Panel
Design Science Research: Recent Developments, Current Status & Open Issues

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Overview

- The nature of the IT artifacts relevant to DSR
- The role of theory in DSR
- Standards for evaluation of IT artifacts and theories

What IT Artifacts or Topics are Relevant to IS DSR?

Design Science Research Topic: Designed Artifact or Design Process?

- Is the object of the research the *artifact* that is produced by design or is it the *process* of design?
- Nunamaker et al (1991): Design (and implementation) of IS is a research activity (research method) and the (new type of) IS was the outcome
- Walls et al, March & Smith, Hevner et al: Concerned with both the IS/IT artifact and the process by which it is designed – a bit confusing
  - Design method/process used to instantiate a generalised design into a particular situation

Relevant Topics in IS DSR

- Design processes are themselves artifacts that can be designed
- Need not limit artifacts that can be designed to IS themselves or their design processes
- Can study any relevant artifacts that can be designed
- Gregor & Jones (2007) argue there are two types of designed artifacts – product and process (method) – DSR applies to both

Artifacts Designed in Existing IS Research

- Applications: DSS, GSS, eBusiness applications
- Computer Technologies: Agents, Knowledge-based Systems, Relational DBMS, OODBMS
- Algorithms: Database, DSS
- Information Systems Development (ISD), methods, methodologies, techniques and tools: DFDs, ERDs, SSADM, JAD, UML, OOA&D, XP, ETHICS
- IS Planning Methods: BSP, Information Engineering
- Other Methodologies: BPR, Security Mgmt
- Managerial practices: CSFs, Balanced scorecards

Design Science Research (1)

IS Design Research should be aimed at solving some *type* or *kind* of problems (relevant to IS field)

- Goal is elimination, reduction, or alleviation of a (potentially) undesirable circumstance (and therefore an improvement)
- Should not be limited by the type of solution designed!
- Accomplished by
  - compensating for undesirable circumstances or
  - eliminating or reducing one or more of the causes

Design Science Research (2)

"Research in which a new or improved solution technology is invented"

- **Solution technology** (in IS) includes system, method, methodology, procedure, practice, or any other technology (in the very general sense of Plato's use of the Greek work 'techne').
- **Invention** includes derivation, design, development, construction, prototyping, or other way of creating something new

Current Status – Artifacts

- Most published DSR practice is focussed on Computer-Based IS – software and whole systems
- Some work in DSR community is on system development method
- Little to no work considers other artifacts from a DSR perspective

What form for theory in IS DSR?

Walls et al (1992)

- Information Systems Design Theory (ISDT)

  "a prescriptive theory which integrates normative and descriptive theories into design paths intended to produce more effective information systems." (p. 36).

