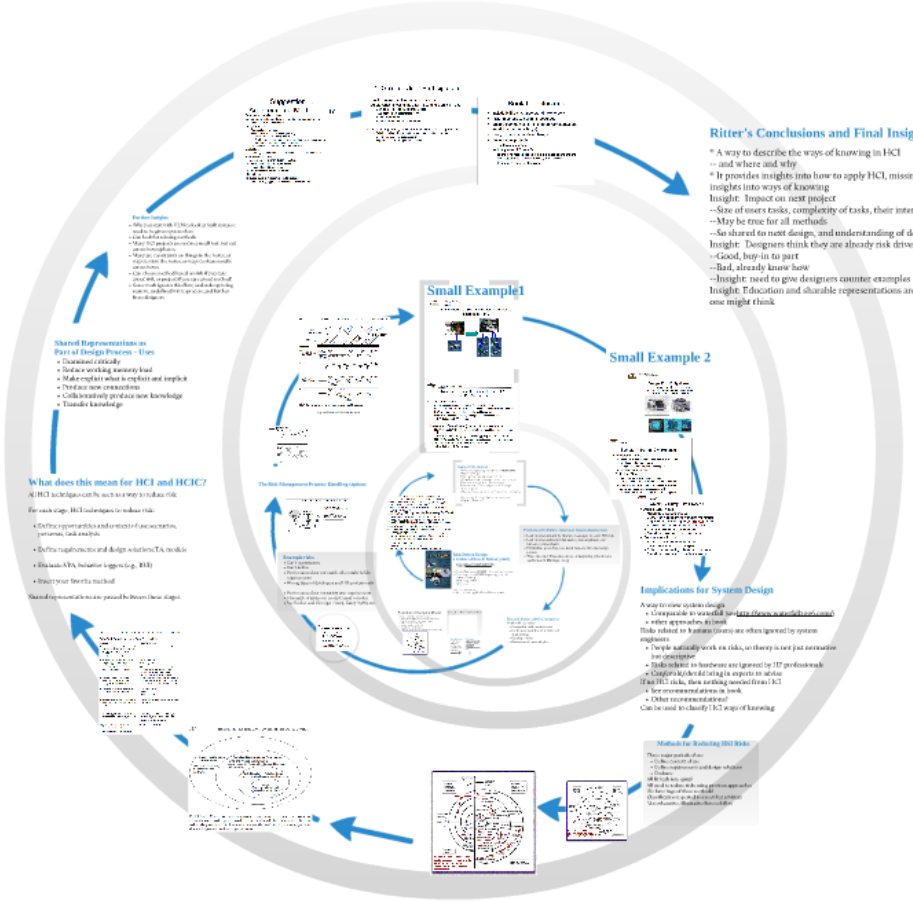
Risk-Driven Design

frank.ritter@psu.edu

HCIC Workshop, 15 June 2011



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

Acknowledgements

- Barry Boehm
- Jeremy Lothian
- Dick Pew
- Anne Mavor
- Erika Poole
- ACS Lab
- guy on plane
- ONR N091-086/P10008, N00014-11-1-0275, N00014-06-1-0164
- The committee

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Stark, R. F., & Kokini, C. (2010). Reducing risk in system design through human-systems integration. Ergonomics in Design, 18(2), 18-22.

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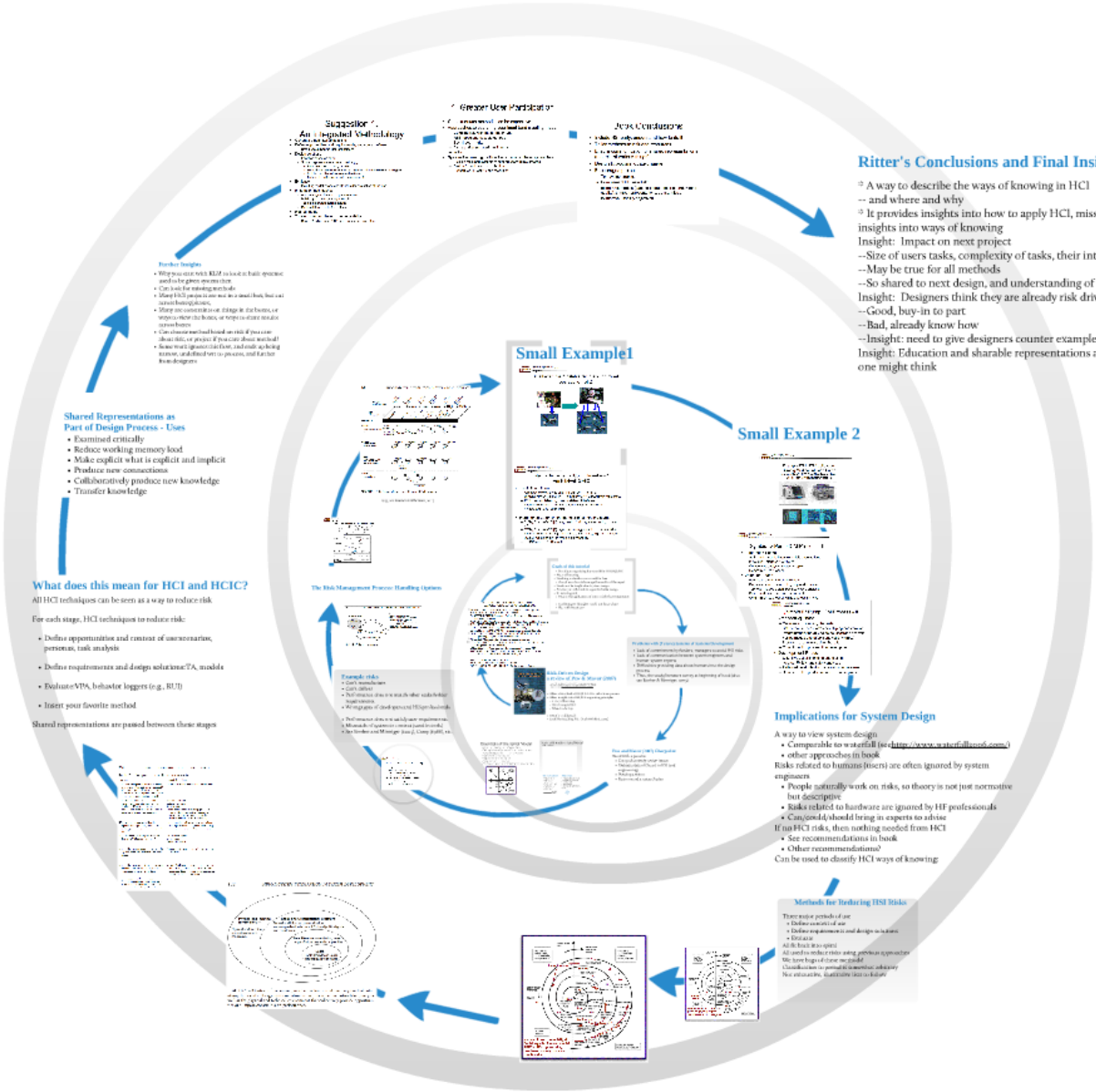

