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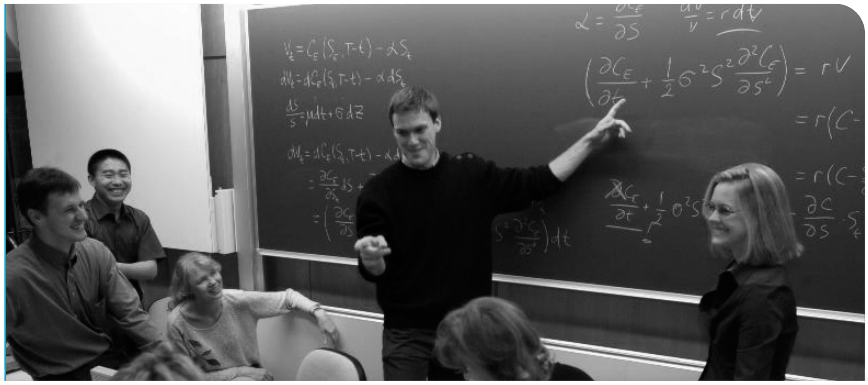

Design Research in Information Systems

CRUS

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Spring 2012

| le savoir vivant |

design science research in IS

prepared by yves pigneur
DRIS March 2012

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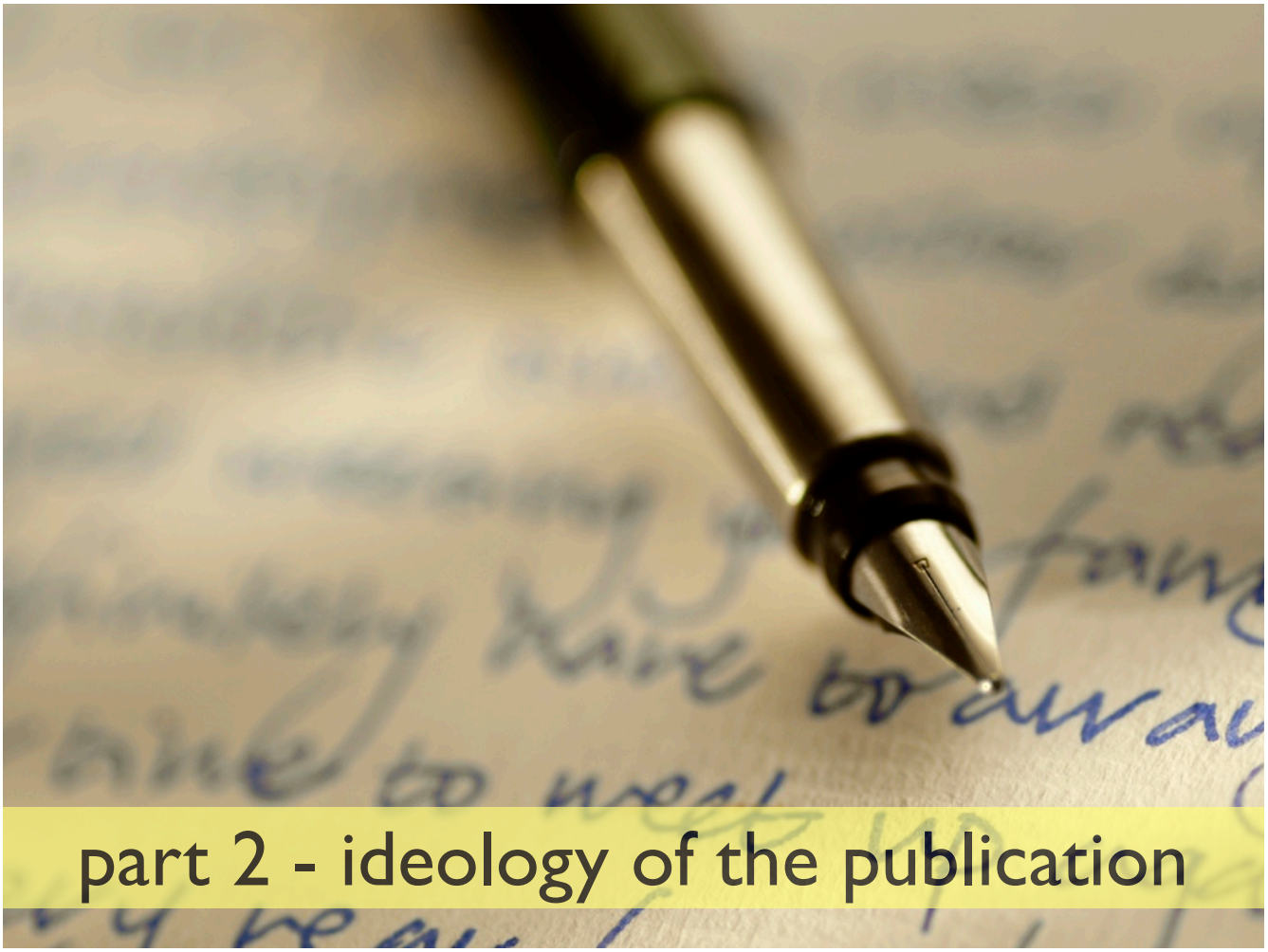
DESIGN SCIENCE