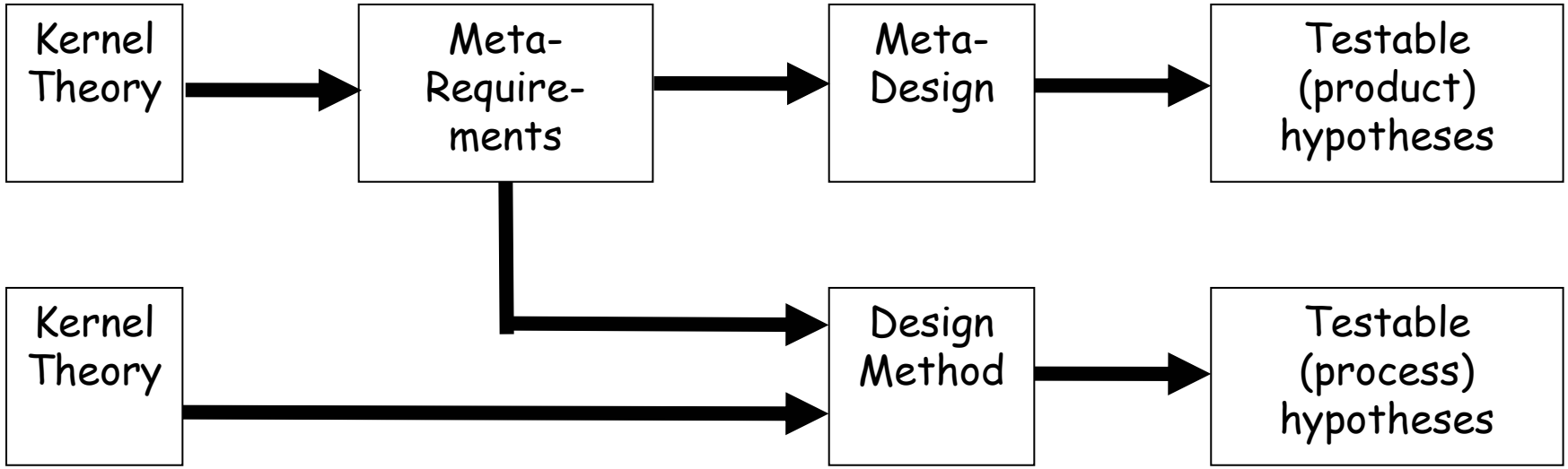
- Seven characteristics

  1. "Design theories must deal with goals as contingencies. …
  2. A design theory can never involve pure explanation or prediction. …
  3. Design theories are prescriptive. …
  4. Design theories are composite theories which encompass kernel theories from natural science, social science and mathematics. …
  5. While explanatory theories tell 'what is', predictive theories tell 'what will be', and normative theories tell 'what should be', design theories tell 'how to/ because.' …
  6. Design theories show how explanatory, predictive, or normative theories can be put to practical use. …
  7. Design theories are theories of procedural rationality." (Walls et al, 1992, pp. 40-41)

Walls et al (1992) (part 2)

- Seven components of IS Design Theories
  1. Meta-requirements
  2. Meta-design (of the design product)
  3. Kernel theories (informing the design product)
  4. Testable design product hypotheses
  5. Design method
  6. Kernel theories (informing the design method)
  7. Testable design process hypotheses

IS Design Theory (Walls et al, 1992)



March & Smith (1995)

- Design Artefacts:
  - Concepts, Models, Methods, Instantiations
- Theory explicitly excluded
  - Theory viewed as the province of natural and social/behavioural sciences
  - Activities of “theorise and justify” cycle seen as outside of Design Science
- However, “concepts” and “models” seem to be partway toward theory

Gregor and Jones (2007)

Core components (anatomy of a design theory)

1. Purpose and scope - "What the system is for" or goals (*cf.* meta-requirements, Walls et al 1992)
2. Constructs - Representations of the entities of interest in the theory *(cf.* constructs, March & Smith 1995, meta-design, Walls et al 1992).
3. Principle of form and function - The "blueprint" or architecture for an IS artifact *(cf.* meta-design, Walls et al 1992, models, March & Smith 1995).
4. Artifact mutability - The changes in state of the artifact anticipated in the theory, that is, what degree of artifact change is encompassed by the theory *(cf.* design method, Walls et al 1992).
5. Testable propositions - Truth statements about the design theory *(cf.* testable product and process hypotheses, Walls et al 1992).

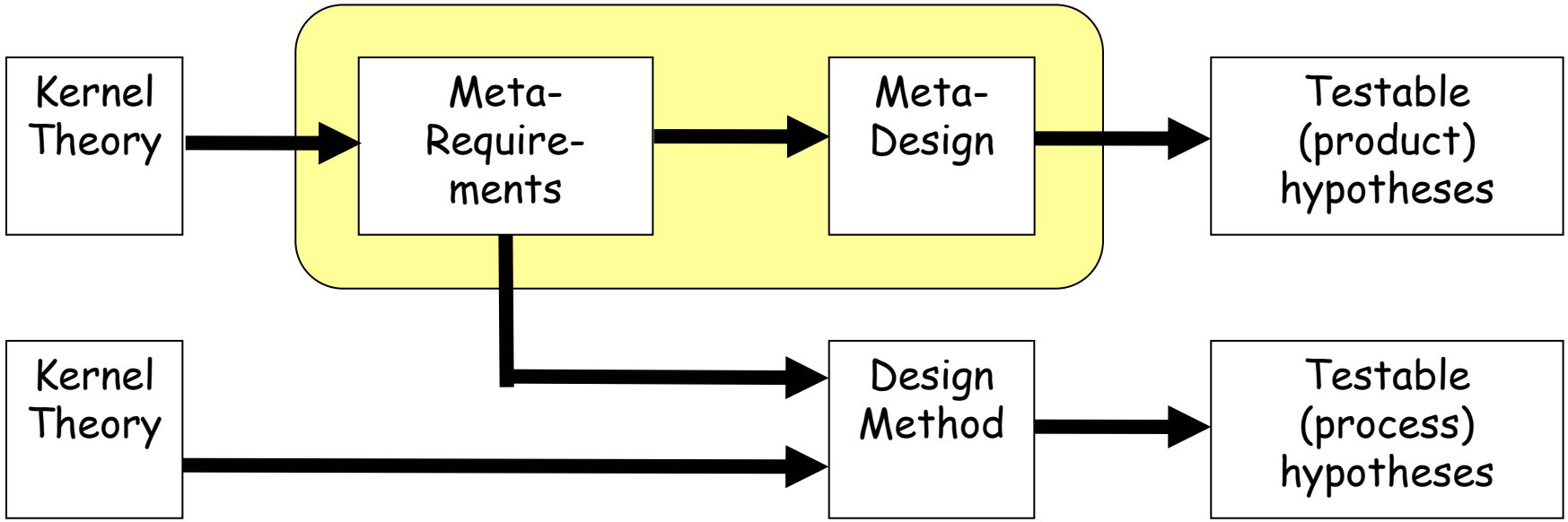
Gregor and Jones (2007) (2)