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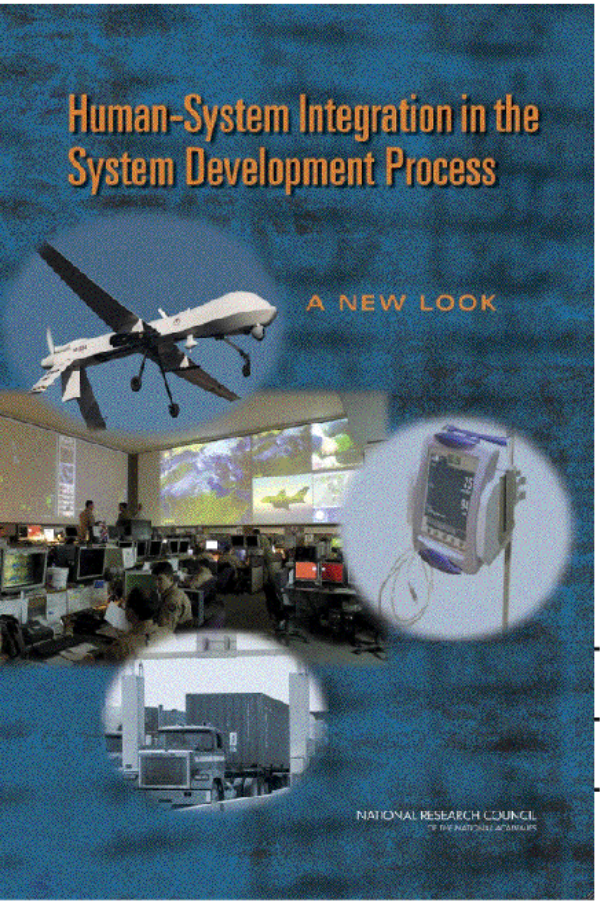

Risk-Driven Design
a review of Pew & Mavor (2007)

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

- 17% of my sabbatical
- Useful for teaching PSU (Stark & Kokini, 2010)

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COMMITTEE ON HUMAN-SYSTEM DESIGN SUPPORT FOR CHANGING TECHNOLOGY

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NIGEL BEVAN, University of York, London
BARRY W. BOEHM, Computer Science Department, University of Southern California
NANCY J. COOKE, Department of Psychology, Arizona State University
* **SHELLEY EVENSON**, School of Design, Carnegie Mellon University
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  - $25M, 6 mo. to VCR [4]: may beat 1:2 with agent technology, but not 4:1
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  - $225M, 10 mo. to DCR [2]: validated architecture, high-risk elements
  - $675M, 18 mo. to IOC [1]: viable 1:1 capability
  - 1:1 IOC after $1B, 42 months

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
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-- by reducing risk
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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:

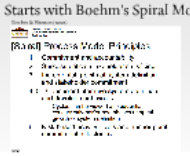
Work with a panel to

- Comprehensively review issues
- Evaluate state of the art in HSI (and engineering)
- Develop a vision
- Recommend a research plan

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

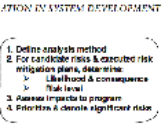
Starts with Boehm's Spiral Model



Life cycle phases
- Exploration
- Valuation
- Architecting
- Development
- Operation

Phase steps

ss: Handling Options



not match other stake holder

elopers and HIS professionals

not satisfy user requirements
n to context (sand in tools)
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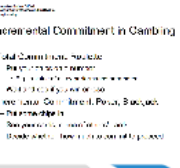

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Symbiq IV Pump ICM Process

- Exploration Phase
  - Stakeholder needs interviews, field observatio
  - Initial user interface prototypes
  - Competitive analysis, system scoping
  - Commitment to proceed
- Valuation Phase
  - Feature analysis and prioritization
  - Display vendor option prototyping and analysi
  - Top-level life cycle plan, business case analys
  - Safety and business risk assessment
  - Commitment to proceed while addressing risk

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Symbiq IV Pun

- Architecting Phase
  - Modularity of pumpin
  - Safety feature and al
  - Programmable therap
  - Failure modes and ef
  - Prototype usage in te
  - Commitment to proce
- Development Phase
  - Extensive usability cr
  - Iterated FMEAs and s
  - Patient-simulator test
  - Commitment to produ

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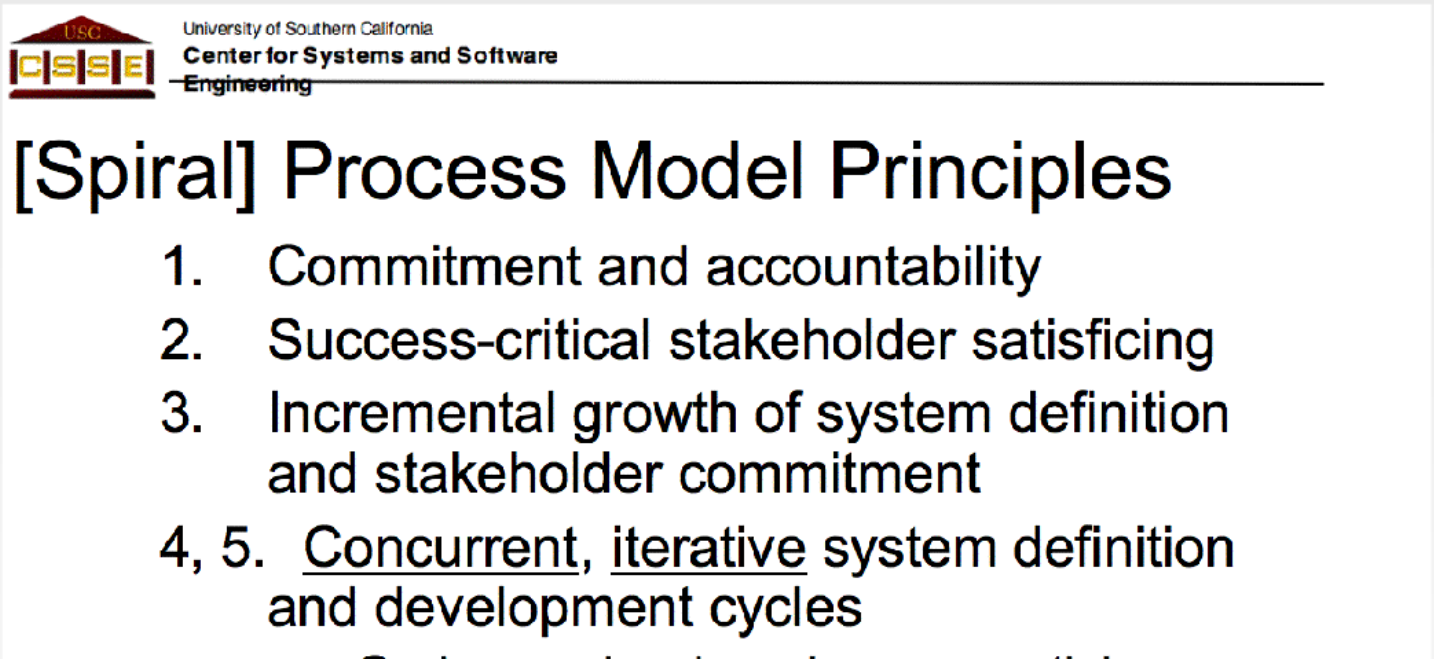

[Spiral] Process Model Principles

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
    - 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

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

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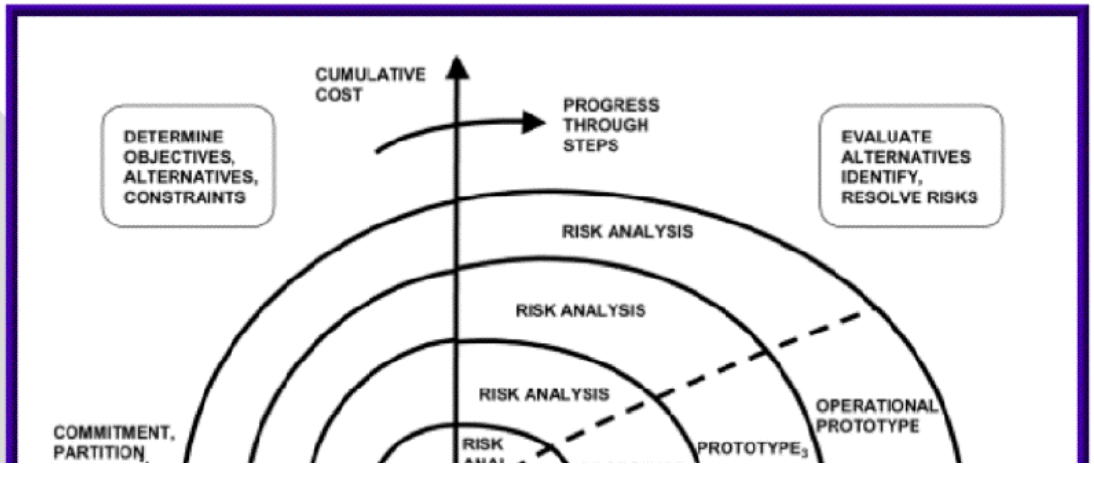