part 1 - design science framework

http://pstevensonkeating.co.uk/



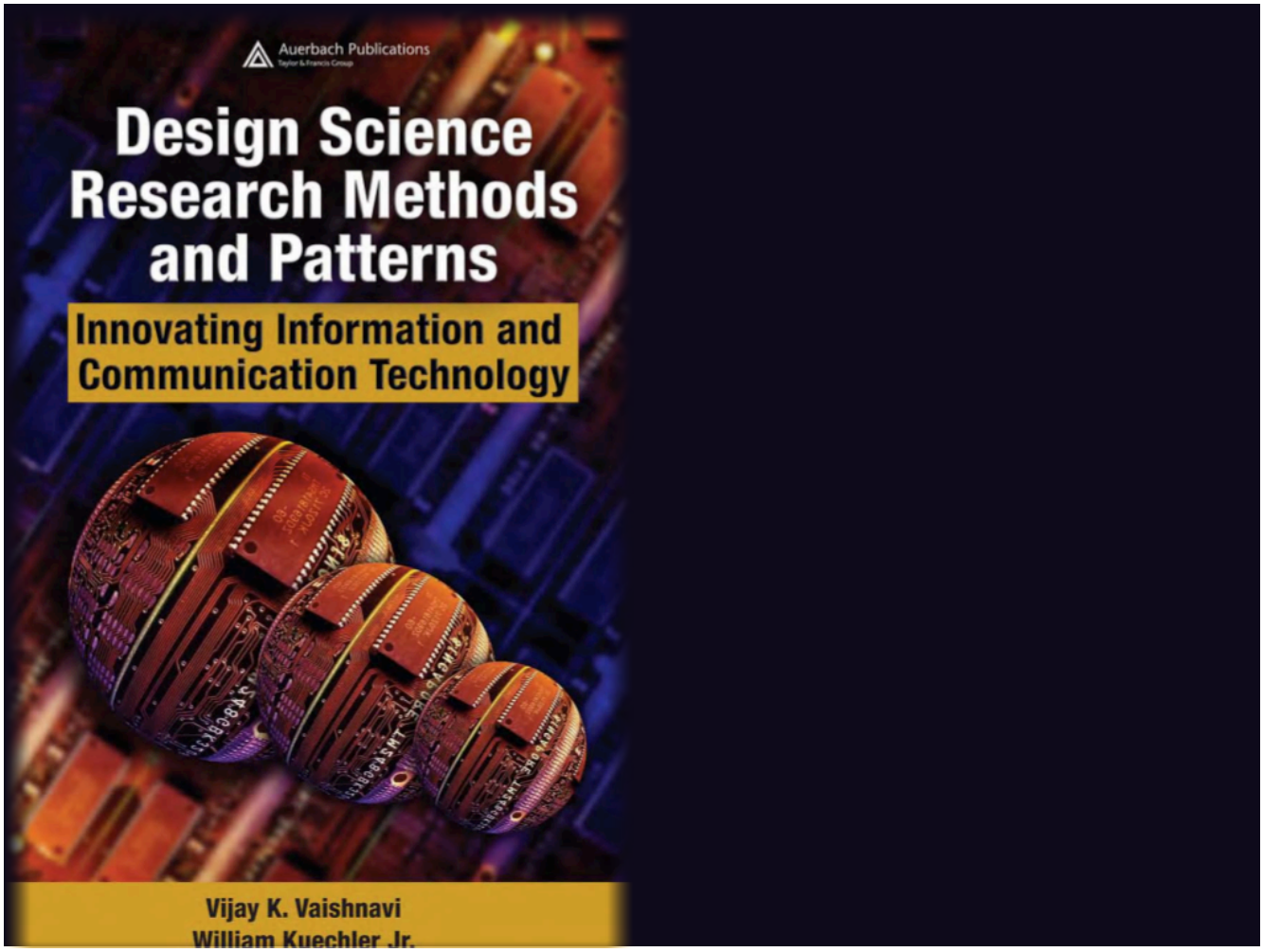
part 2 - ideology of the publication

1. framework & publication
2. theory & anatomy
3. methodology & action design
4. patterns & evaluation
5. design rationale (C-K)