6. Justificatory knowledge - The underlying knowledge or theory that gives a basis and explanation for the design (*cf.* kernel theories, Walls et al 1992).

Additional components

- Principles of implementation - Processes for implementing the theory (either product or method) in specific contexts *(cf.* method, March & Smith, 1995, design method, Walls et al 1992).
- Expository instantiation - A physical implementation of the artifact that can assist in representing the theory both as an expository device and for purposes of testing *(cf.* instantiation, March & Smith 1995).

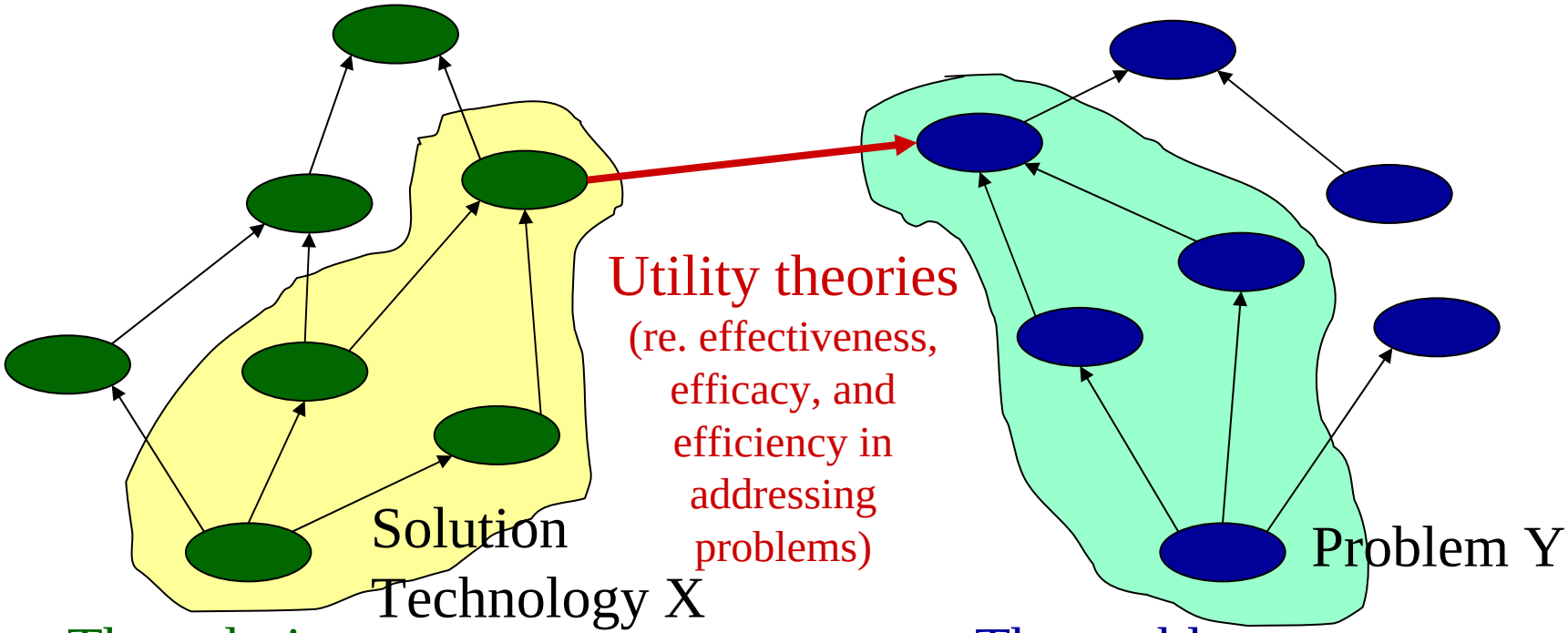
IS Design Theory (Walls et al, 1992)