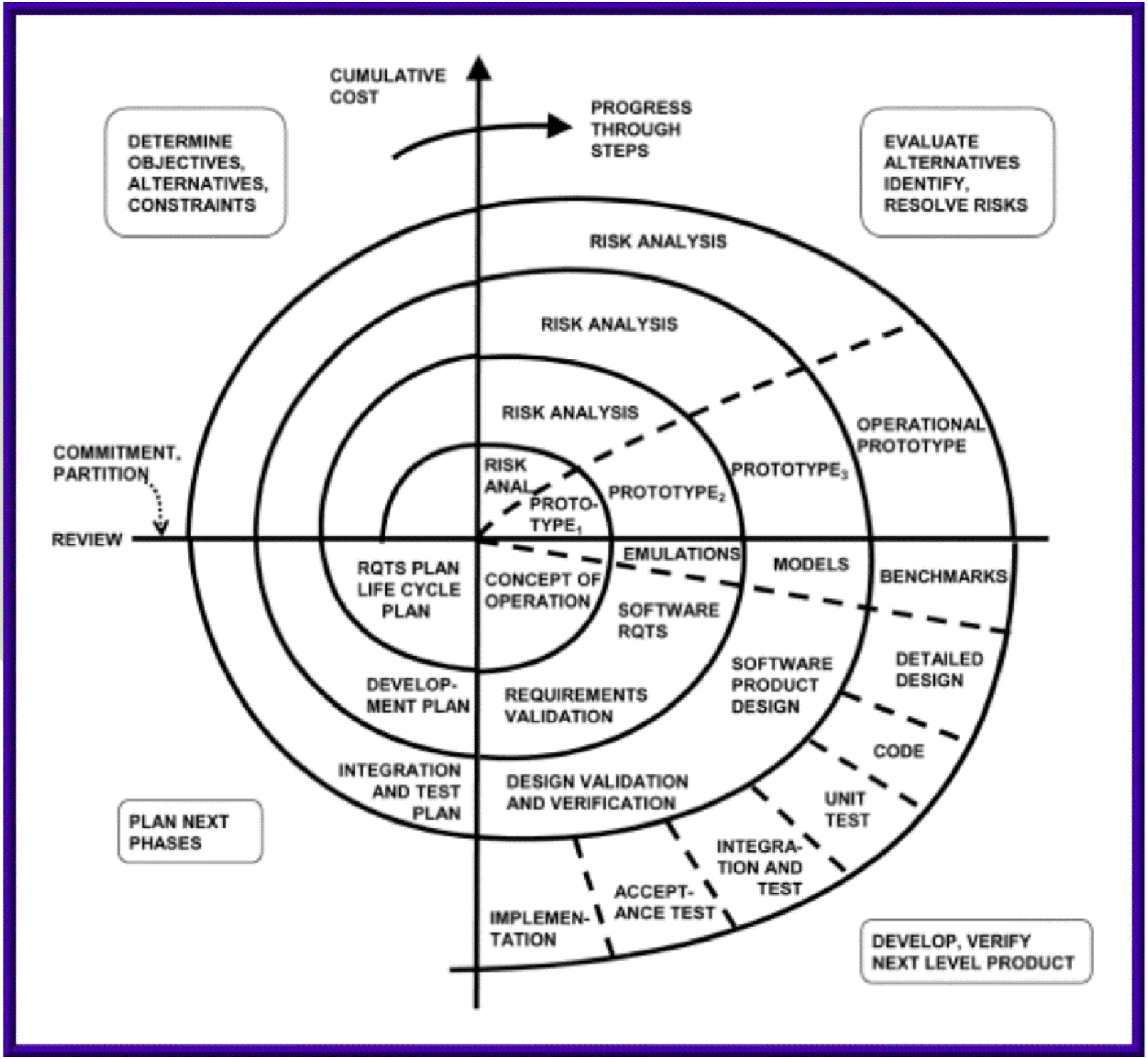
CUMULATIVE COST
PROGRESS THROUGH STEPS
DETERMINE OBJECTIVES, ALTERNATIVES, CONSTRAINTS
EVALUATE ALTERNATIVES IDENTIFY, RESOLVE RISKS
RISK ANALYSIS
RISK ANALYSIS
RISK ANALYSIS
COMMITMENT, PARTITION
REVIEW
RISK ANAL
PROTO-TYPE1
PROTOTYPE2
PROTOTYPE3
OPERATIONAL PROTOTYPE
RQTS PLAN LIFE CYCLE PLAN
CONCEPT OF OPERATION
EMULATIONS
SOFTWARE RQTS
MODELS
BENCHMARKS
DEVELOP-MENT PLAN
REQUIREMENTS VALIDATION
SOFTWARE PRODUCT DESIGN
DETAILED DESIGN
CODE
INTEGRATION AND TEST PLAN
DESIGN VALIDATION AND VERIFICATION
UNIT TEST
INTEGRA-TION AND TEST
ACCEPT-ANCE TEST
IMPLEMEN-TATION
PLAN NEXT PHASES
DEVELOP, VERIFY NEXT LEVEL PRODUCT

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

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way to reduce risk

duce risk:

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solutions:TA, models

e.g., RUI)

etween these stages

-- and where and why
* It provides insights into how to apply HC
insights into ways of knowing
Insight: Impact on next project
--Size of users tasks, complexity of tasks, th
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Insight: Designers think they are already ri
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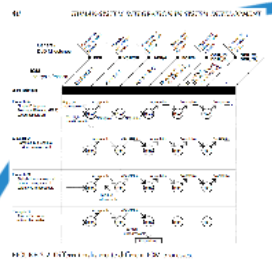
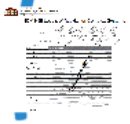
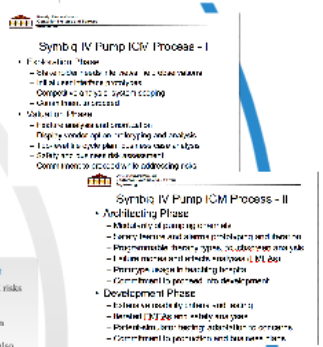
Small Example1





Small Example 2

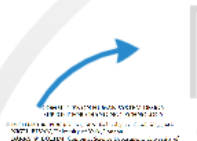


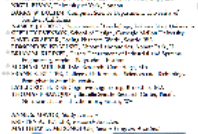
The Risk Management Process: Handling Options

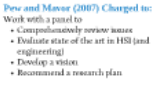
Example risks

- 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.