paper review

research proposal

article



www.hec.unil.ch/yp/DRIS_articles.zip

readings

researching as designing

1 managing as designing

2 design science

3 design science framework

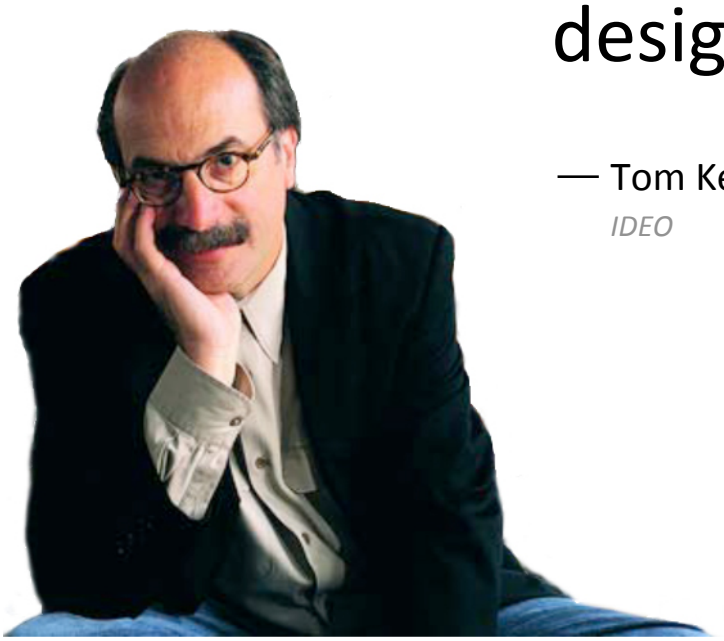
1

managing as designing

> “Engineering, medicine, business, architecture and painting are concerned not with the necessary but with the contingent, not with how things are but with how they might be, in short, with design.”
>
> — Herbert Simon

“the only thing that’s not designed is nature.”

— Tom Kelley
IDEO



MANAGING *as* DESIGNING

Bringing the art of design to the practice of management

We believe that if managers adopted a design attitude, the world of business would be different and better

[Boland & Collopy, 2004]

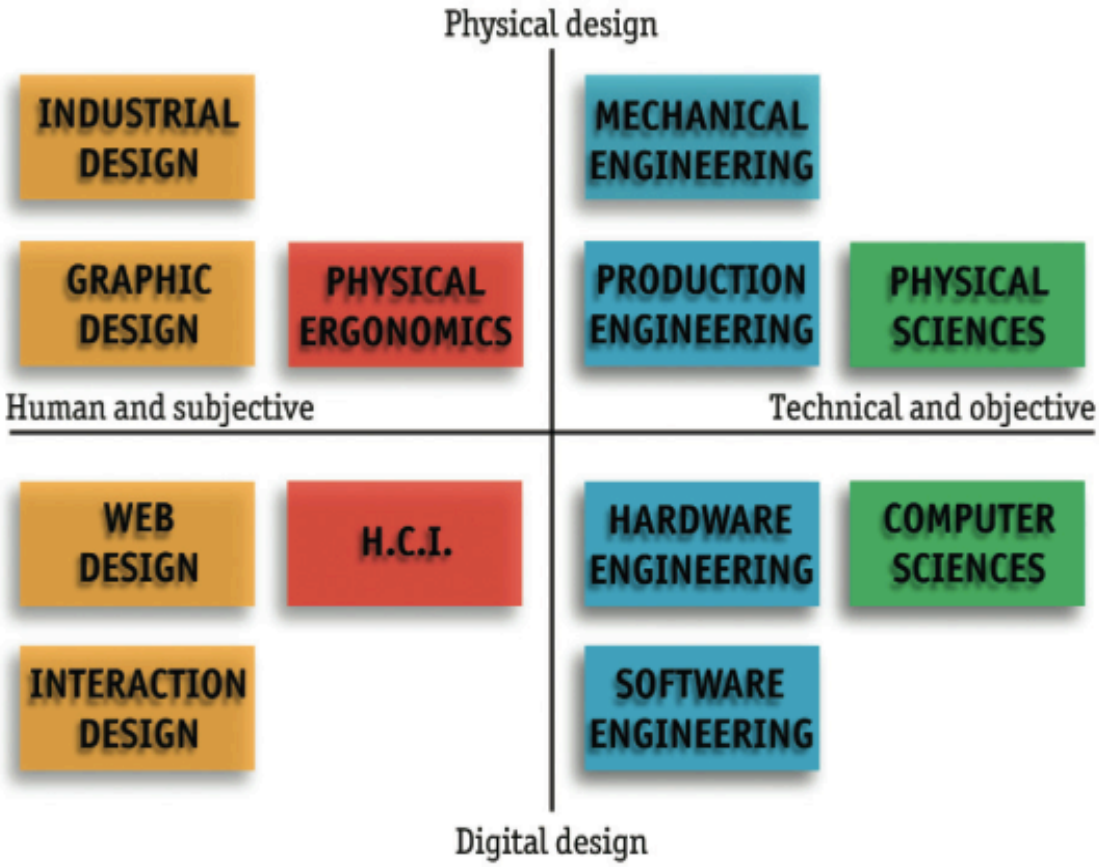
[source: Sony Pictures]

“The premise [...] is that managers are designers as well as decision makers and that although the two are inextricably linked in management action, we have for too long emphasized the decision face of management over the design face.”

— Richard Boland and Frank Collopy
Managing as designing

“This is one hell of a book.... Part history lesson, part computer science thesis, part design education, part personal design philosophy, it is fascinating, inspirational, occasionally baffling, and often hilarious.”

— Helen Walters
BusinessWeek.com, November 30, 2006.



> “To synthesize a solution from all of the relevant constraints, understanding everything that will make a difference to the result; to frame, or reframe, the problem and objective; to create and envision alternatives; to select from those alternatives, knowing intuitively how to choose the best approach; to **visualize and prototype** the intended solution.”