Theory Building (Venable, 2006b)

- As a precursor to Design Science Research, one should develop a *utility* theory or hypothesis of a kind of approach to reduce the problem
  - Solution technology *X* (when applied properly) will help solve problems of type *Y*
  - Solution technology *X* (when applied properly) will provide improvement of type *Y*
- Also investigate or formulate relevant theories of problem understandings and frameworks of solution technologies

Components of Theories in Design Science Research (Venable, 2006a)



Utility Theory vs Design Theory

- Utility theory describes effectiveness, efficacy, or efficiency of a solution technology for achieving a given goal
  - Presumes some way to measure or assess improvement
- Design theory indicates recommendation (prescription) – to achieve goal, use this solution technology
  - Problem (?) – the recommendation or prescription changes with changes in the state of the art – as more effective, efficacious, or efficient technologies are developed and evaluated
- Problem with both – the problem space changes as other technologies are introduced and become part of the space

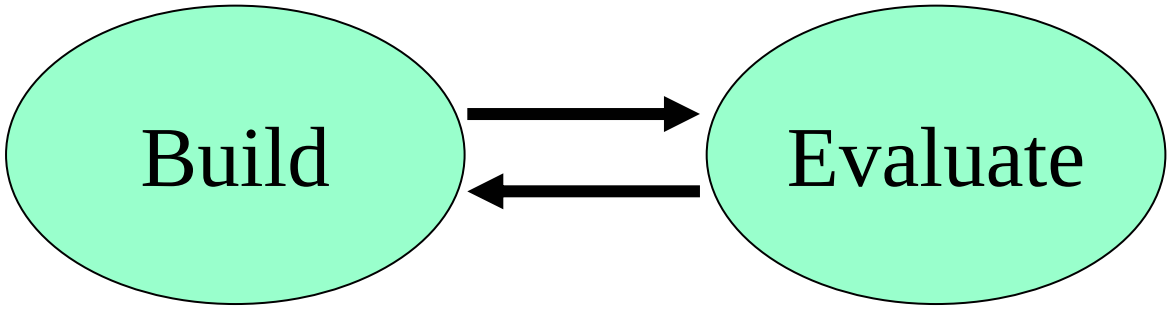
Current Status – Theory

- Walls et al (1992) still the received view
- Gregor (2006) and Gregor & Jones (2007) should have a strong impact
- Ideas of utility theory need further development

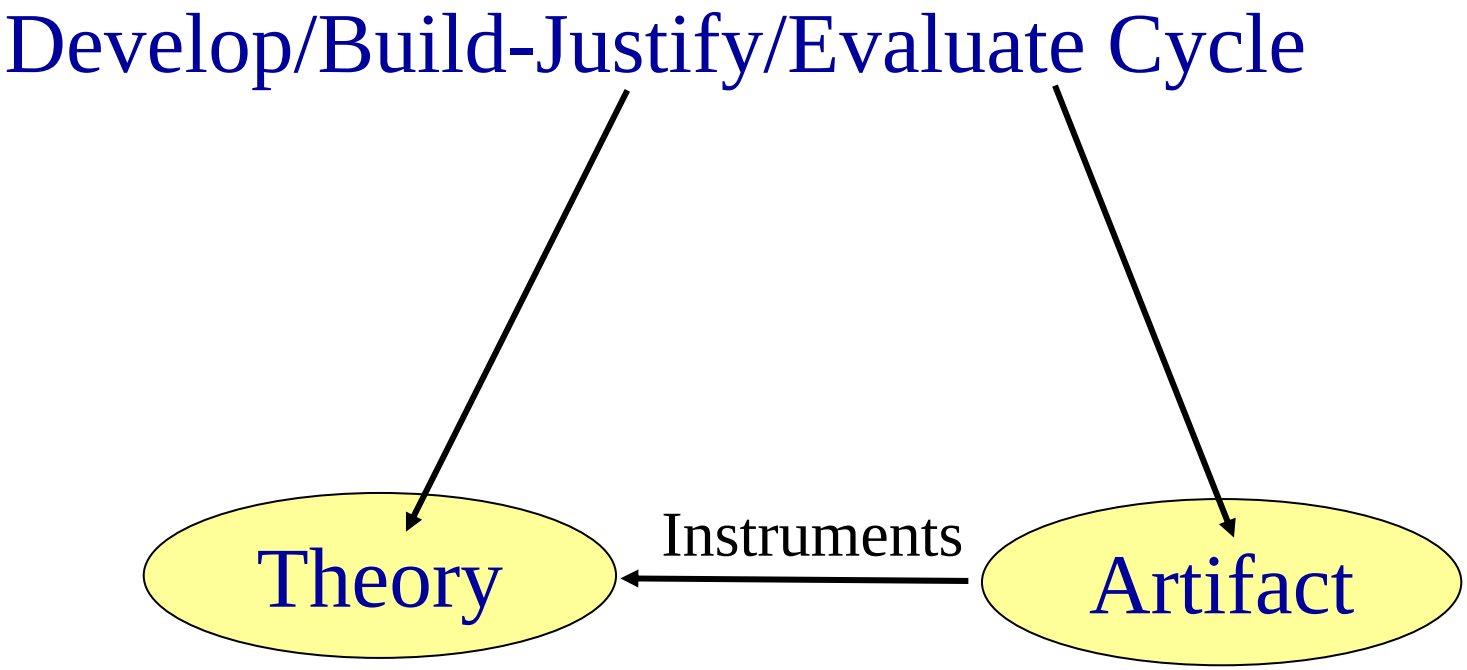
What standards for evaluation in IS DSR?