Implications for System Design

A way to view system design

- Comparable to waterfall (seehttp://www.waterfall2006.com/)
- 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 HF 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

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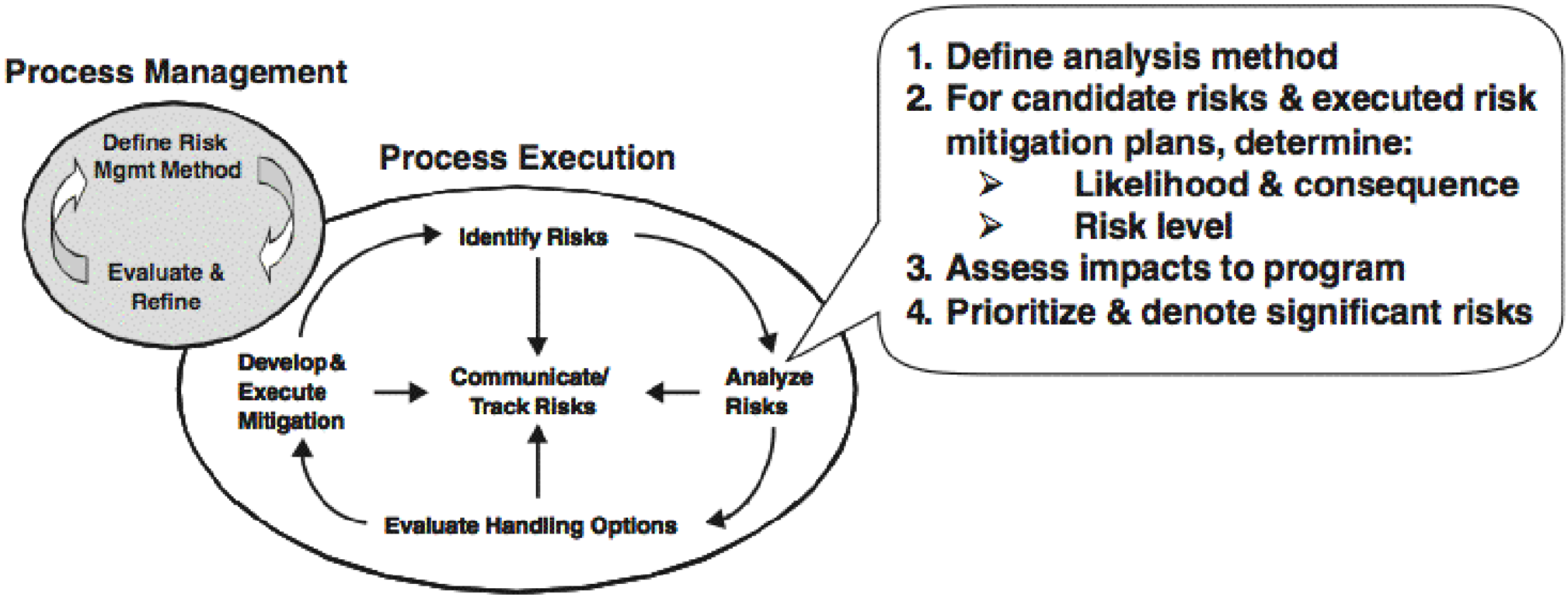
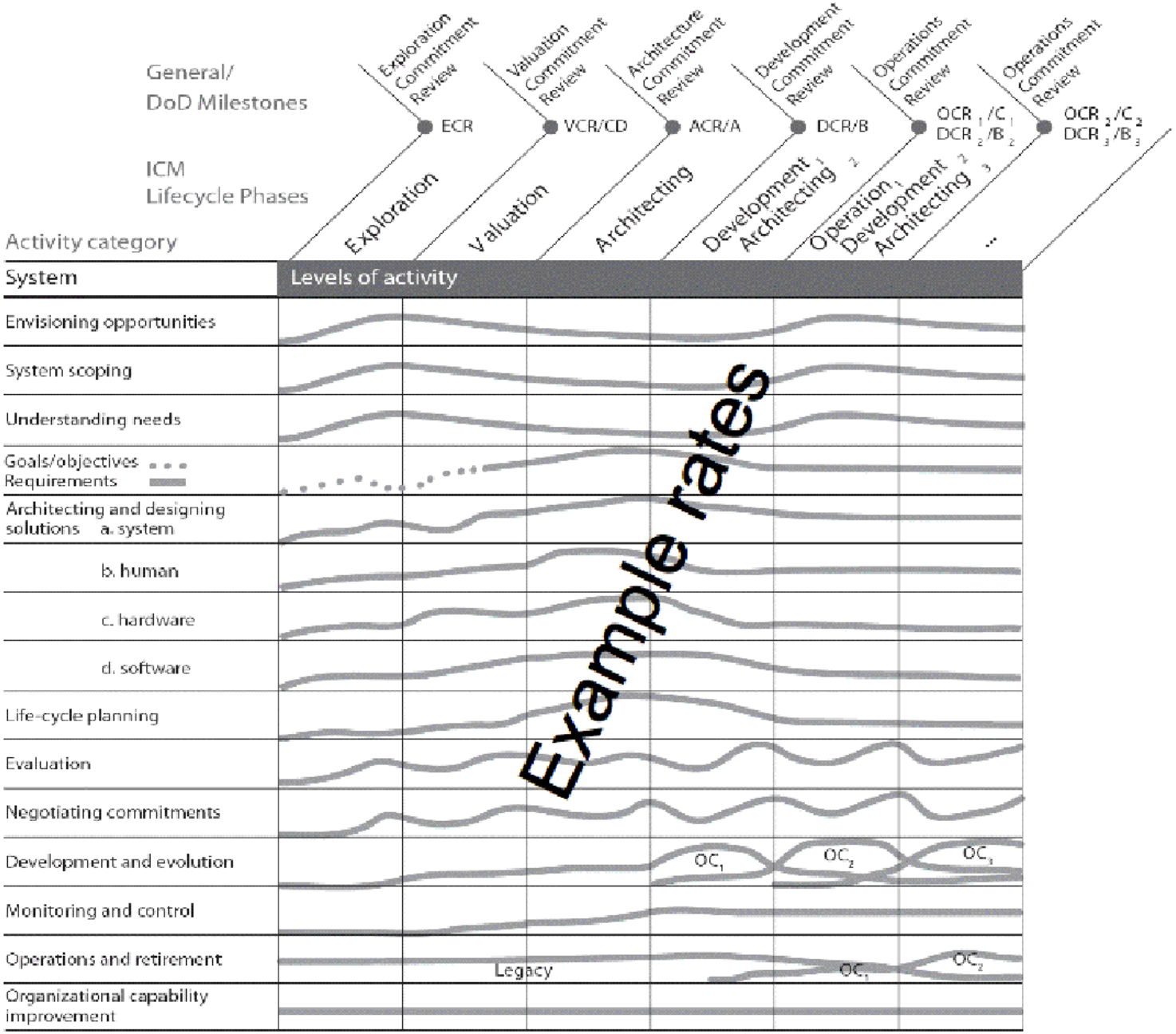


FIGURE 4-3 Steps in risk analysis.

