Problem Choice in Engineering Research

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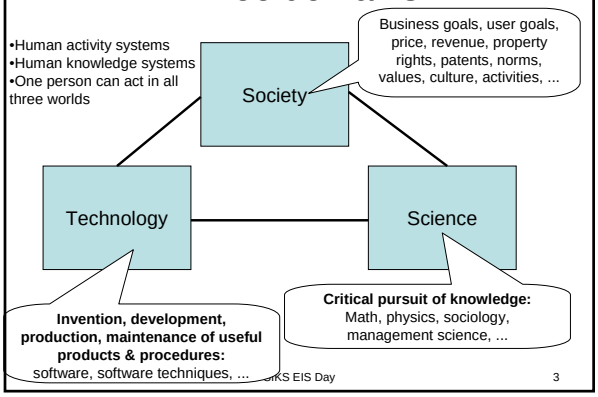
The Problem of the Problem

- When is research in [illegible] relevant?
- When is research relevant?
  - In **basic research**: Knowledge agreed to be interesting by peer group
  - In **engineering research**: Solution are used by technologists
- How do we choose our research problems?

Three domains



The problem of the problem, reformulated

- Problems can be relevant for
  - society
  - technology
  - science
- How do we choose relevant problems?
- Relevant for whom?

IS research problem (Department of management science)

- 1980s
  - Complaints about lack of empirical rigour
  - Papers about empirical methods for IS research
- 1990s
  - Empirical papers
- 2000s
  - Complaint about lack of relevance
  - Attempt to include design in IS research

ICIS 1997:
Successful IS innovation: the contingent contributions of innovation characteristics and implementation process
The effects of task interruption and information presentation on individual decision making
The impact of CASE on IS professionals' work and motivation to use CASE
The impact of information technology on coordination costs: implications for firm productivity
....

SE ``research'' problems (Department of computer science)

- 1990s
  - Complaints about lack of validation
  - Papers about how to do experimental and case study research
- 2000s
  - Increasing number of papers validate their solution
  - Complaints about transfer of solutions to practice

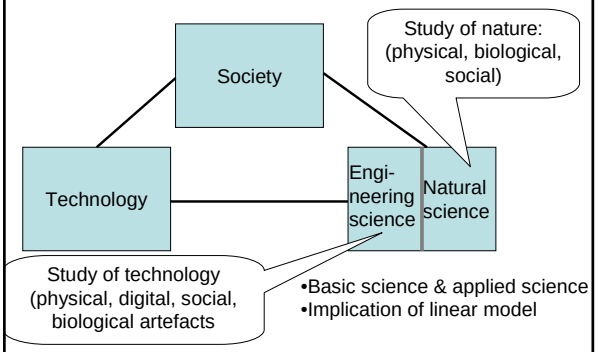
ICSE 2003:
Improving web application testing with user session data
Constructing test suites for interaction testing
Improving test suites via operational abstraction
Recovering documentation-to-source-code traceability links using latent semantic indexing
Computer-assisted assume/guarantee reasoning with VeriSoft
``How to do X, or how to do it better''

The engineering cycle

- Problem investigation
- Solution design → SE ``research''
- Solution validation
  - What are the solution properties?
  - Does this solve our problem?
- Solution implementation
- Implementation evaluation → IS research

But which problems to investigate/solve/evaluate??

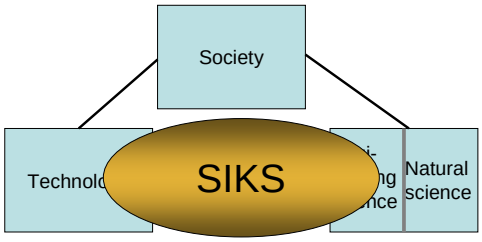
Two kinds of science



(Non)distinctions

- Engineering science and natural science are both curiosity-driven
- Sponsoring of all science is utility-driven
- Subject of engineering science is utility-driven artefact (product or procedure)
- Engineering science aims for applicable results
  - conditions of practice not abstracted away
  - modeling and simulation; law of similitude

Domain of SIKS

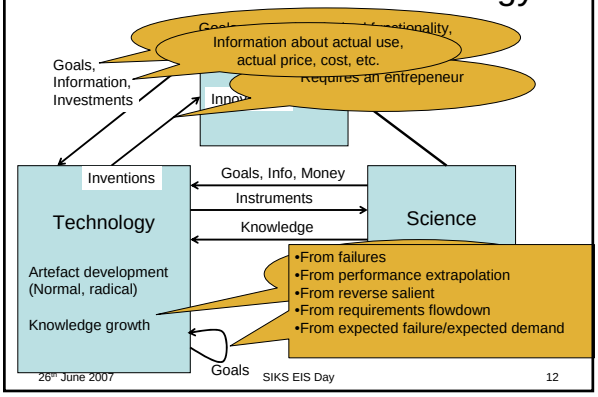


- Designing novel artefacts
- Validating them
- Evaluating their use

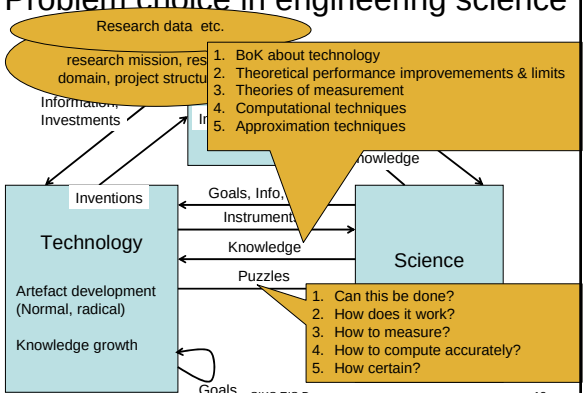
The engineering cycle

- Problem investigation
  - What are the stakeholders and their goals G?
  - What is the environment E of the future solution?
- Solution design
- Solution validation
  - What are the solution properties of S?
  - Does this solve our problem? E and S imply G
- Solution implementation
- Implementation evaluation