March & Smith (1995)

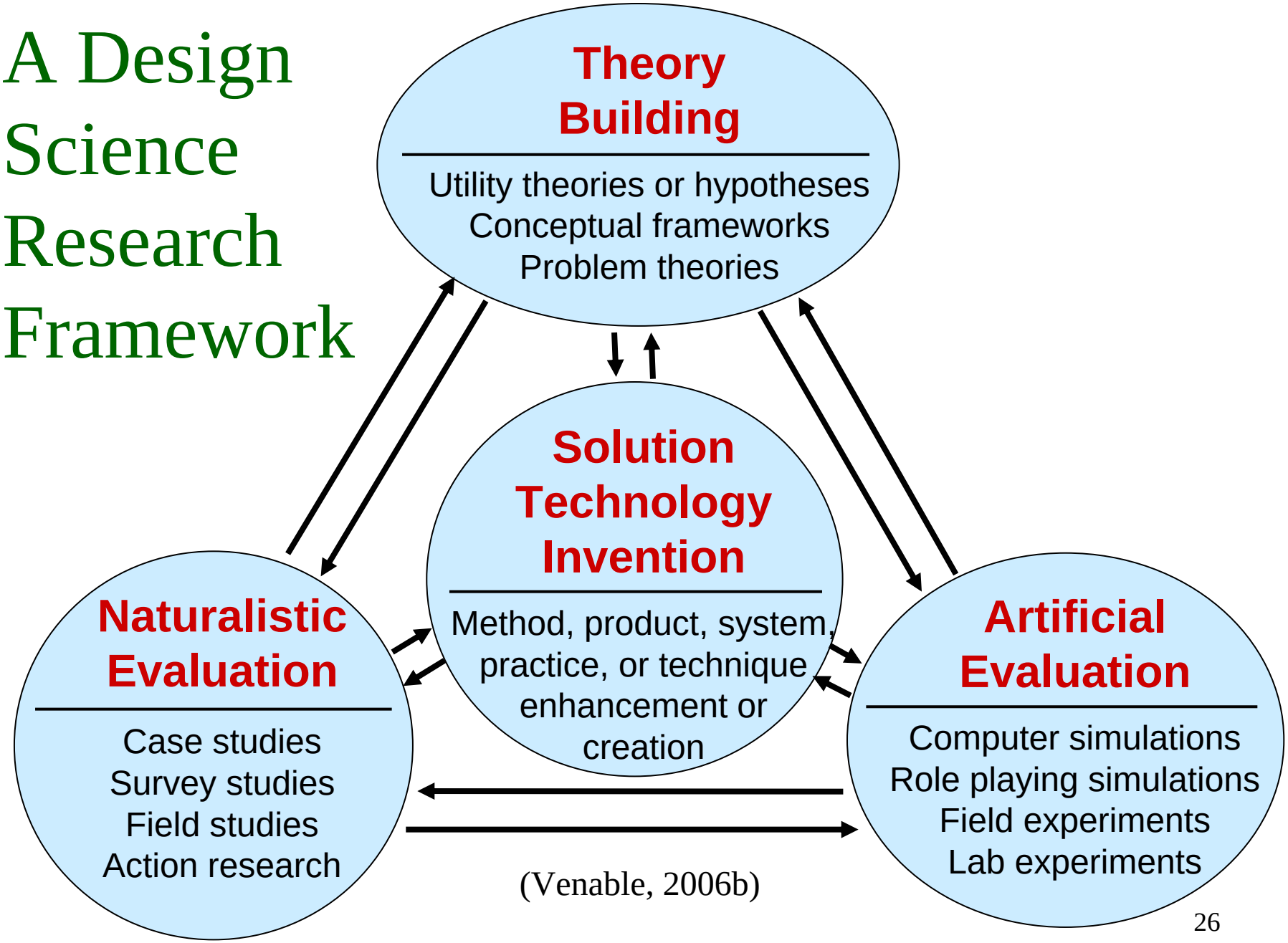
- Research Process:
  - Build-Evaluate Cycle