— Bill Moggridge
Designing interaction

2

design science

Design Science Research Methods and Patterns

Vijay Vaishnavi and William Kuechler
Auerbach Publications (2008): 244 p.

chapter 1

a paradigmatic analysis of information systems as a design science

Juhani Iivari
Scandinavian Journal of Information Systems, 19(2), 2007: 39–64

▸ see also [Vaishnavi and Kuechler, 2007] *Design science research methods and patterns* ch. 2

questions

How to define design science research? where is is practiced?

How design science research creates knowledge?

What are the differences with natural science research?

design science research ...

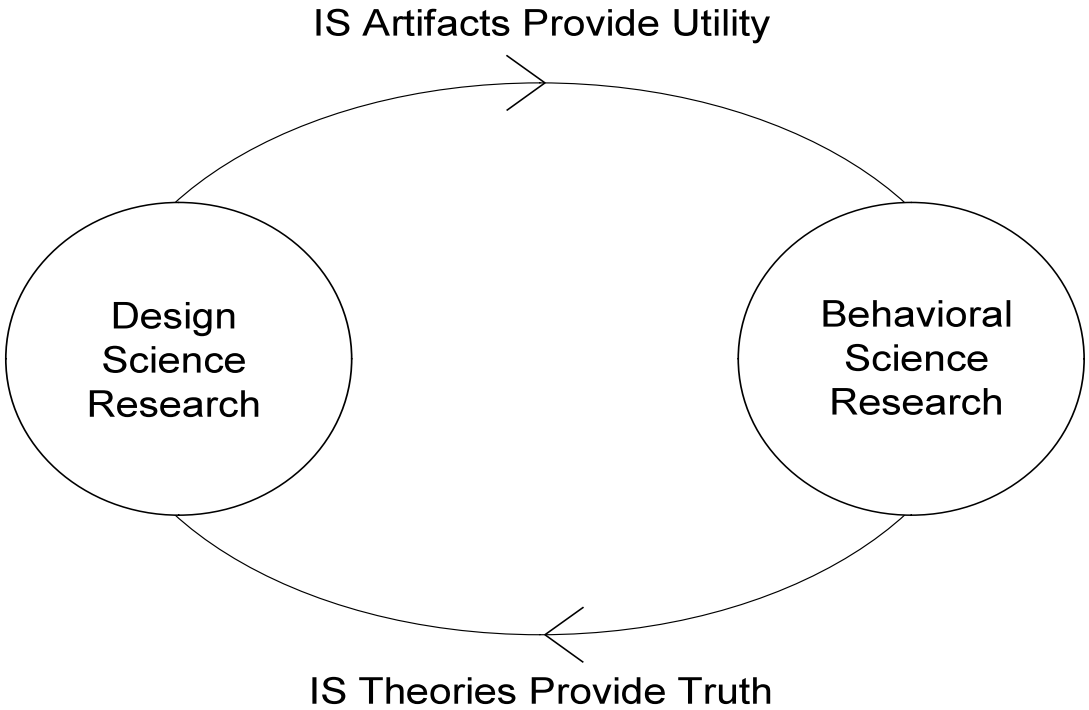
“... changes the state-of-the-world through introduction of novel artifacts ”

- Vaishnavi and Kuechler, 2007

design science Vs behavioral science

Behavioral science seeks to develop and justify theories that explain or predict organizational and human phenomenon surrounding the use of IS
>>> description-driven research

Design science is fundamentally a problem-solving paradigm that builds and evaluates IT artifacts
>>> prescription-driven research



IS research cycle

research activities

design science

build | evaluate

behavioral science

theorize | justify

adapted from [March and Smith,1995] *Design and natural science research on information technology*

Research Perspective			
Basic Belief	*Positivist*	*Interpretive*	*Design*
Ontology	A single reality Knowable, probabilistic	Multiple realities, socially constructed	Multiple, contextually situated alternative world-states Socio-technologically enabled
Epistemology	Objective; dispassionate Detached observer of truth	Subjective (i.e., values and knowledge emerge from the researcher-participant interaction)	Knowing through making: objectively constrained construction within a context Iterative circumscription reveals meaning
Methodology	Observation; quantitative, statistical	Participation; qualitative. Hermeneutical, dialectical	Developmental Measure artifactual impacts on the composite system
Axiology: what is of value	Truth: universal and beautiful; prediction	Understanding: situated and description	Control; creation; progress (i.e., improvement); understanding

philosophical assumptions of three research perspectives

adapted from [Vaishnavi and Kuechler, 2007] *Design science research methods and patterns*

ontology of design science

what is the nature of reality?

ontology

POSITIVIST (EMPIRICIST)

- one reality
  knowable with probability

dominant paradigm in IS (?)

assumption that social worlds are analogous to the natural world

INTERPRETIVE/CONSTRUCTIVIST

- multiple socially constructed realities

adapted from [Gregg et al., 2001] *Understanding the philosophical underpinnings of software engineering research in information systems*

theorizing the IT artifact

> “ the IT artifact itself tends to disappear from view, be taken for granted, or is presumed to be unproblematic once it is built and installed

> “ we propose that IS researchers begin to theorize specifically about IT artifacts, and then incorporate these theories explicitly into their studies

- Orlikowski and Iacono, 2001

epistemology of design science

what what is the nature of knowledge?

epistemology

What is knowledge?

