
Models of user: potentially all
Social aspects: too many to list
ABCS of HCl: up to coding
How to run a study: reviews, benchmarks
FIGURE 6-2 Context of use encompasses consideration of the user, the task situation, the social and organizational structure within which activities take place, as well as the physical and technical environment that collectively provide opportunities and impose constraints on performance.
### TABLE 6-4 Examples of Uses of Event Data Analysis

<table>
<thead>
<tr>
<th>Question</th>
<th>Type of Event Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>What does the operator do from moment to moment? What options are not used? What options precede the request for help? What action sequences occur often enough to be automated or assisted?</td>
<td>Keystrokes, mouse movements, click streams.</td>
</tr>
<tr>
<td>What are the service demands made on a shared resource (like a server or a database)? What are critical dates or times of day? How can server/database traffic be anticipated or smoothed?</td>
<td>Hits on a web site. Database accesses. Server traffic. (While conventional server logs provide a very low-level view of these demands, instrumentation can provide a work-oriented account of server demands.)</td>
</tr>
<tr>
<td>What are the current issues that the organization is grappling with? What is the organization’s current intellectual capital?</td>
<td>User-initiated social-software events and data, like tag creation and tag modification, blog entries, wiki entries, and current searches.</td>
</tr>
<tr>
<td>What are people thinking and planning as they work? What confuses them?</td>
<td>Think-aloud reports. Verbal reports. Paired-user testing.</td>
</tr>
<tr>
<td>What is the communication network in the organization? Who communicates with whom?</td>
<td>Communications events (email, chat, meeting attendance).</td>
</tr>
<tr>
<td>What is the context of critical events? How often do critical events occur and what events preceded and follow them?</td>
<td>Stream of video events (e.g., in an emergency room or air traffic control center). One or more recordings of shared radio frequencies among emergency responders.</td>
</tr>
<tr>
<td>How do people use the work space? What communication patterns or traffic patterns occur? How can the space be used more effectively or efficiently?</td>
<td>Movement in an office space.</td>
</tr>
</tbody>
</table>
What does this mean for HCI and HCIC?

All HCI techniques can be seen as a way to reduce risk.

For each stage, HCI techniques to reduce risk:

- Define opportunities and context of use: scenarios, personas, task analysis
- Define requirements and design solutions: TA, models
- Evaluate: VPA, behavior loggers (e.g., RUI)
- Insert your favorite method

Shared representations are passed between these stages.
Shared Representations as Part of Design Process - Uses

- Examined critically
- Reduce working memory load
- Make explicit what is explicit and implicit
- Produce new connections
- Collaboratively produce new knowledge
- Transfer knowledge
Further Insights

- Why you start with KLM to look at built systems: used to be given system then
- Can look for missing methods
- Many HCI projects are not in a small box, but cut across boxes/ phases,
- Many are constraints on things in the boxes, or ways to view the boxes, or ways to share results across boxes
- Can choose method based on risk if you care about risk, or project if you care about method!
- Some work ignores this flow, and ends up being narrow, undefined wrt to process, and further from designers
Suggestion 1.
An Integrated Methodology

- Generate a quantitative baseline
- Define opportunities and requirements, and context of use
  - Broad use of Shared Representations
- Design solutions
  - Priorities based on risks
  - Shared representations developed, e.g.,
    - From personas to running models
    - Gantt charts become time-based and synched with scenarios and prototypes
    - Scripted modules to hardware and software
    - Software from designs to code (seamlessly (!))
- Evaluation
  - Including model-based and stakeholder evaluation at the end
- Integration thus means:
  - Across stages of shared representations
  - Builds upon previous stages results
  - Teams integrated across stages
  - System integrated before release
- HSI-led teams
- To avoid risks to mission, risks to usability
  - Booher & Minneger, 2003 have numerous examples
4. Greater User Participation

- Context of use methods can be expensive
- Approaches to capturing user input (and creating mods)
  - Combine lists with maps (mash-ups)
  - RSS feeds and associated tools
  - Social bookmarks
  - Blogs and associated multimedia
  - Wikis
- Systems Engineering for User Participation in these approaches
  - Building tools and systems to support users in this process
  - Design for end user customization
  - Support issue tracking and resolution
Book Conclusions

- Include HSI early, understand how to do it
- Tailor methods to risk and resources
- Ensure communication of shared representations (models of various things)
- Design to accommodate change
- Encourages projects
  - To develop process
  - to implement HSI as a field
  - to improve models (ease to create, ease to understand, quality), shared representations, data analysis
  - to improve usability objectives
Ritter's Conclusions and Final Insights

* A way to describe the ways of knowing in HCI
-- and where and why
* It provides insights into how to apply HCI, missing aspects of HCI, and insights into ways of knowing
Insight: Impact on next project
--Size of users tasks, complexity of tasks, their interrelation, scope
--May be true for all methods
--So shared to next design, and understanding of designer
Insight: Designers think they are already risk driven
--Good, buy-in to part
--Bad, already know how
--Insight: need to give designers counter examples
Insight: Education and sharable representations are more important than one might think
References


Ritter's Conclusions and Final Insights

- A way to describe the ways of knowing in HCI
- And where and why
- It provides insights into how to apply HCI, missing aspects of HCI, and insights into ways of knowing

Design: Impact on next project
- Size of users, tasks, complexity of tasks, their interrelation, scope
- May be true for all methods
- So shared to next design, and understanding of designer
- Insight: Designers think they are already risk driven
- Good, buy-in to part
- Fail, already know how
- Insight: need to give designers counter examples

Small Examples

Shared Representations as Part of Design Process - Uses
- Exemplary artifacts
- Resolve modeling, memory load
- Make explicit what is explicit and implicit
- Produce new connections
- Collaboratively produce new knowledge
- Transfer knowledge

What does this mean for HCI and HCIC?

All HCI techniques can become as a way to reduce risk

For each stage, HCI techniques can reduce risk
- Define opportunities and context of use, scenarios, personas, task analysis
- Define requirements and design solutions, TAs, models
- Tasks, TAs, behavior engineering, (R&D)
- Study your forensic method

Shared representations are passed between these stages

Implications for System Design

A way to view system design
- A problem to be solved (https://www.mdot.mdot.md.gov/)
- Either approach is valid
- Rules created and justifying (users) are often ignored by system engineers
- People normally work on risk, so theory is not just processive but descriptive
- Rules of static to dynamic are ignored by II professionals
- Context should bring us to expertise to advise II engineers, then nothing needed from HCI
- See recommendations in book
- Other recommendations?
- Can be used to study HCI ways of knowing

Methods for Studying HCI Links

Three main perspectives on
- Before system is on
- During system and design are attended
- After system is up and running

All and nothing to reduce many scenarios operation
- The use of tools and tools, which are not typically discussed
- Generalization of systems and systems
- But not into different