ICM HSI Levels of Activity for Complex Systems



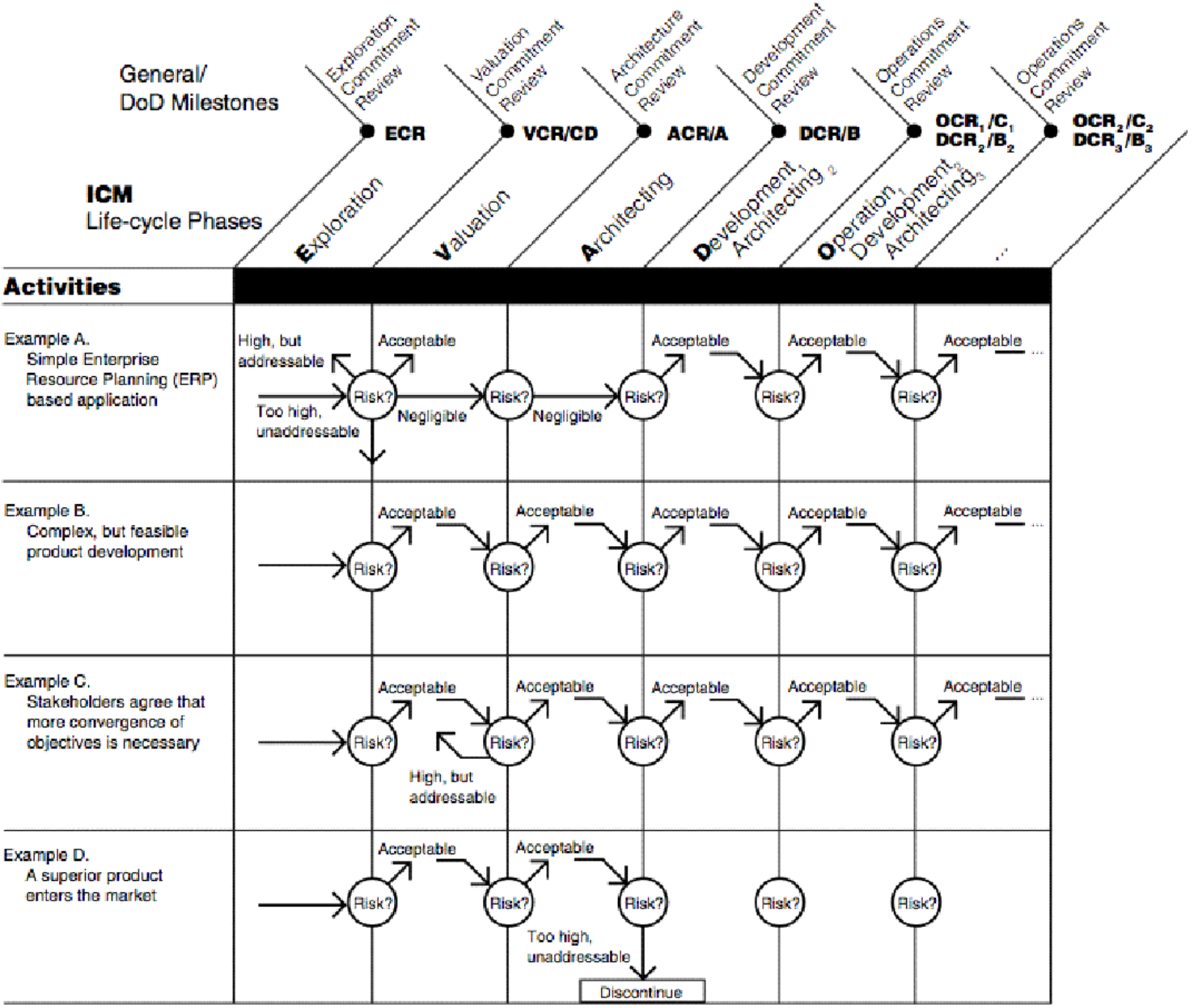
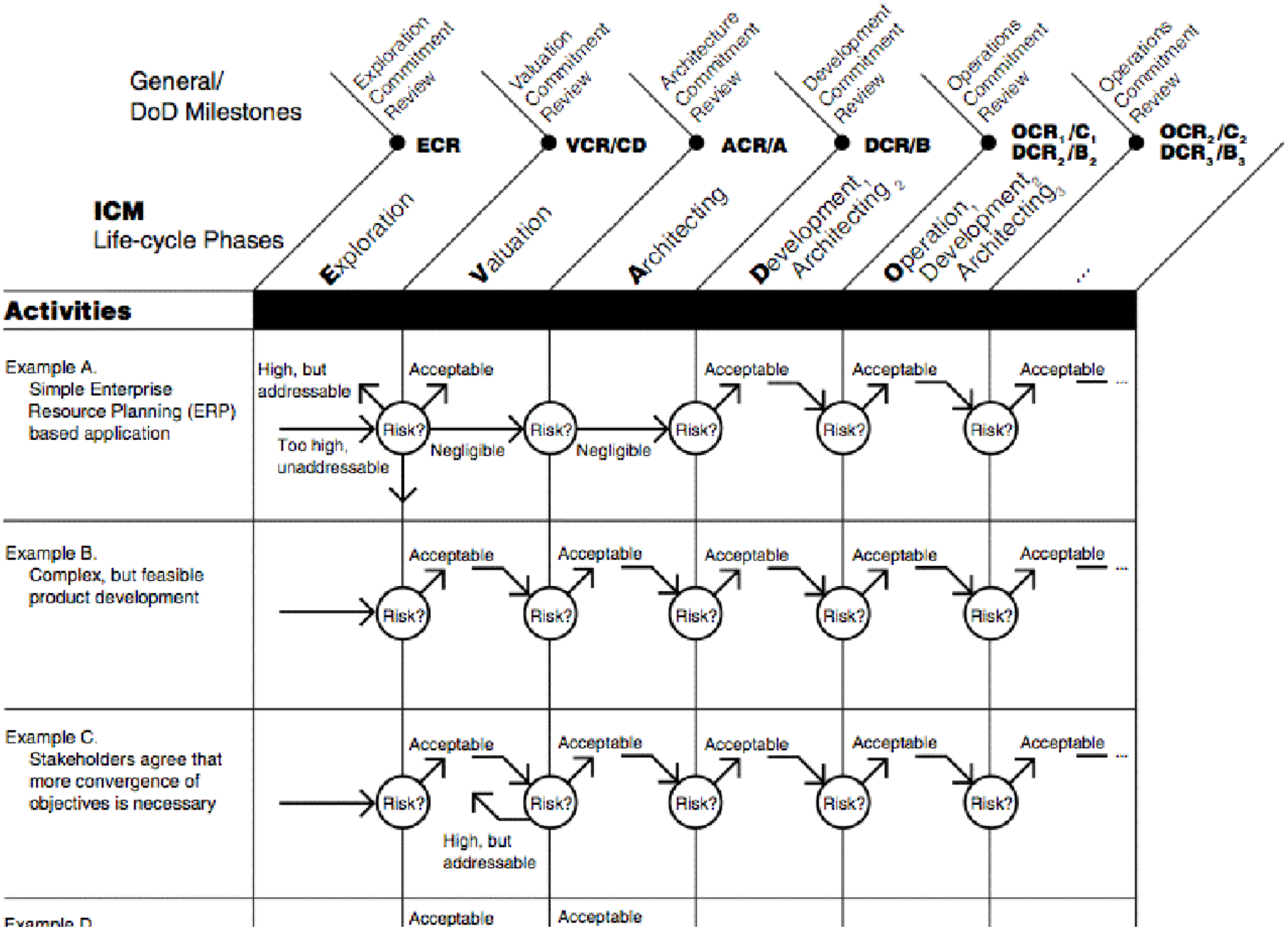


FIGURE 2-2 Different risks create different ICM processes.


General/
DoD Milestones
Exploration Commitment Review
Valuation Commitment Review
Architecture Commitment Review
Development Commitment Review
Operations Commitment Review
Operations Commitment Review
ECR
VCR/CD
ACR/A
DCR/B
OCR1/C1 DCR2/B2
OCR2/C2 DCR3/B3
ICM
Life-cycle Phases
Exploration
Valuation
Architecting
Development1 Architecting2
Operation1 Development2 Architecting3
Activities
Example A.
Simple Enterprise Resource Planning (ERP) based application
High, but addressable
Too high, unaddressable
Risk?
Negligible
Acceptable
Example B.
Complex, but feasible product development
Example C.
Stakeholders agree that more convergence of objectives is necessary
High, but addressable
Example D