How is knowledge acquired?

What do people know?

How do we know what we know?

epistemology

POSITIVIST

- objectivity is important
- researcher manipulates and observes in dispassionate objective manner

INTERPRETIVE/CONSTRUCTIVIST

- interactive link between researchers and participants
- values are made explicit
- created findings

adapted from [Gregg et al., 2001] *Understanding the philosophical underpinnings of software engineering research in information systems*

design science research ...

"the generation of knowledge through making"

- Vaishnavi and Kuechler, 2007

methodology of design science

what is the approach for obtaining the desired knowledge and understanding?

methodology

POSITIVIST	INTERPRETIVE/CONSTRUCTIVIST
• quantitative (primarily)	• qualitative (primarily)
• interventionist	• hermeneutical, dialectical, ...
• decontextualized	• contextual factors are described

adapted from [Gregg et al., 2001] *Understanding the philosophical underpinnings of software engineering research in information systems*

questions

Why the existence of constructive research methods is essential for the identity for information systems as a design science?

How to balance creativity and rigor?

What distinguishes design science from IT development practice?

difference between design research and design ...

1. lies in the **evaluation** of artifacts
2. lies in the rigor of the constructive research **method**

four interacting research activities ...

- system development (build)
- theory building (knowledge base)
- experimentation (evaluate)
- observation (environment)

▸design framework

four sources of ideas for design science

1. practical problem and opportunities
2. existing artifacts
3. analogies and metaphors
4. theories

Research Perspective			
Basic Belief	*Positivist*	*Interpretive*	*Design*
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philosophical assumptions of three research perspectives

adapted from [Vaishnavi and Kuechler, 2007] *Design science research methods and patterns*

3

design science framework

Design science in information system

Allan Hevner, et al.
MIS Quarterly, 28(1), 2004: 75–105

▸ see also [Vaishnavi and Kuechler, 2007] *Design science research methods and patterns* ch. 2

a framework for IS research
guidelines for design science in IS
challenges of design science

design is ...

- a product
- a process
- a wicked problem

design is a product

	Output	*Description*
1	Constructs	The conceptual vocabulary of a domain
2	Models	A set of propositions or statements expressing relationships between constructs
3	Methods	A set of steps used to perform a task — how-to knowledge
4	Instantiations	The operationalization of constructs, models, and methods
5	Better theories	Artifact construction as analogous to experimental natural science

outputs of design science research

adapted from [March and Smith,1995] *Design and natural science research on information technology*