Problem choice in technology



Problem choice in engineering science



Discussion

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Design questions at ICSE02 (Mary Shaw reformulated by me)

Design
- How to create X
- How to automate X
- What is a design of X
- What is a better design of X

Evaluation
- How to evaluate X
- How to choose between X and Y

- Problem domain is software technology
- Design goal not always clear
- Source of design goal usually not indicated
- Curiosity-driven engineering

Research questions at ICSE02 (Mary Shaw reformulated by me)

Practical questions not an issue

Desk research
- s.o.t.p. of X?
- s.o.t.a. of X?

What is X
- Does X exist?
- Model of X?
- Kinds of Xs?
- Property P of X?
- Relationships among Xs?
- What is X given Y?

Evaluation
- How does X compare to Y?

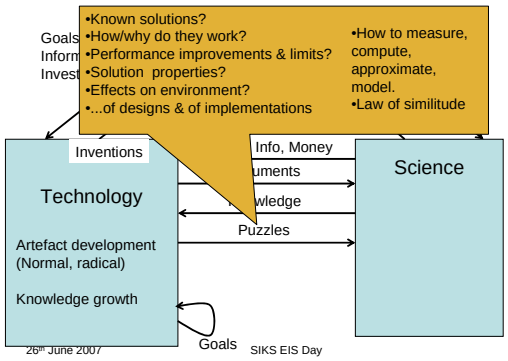
- s.o.t.p/a of X
- Why does it work
- Why does it fail
- How to measure/compute
- How certain

Epistemological questions not an issue either except at empirical conferences

Knowledge problems in the engineering cycle (could turn into research problems)

- Practical problem investigation
  - Stakeholders? Goals?
  - Phenomena? Causes?
- Solution design
  - Available solutions? BoK?
  - How does it work?
  - Performance limits?
- Solution validation
  - Solution properties?
  - Effects on E?
  - S & E imply G?
  - Compared to other designs?
    - How to measure, compute, approximate? How certain?
- Implementation
  - Resources?
  - (Recursion)
- Implementation evaluation
  - Implementation properties
  - Effects on E?
  - S & E imply G?

Problem choice in engineering science



Another non-empty slide

Problem choice in IS projects (1)

- VITAL/COOP
  - Domain: Value networks
  - Goal: To develop techniques for designing coordination processes and IT support for value networks
  - Source: Failures of E-commerce
- QUIDS/QuadRead
  - Domain: software systems/large administrative applications
  - Goal: To find empirically validated relations among architecture decisions and some quality attributes; to quantify these relations where possible.
  - Sources: Extrapolation (poor performance of current guidelines), potential failure (pressure to improve quality, potential to find nuggets by means of empirical studies)
- CARES/COSMOS
  - Domain: Cross-organizational ERP implementation
  - Goal: To develop cost/quality trade-off techniques
  - Source: Extrapolation of single-company techniques; potential failure (more Xorg implementation, possible usefulness of technqiues from other domains)
- MOCA
  - Domain: Embedded systems
  - Goal: To develop modeling guidelines for design and verification of embedded systems, taking physical environment into account
  - Source: Failure of current guidelines (total dependence on genius of modeler); Potential failure (software everywhere, hope to find useful guidelines); Desire to transfer verification technology to practicing software engineers

Problem choice in IS projects (2)

- IPID
  - Domain: Intrusions in IT networks
  - Goal: To relate low-level to high-level intrusion events
  - Source: Failure of current techniques, absence of governance loop
- Privacy in healthcare (NvN)
  - Domain: Telemedicine
  - Research goal: S.o.t.p. in privacy protection in telemedicine
  - Source: Potential failure wrt certain norms of privacy
- VISPER
  - Domain: physical and digital security policies
  - Goal: To integrate their specifications
  - Source: Potential failure (development of mobile technology, possibility of integrated language)
- VRIEND
  - Domain: Security in decentralized networks
  - Goal: To develop decision support for cost-effective policy specification and implementation
  - Source: Potential failure (increase of virtual networks, lack of attention to security)

Problem choice in IS projects (3)

- ADEPT
  - Domain: Process management
  - Goal: To advance s.o.t.a. of PM
  - Source: Extrapolation of current technology
- COREPRO
  - Domain: Release management of electrical components in auto development
  - Goal: To provide consistent RM
  - Source: Failure of current RM at DaimlerChrysler
- ECOPOST
  - Domain: Evaluation of process support IT
  - Goal: To evaluate impact financially/economically
  - Source: Extrapolation of current practice; potential failure (increasing pressure from business; potentially useful techniques available)
- SEINE
  - Domain: Interoperability of IT in health care
  - Goal: To detect and resolve semantic inconsistencies
  - Source: Potential failure (things work more or less but may deteriorate; continuing hope for solution, now with semantic web technology)