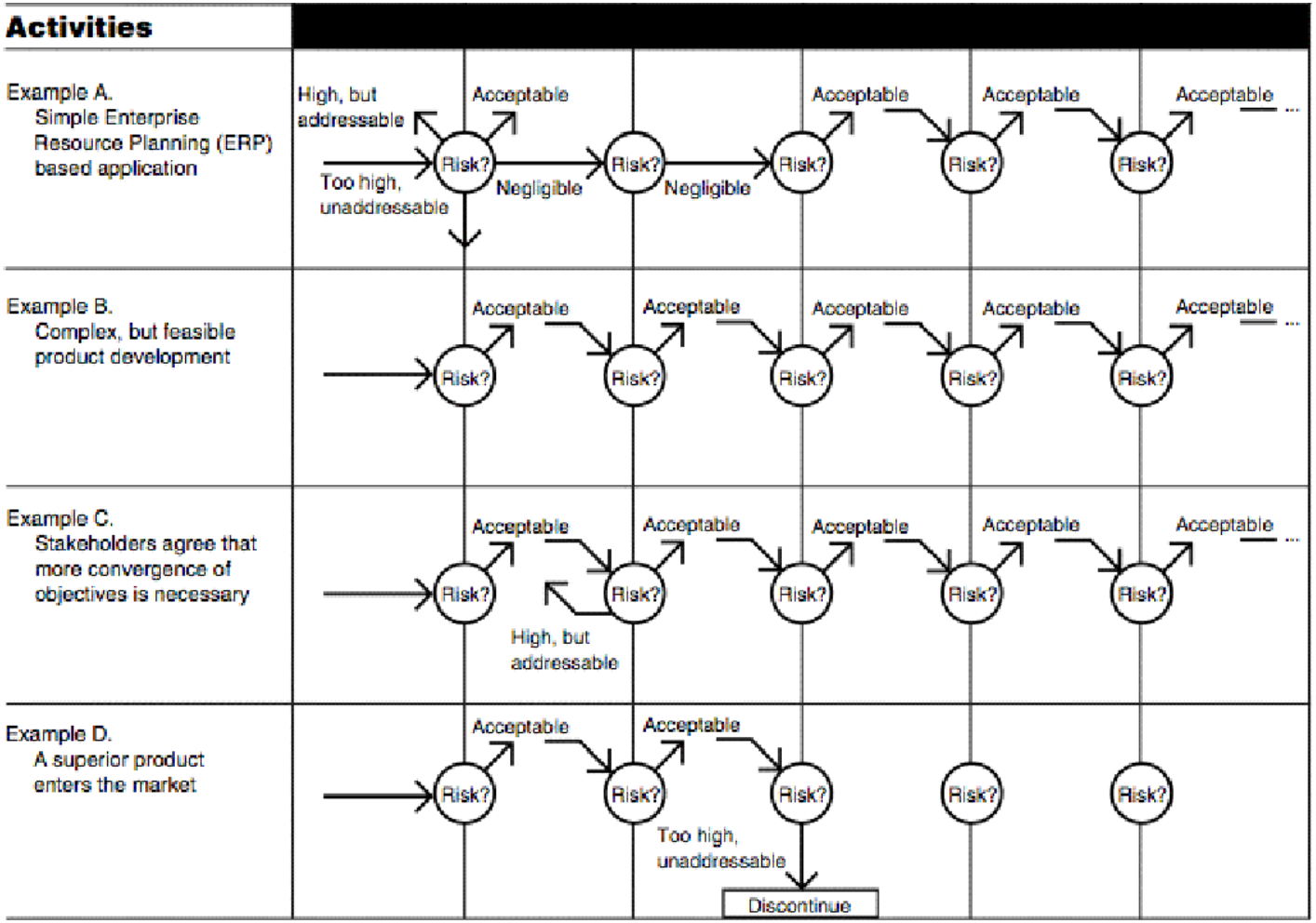


FIGURE 2-2 Different risks create different ICM processes.

(e.g., see Baumer & Silberman, 2011)

Small Example1

processes.

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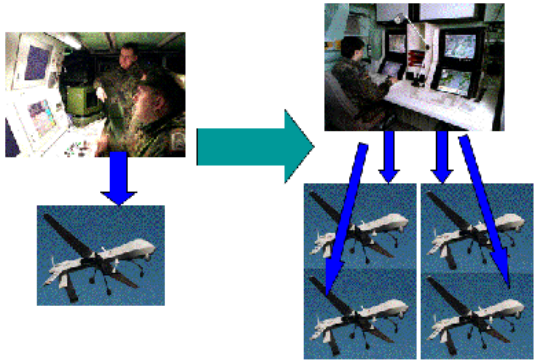
Small example: Scalable remotely controlled operations 1 of 2



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Total vs. Incremental Commitment – 4:1 RemPilotVeh 2 of 2

- 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
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Small Example 2

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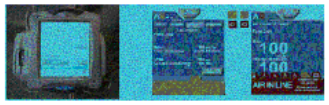
Example ICM HCI Application: Symbiq Medical Infusion Pump

Winner of 2006 HFES Best New Design Award
Described in NRC HSI Report, Chapter 5



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Symbiq IV Pump ICM Process - I

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- Valuation Phase
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  - Top-level life cycle plan, business case analysis
  - Safety and business risk assessment
  - Commitment to proceed while addressing risks

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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

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)

Example ICM 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
  - Initial user interface prototypes
  - Competitive analysis, system scoping
  - Commitment to proceed
- Valuation Phase
  - Feature analysis and prioritization
  - Display vendor option prototyping and analysis
  - Top-level life cycle plan, business case analysis
  - Safety and business risk assessment
  - Commitment to proceed while addressing risks

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

Implications for System Design

A way to view system design

- Comparable to waterfall (seehttp://www.waterfall2006.com/)
- 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 HF 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:

Methods for Reducing HSI Risks

Three major periods of use

- Define context of use
- Define requirements and design solutions
- Evaluate

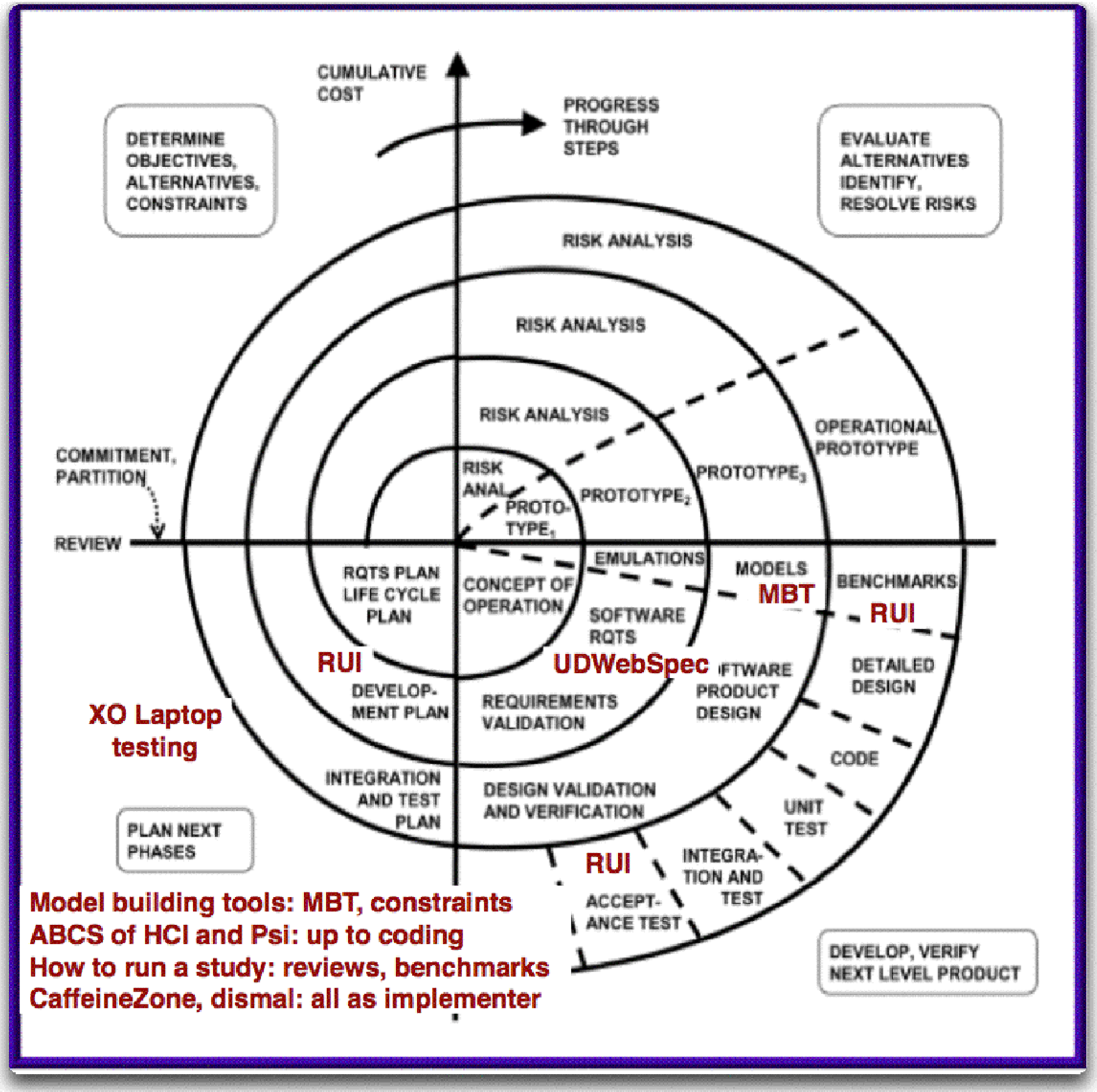
All fit back into spiral

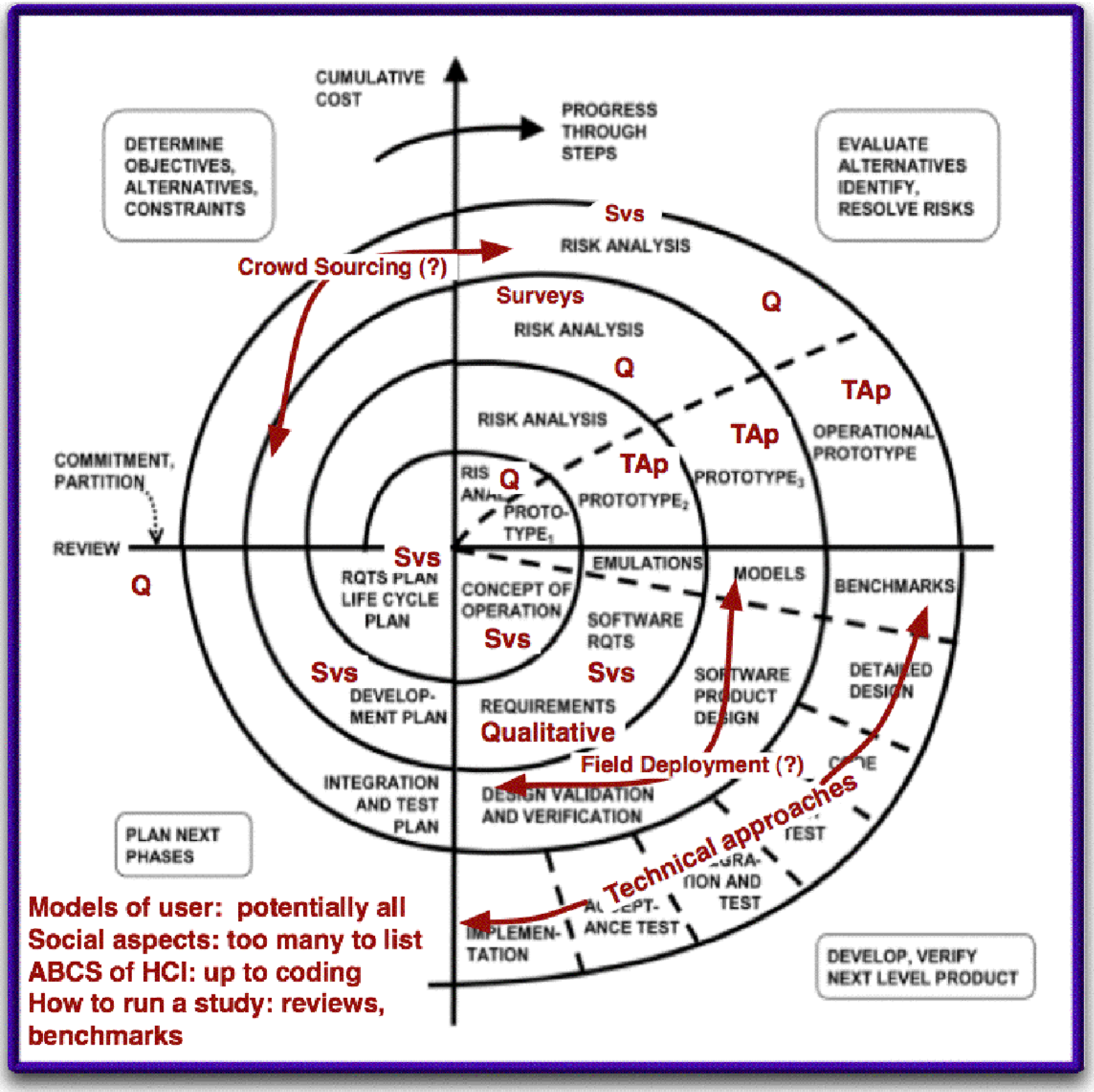
All used to reduce risks using previous approaches

We have bags of these methods!

Classification to period is somewhat arbitrary

Not exhaustive, illustrative lists to follow


CUMULATIVE COST
PROGRESS THROUGH STEPS
DETERMINE OBJECTIVES, ALTERNATIVES, CONSTRAINTS
EVALUATE ALTERNATIVES IDENTIFY, RESOLVE RISKS
RISK ANALYSIS
RISK ANALYSIS
RISK ANALYSIS
COMMITMENT, PARTITION
REVIEW
RISK ANAL
PROTO-TYPE1
PROTOTYPE2
PROTOTYPE3
OPERATIONAL PROTOTYPE
RQTS PLAN LIFE CYCLE PLAN
CONCEPT OF OPERATION
EMULATIONS
SOFTWARE RQTS
MODELS
MBT
BENCHMARKS
RUI
RUI
UDWebSpec
DEVELOP-MENT PLAN
REQUIREMENTS VALIDATION
IFTWARE PRODUCT DESIGN
DETAILED DESIGN
XO Laptop testing
CODE
INTEGRATION AND TEST PLAN
DESIGN VALIDATION AND VERIFICATION
UNIT TEST
PLAN NEXT PHASES
RUI
INTEGRA-TION AND TEST
ACCEPT-ANCE TEST
DEVELOP, VERIFY NEXT LEVEL PRODUCT
Model building tools: MBT, constraints
ABCS of HCI and Psi: up to coding
How to run a study: reviews, benchmarks
CaffeineZone, dismal: all as implementer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PROGRESS THROUGH STEPS
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Crowd Sourcing (?)
Svs
RISK ANALYSIS
Surveys
Q
TAp
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BENCHMARKS
SOFTWARE RQTS
DEVELOP-MENT PLAN
REQUIREMENTS
Qualitative
SOFTWARE PRODUCT DESIGN
DETAILED DESIGN
Field Deployment (?)
INTEGRATION AND TEST PLAN
DESIGN VALIDATION AND VERIFICATION
Technical approaches
PLAN NEXT PHASES
IMPLEMEN-TATION
ACCEPT-ANCE TEST
INTEGRA-TION AND TEST
DEVELOP, VERIFY NEXT LEVEL PRODUCT
Models of user: potentially all
Social aspects: too many to list
ABCS of HCI: up to coding
How to run a study: reviews, benchmarks