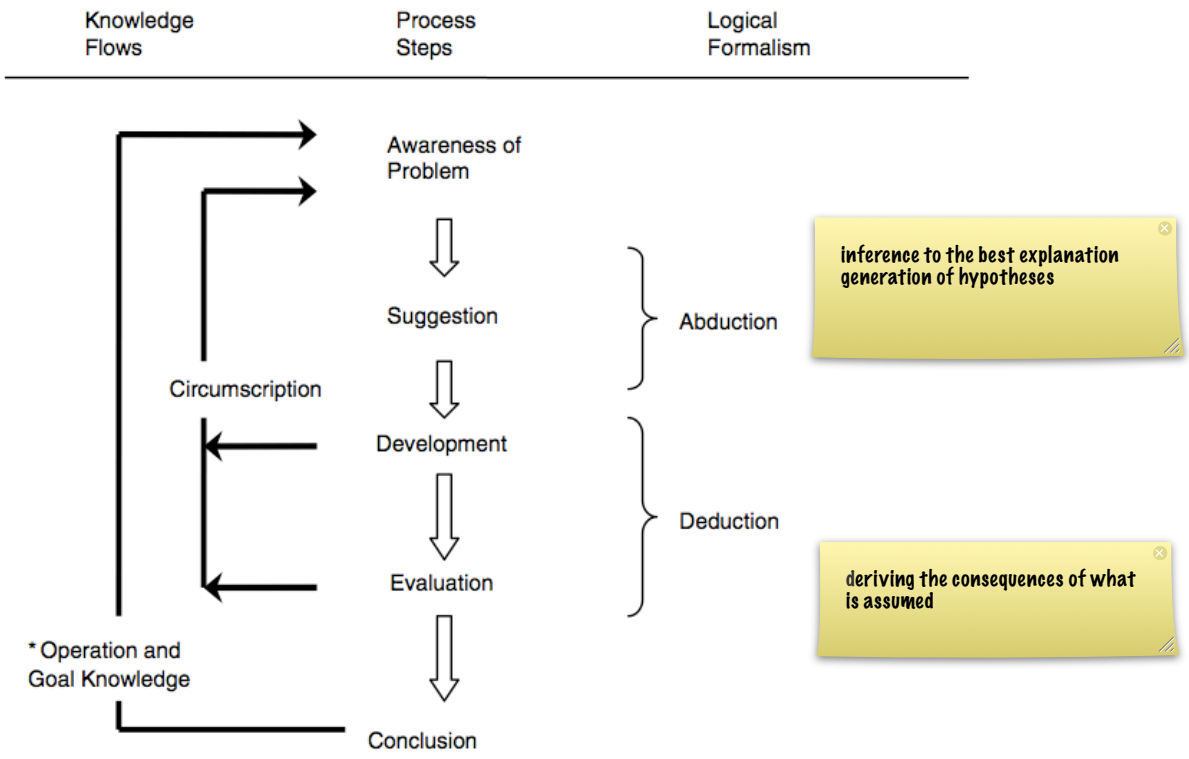
design is a process

design science

build evaluate

natural science

theorize justify



general design cycle (GDC)

adapted from [Vaishnavi and Kuechler, 2007] *Design science research methods and patterns*

design is a wicked problem

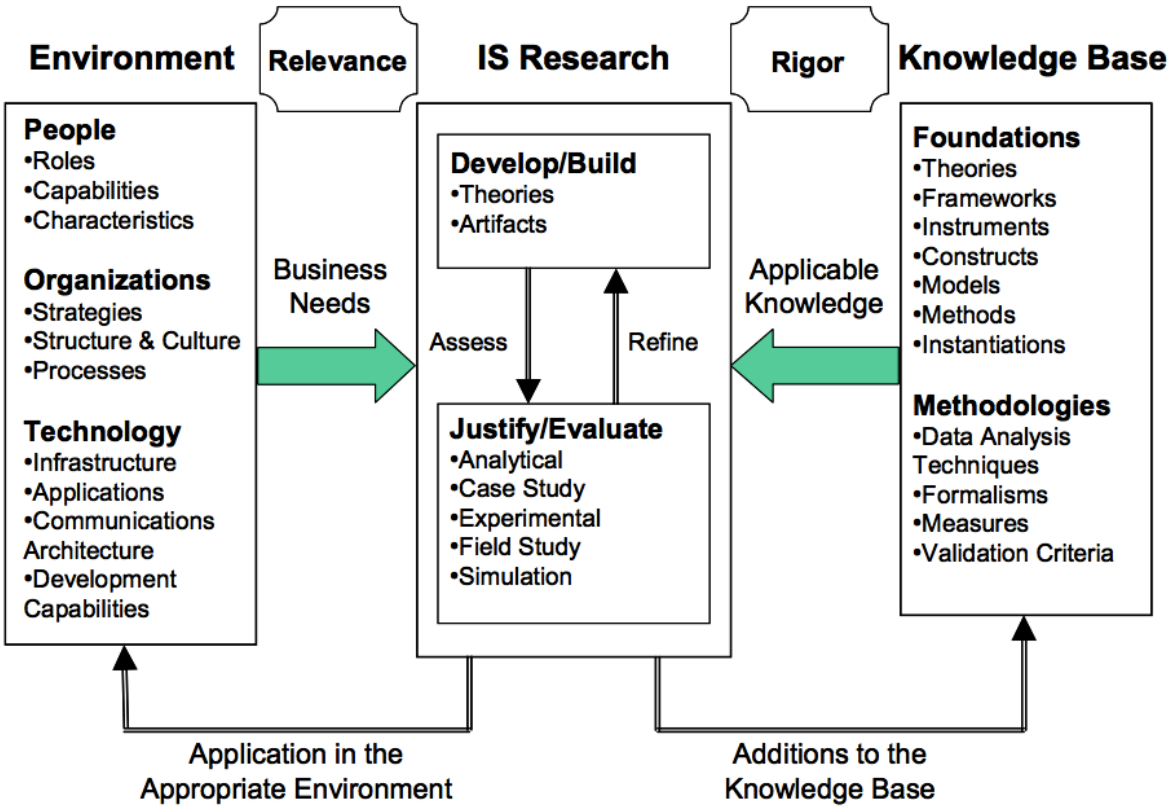
- unstable requirements, constraints and environmental context
- complex interactions among components of problem and resulting components of solution
- inherent flexibility to change processes and artifacts
- critical dependence upon human cognitive abilities > creativity
- critical dependence upon human social abilities > teamwork

essence of design science ...

what utility does the artifact provide?