Hevner et al (2004)



A Design Science Research Framework



(Venable, 2006b)

Solution Technology Evaluation

- Once built, a solution technology is still only hypothesised to be useful to address problems unless it is evaluated
  - I.e., need to test the utility theories
- It may be evaluated in three main ways
  - on its effectiveness, efficacy, etc. in solving or alleviating 'the problem' (i.e. validating a utility theory)
  - in comparison to other solution technologies
  - for other (undesirable) impacts (i.e. side effects)

Artificial Evaluation

- Evaluating a solution technology in a contrived, non-real way
  - Laboratory experiments
  - Field experiments – closest to naturalistic
  - Simulations
- Predominantly positivist, but can be interpretivist or even critical

Naturalistic Evaluation

- Evaluating a solution technology in a real organisational situation
- The real ‘proof of the pudding’
- Subject to all the difficulties of assessing the effects of the myriad of confounding variables in the real world
- Nearly impossible in many cases to compare with other solution technologies
- May be interpretivist, positivist, or critical

DSR Evaluation Error Framework (Baskerville et al 2007)

Evaluation errors at some specific evaluation stage

Requirements elicitation: 1a) Tacit 1b) Never articulated	Matching situation with meta-requirements: 2) Inappro-priate match	Selecting meta-design & design method: 3) Improper application of ISDT	Design of the artifact: 4) Improper application of meta-design or design method	Building: 5) Program or components not aligned with design	Installation: 6) Complica-tions within business

Evaluation errors that span the entire evaluation process

A) Dynamic/changing requirements B) Change management C) Assessment of success/failure

Evaluation errors from the social and organizational context

I) Social factors II) Organizational factors III) Emergence

Soft Design Science Research (Baskerville et al 2007)

Enhance Traditional ('Hard') DSR to …

1. Use social and behavioral theory by thinking through the potential errors in the three groups that we identified.
2. Treat problems and problem solving activities as complex and situated.
3. Use interpretive research methods for the investigation and evaluation of IT artifacts.
4. Examine the entire design and implementation process during evaluation/justification, rather than just measuring performance at the end.

Current Status – Evaluation

- Strong positivist influence in IS DSR
- Theory testing through quantitative measures
- Strong experimental and artificial evaluation trend
- Also surveys and (superficial) case studies
- Practical reasons (e.g. resources, skills) may not allow naturalistic evaluation by technology inventors
- People who develop technologies don't really want to subject them to rigourous evaluation
- Decentralising research with specialist Soft evaluation seems reasonable
- Issues of rigour before publication need consideration


Questions?

Design Practice vs Design Science Research

- Applied Problem Solving vs Research
- Problem Solving is related to a *particular*, *situated* problem (or group of problems)
  - Particular stakeholders
  - Results in benefit for those stakeholders in that situation
- Design Science Research should be related to a *type*, *kind*, *or class* of problems
  - Relevant to typical classes of stakeholders
  - Creates new solution type can be applied to solve a class of problems when or where they occur
  - Results in new knowledge that can be used by others

Action Research in Design Research

- Action research may include any or all of the activities of design research
  - May follow cycle 1 or any combination of secondary cycles
  - May be confined to a single activity to evaluate a given (fixed) solution means
  - May involve some enhancing of the solution means
    - If so, it complicates the evaluation (moving target)
  - Generally does not concern artificial evaluation

DSR Justification & Evaluation Artifacts and Relationships