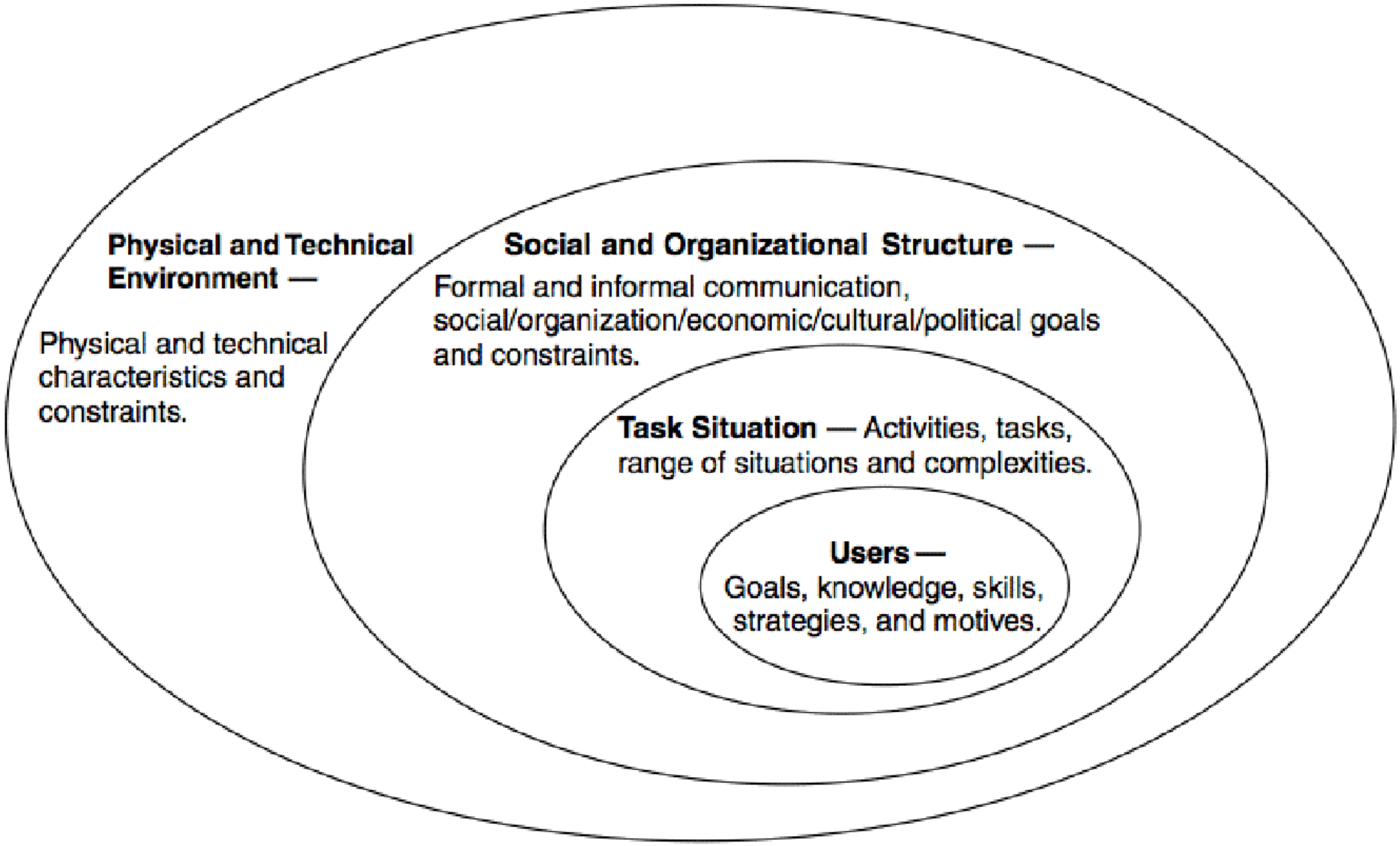

FIGURE 6-2 Context of use encompasses consideration of the user, the task situation, the social and organizational structure within which activities take place, as well as the physical and technical environment that collectively provide opportunities and impose constraints on performance.

TABLE 6-4 Examples of Uses of Event Data Analysis

Question	Type of Event Data
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?	Keystrokes, mouse movements, click streams.
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?	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.)
What are the current issues that the organization is grappling with? What is the organization's current intellectual capital?	User-initiated social-software events and data, like tag creation and tag modification, blog entries, wiki entries, and current searches.
What are people thinking and planning as they work? What confuses them?	Think-aloud reports. Verbal reports. Paired-user testing.
What is the communication network in the organization? Who communicates with whom?	Communications events (email, chat, meeting attendance).
What is the context of critical events? How often do critical events occur and what events preceded and follow them?	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.
How do people use the work space? What communication patterns or traffic patterns occur? How can the space be used more effectively or efficiently?	Movement in an office space.

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

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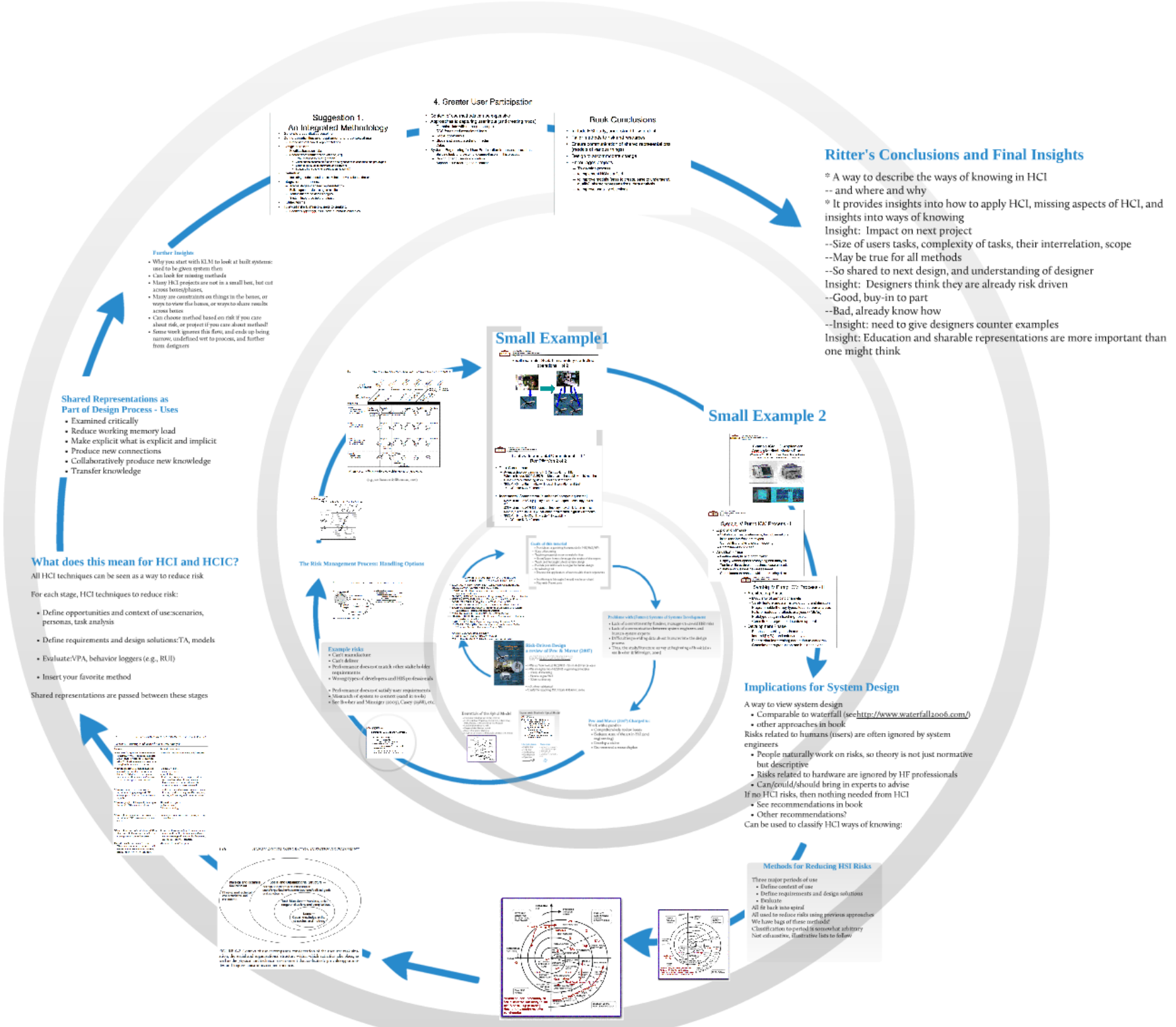
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• Insert your favorite method
Shared representations are passed between these stages
The Risk Management Process: Handling Options
Example risks
• Can't manufacture
• Can't deliver
• Performance does not match other stakeholder requirements
• Wrong types of developers and HIS professionals
• Performance does not satisfy user requirements
• Mismatch of system to context (used to work)
• See Boehm and Ministeri (2003), Casey (1998), etc.
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