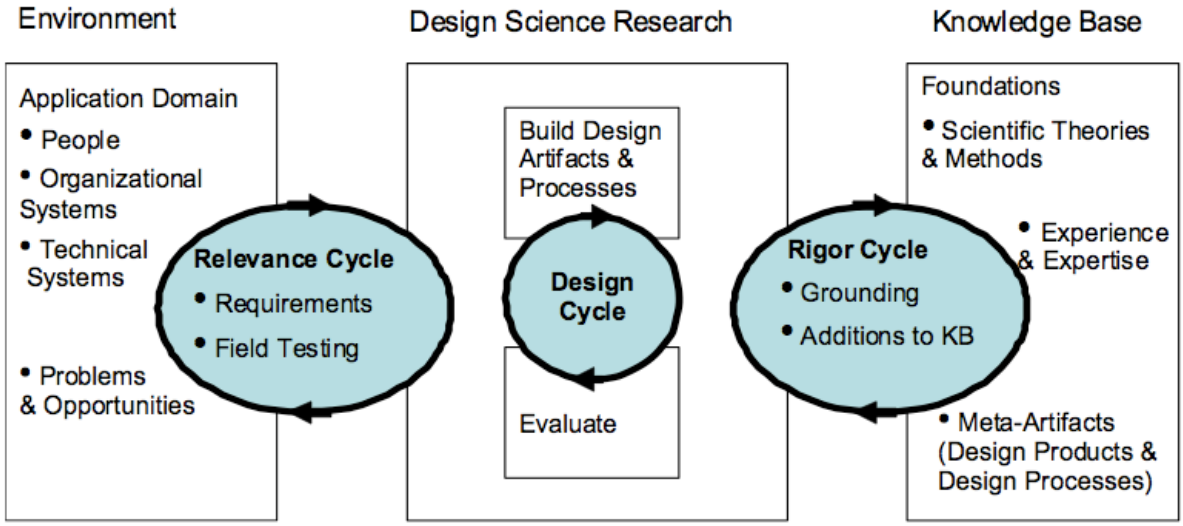
what demonstrates that utility?

a framework for IS research
guidelines for design science in IS
challenges of design science



Information systems research framework

[Hevner et al., 2006]



Design science research cycles

adapted from [Hevner,2007] *A three cycle view of design science research*

design cycle 1

- iteration of build & evaluate activities:
  heart of design science research
- generating alternatives and evaluating the alternatives against requirements until a satisfactory design is achieved
- continue design cycle until
  artifact ready for field test in application domain, and/or new knowledge ready to be included in knowledge base

the relevance cycle > requirements & impact 2

- the application domain initiates design research with
- the requirements for research
  (e.g., the opportunity/problem to be addressed), and
- acceptance criteria for the evaluation of the research results
- impact for practitioners (field test ...)

✓key for practitioners

the rigor cycle > additions to knowledge base

- the rigor cycle provides past knowledge to the research project (design theories, engineering methods, experiences, artefacts ...)
- to ensure its innovation, and
- a research contribution (not a routine design): addition to knowledge base

✓key for academics

a framework for IS research
guidelines for design science in IS
challenges of design science

Guideline	Description
Guideline 1: Design as an Artifact	Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem Relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design Evaluation	The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research Contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.
Guideline 5: Research Rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.
Guideline 6: Design as a Search Process	The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of Research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

Table 1. Design science research guidelines

1. design as an artifact

- the result of design science research in IS is a purposeful IT artifact created to address an important organizational problem
- the IT artifact is the “core subject matter” of the IS field
- artifacts are innovations that define the ideas, practices, technical capabilities, and products through which the analysis, design, implementation, and use of IS can be accomplished

2. problem relevance

- research motivation
- artifact must be relevant and useful to IS practitioners > Utility
- the problem,
  defined as the differences between the current state and a goal state,
  must be real and interesting
- *problem solving is a search process using actions to reduce or eliminate the differences [Simon 1999]*

3. design evaluation

- the utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well executed evaluation methods
- evaluation requires the definition of appropriate metrics and possibly gathering and analysis of appropriate data
- IT artifacts can be evaluated in terms of functionality, completeness, consistency, accuracy, performance, reliability, usability, fit with organization and other relevant quality attributes

1. Observational	Case Study: Study artifact in depth in business environment
	Field Study: Monitor use of artifact in multiple projects
2. Analytical	Static Analysis: Examine structure of artifact for static qualities (e.g., complexity)
	Architecture Analysis: Study fit of artifact into technical IS architecture
	Optimization: Demonstrate inherent optimal properties of artifact or provide optimality bounds on artifact behavior
	Dynamic Analysis: Study artifact in use for dynamic qualities (e.g., performance)
3. Experimental	Controlled Experiment: Study artifact in controlled environment for qualities (e.g., usability)
	Simulation – Execute artifact with artificial data
4. Testing	Functional (Black Box) Testing: Execute artifact interfaces to discover failures and identify defects
	Structural (White Box) Testing: Perform coverage testing of some metric (e.g., execution paths) in the artifact implementation
5. Descriptive	Informed Argument: Use information from the knowledge base (e.g., relevant research) to build a convincing argument for the artifact's utility
	Scenarios: Construct detailed scenarios around the artifact to demonstrate its utility

Table 2. Design evaluation methods

see evaluation

4. research contribution

- research must provide clear (new and interesting) contributions ...
- The Design Artifact:
  exercising the artifact in the environment produces value to the IS practice
- Foundations:
  extend and improve foundations in the design science knowledge base
- Methodologies:
  creative development and use of methods and metrics

5. research rigor

- addresses the way in which research is conducted
- requires rigorous methods in both the construction and evaluation
- often relies on mathematical formalism to specify the artifact
- derived from the effective use of the knowledge base

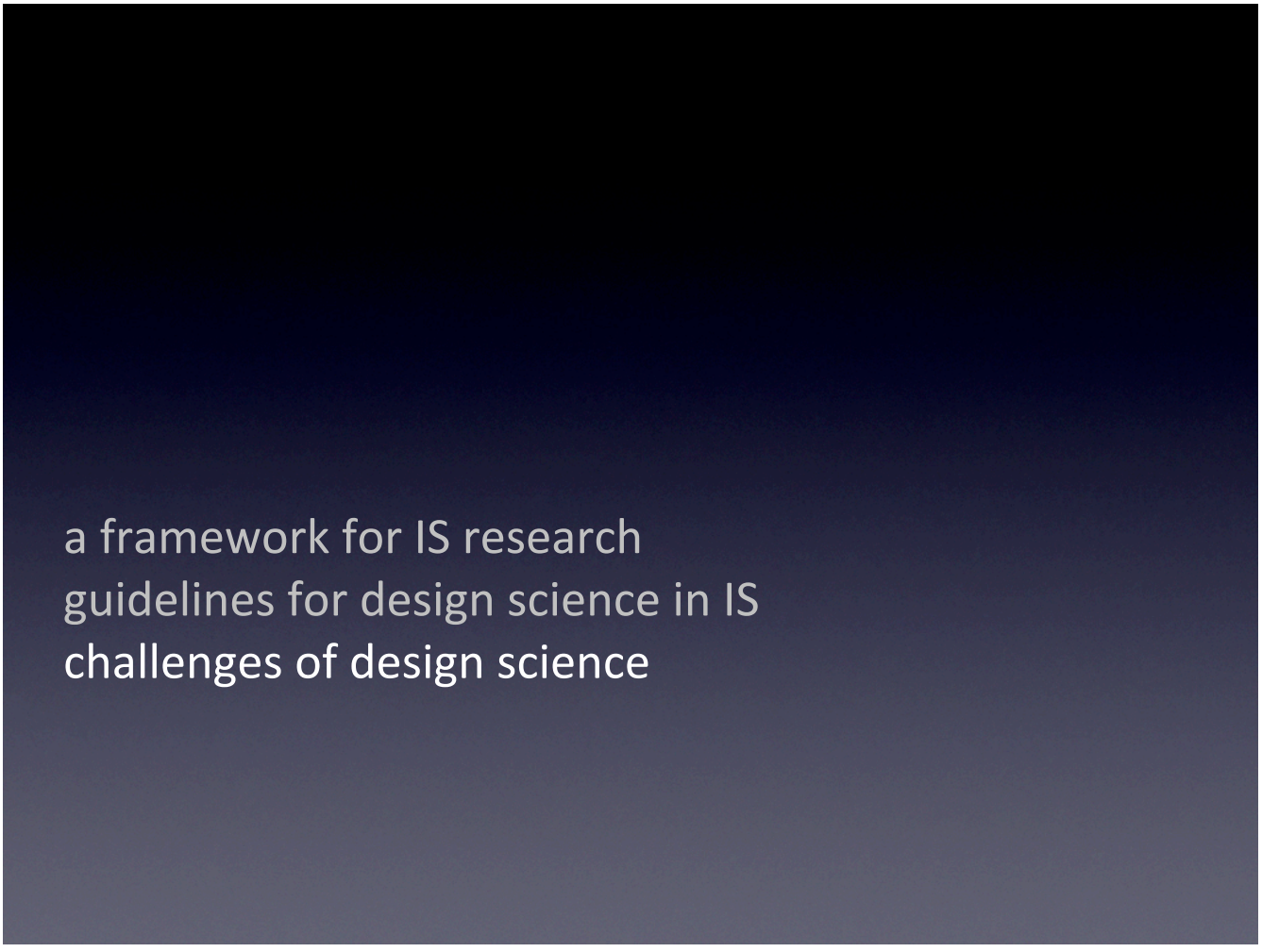
6. design as a search process

- good design is based on iterative, heuristic search strategies
- *problem solving as utilizing available means to reach desired ends while satisfying laws existing in the environment (Simon, 1996)*
- search for optimal or ... satisfactory solutions

7. communication of research

- Technology-oriented audiences need sufficient detail to construct and effectively use the artifact, and understand the process (for establishing repeatability)

- Managerial audiences need sufficient detail to effectively apply the artifact within a specific organizational context, and understand the importance of the problem and the novelty and utility of the artifact.



design science challenges ...

- inadequate theory base for scientific and engineering discipline
- insufficient sets of constructs, models, methods, and tools in knowledge base to represent real-world problems and solutions
- design is still a craft relying on intuition, experience, and trial-and-error
- design science research is perishable as technology advances rapidly
- rigorous evaluation methods are difficult to apply in design science research
- communication of design science results to managers is essential but a major challenge

from Hevner's talk in 2007 *"Design Science Research: Rigorous and Relevant "*

next

The anatomy of a design theory

Shirley Gregor & David Jones
Journal of the Association for Information Systems, 2007, 8(5): 312–335

- see also [Gregor, 2006] *The nature of theory in IS*