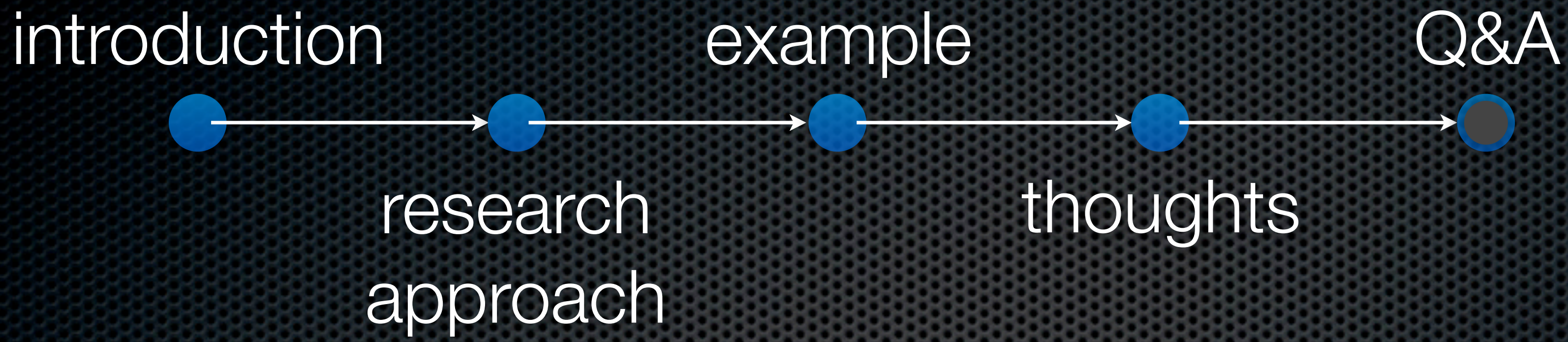
Research and Technology Transfer

Tony Gorschek

Blekinge Institute of Technology

www.bth.se www.gorschek.com


introduction
research approach
example
thoughts
Q&A

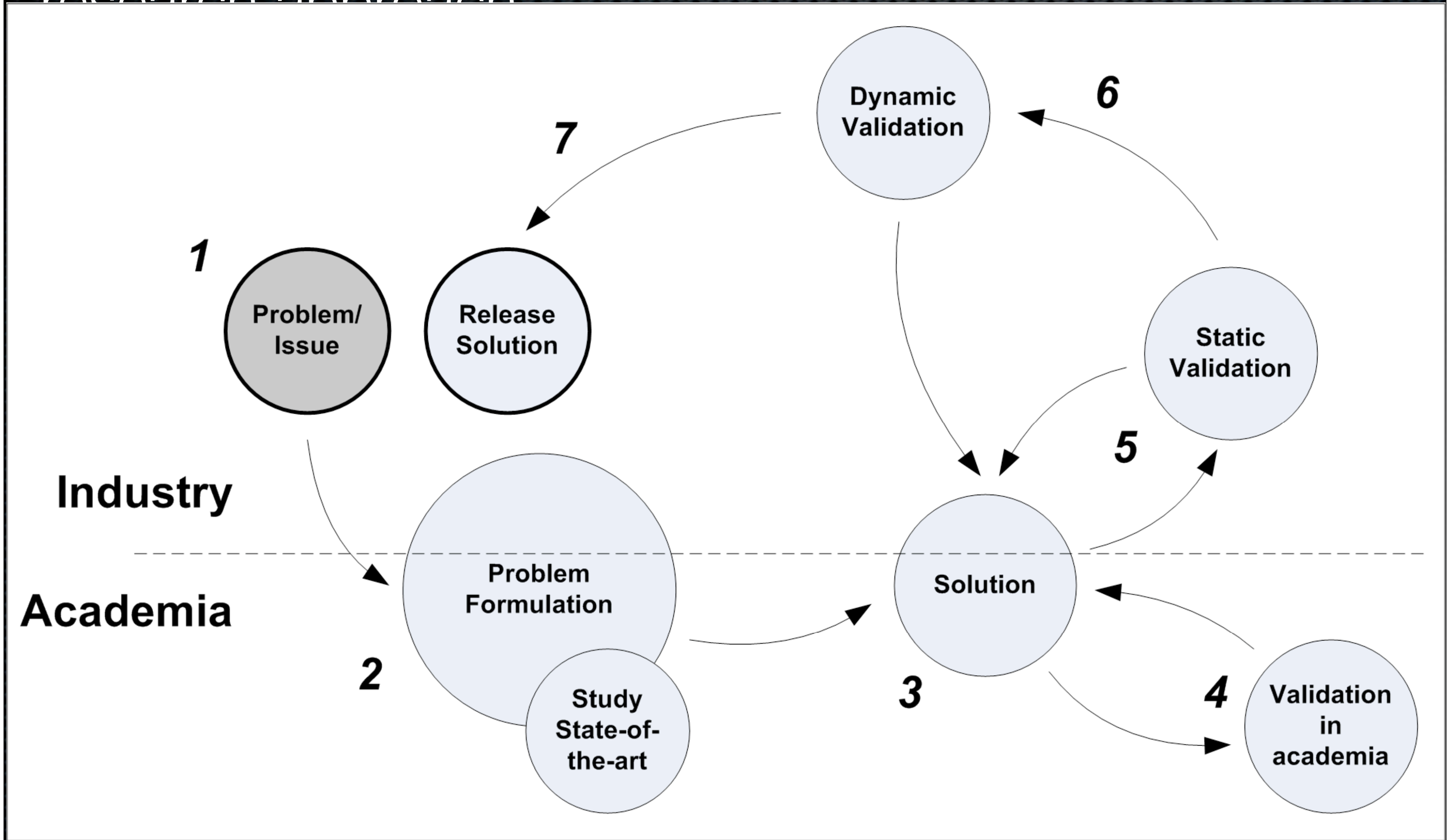
introduction

- PhD Software Engineering, BSc BA
- 8 years in industry as consultant - SW development and system architecture/design and acquisition, 3 start-ups, CTO Jobado AB, CTO Spidexa Tech. AB
- Researcher Blekinge Institute of Technology
    - ABB CRC, ABB Robotics, ABB Power Automation Products, DanaherMotion, Ericsson, Volvo...

research view

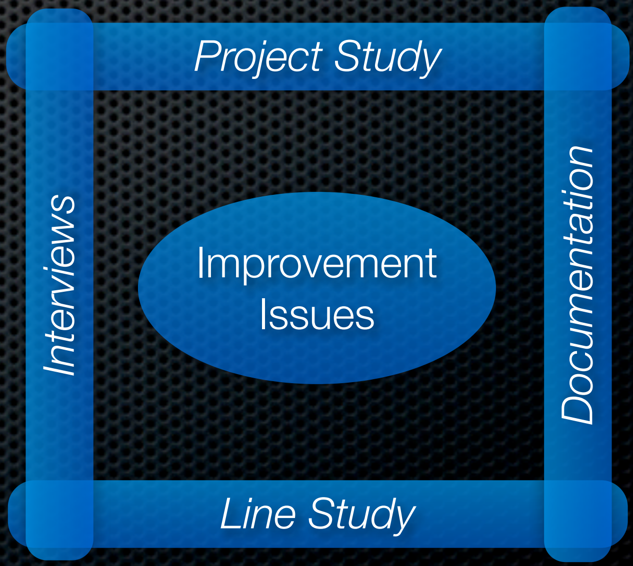
- Fist of all, Engineering vs. Science (as in Software Engineering and Computer Science)...
  - Engineering is the discipline of acquiring and applying scientific and technical knowledge to the design, analysis, and/or construction of works for practical purposes - Applied!
- Base on problems in industry - develop solutions in collaboration with industry - validate in industry
  - Pragmatic (too pragmatic for my own good) - how do I know something works? Well, practitioners using research results is a good start...
  - Technology transfer in my experience is not about transferring results, rather a way of doing research, where the successful transfer is the last stage...
    -- the point of this presentation is to give tips how industry can work with researchers to enable successful research and technology transfer --

research approach



Step 1: identify issues

- Assessing current practices, observing domain and business settings, and identifying the demands imposed on the organization
  - TOOLS: Process Assessment, doing your homework, getting to know people/products/language/culture
  - Project vs Product vs Organization
  - Selection is paramount
- Practitioners prioritize Improvement Issues



Step 2: problem formulation

- Formulate a research problem
  - Research - not consultancy (has to be a generalizable problem and solution)
  - ... on the other hand... **not reinvent the wheel !!!**
  - Should be done in collaboration with practitioner champion(s)
  - Validate process assessment results + get feedback on research plan (involve the same people as in the assessment => practitioner support)
  - Get support - bottom-up (engineers) AND top-down (management) at this early stage

Step 3: “solution”

- A solution can be anything from a new way of doing things to a new technology, or a combination of both
  - Don´t expect it to be a final solution! It´s a first draft of an idea...
  - Many researchers stop here, publish their “solution” and use toy examples to show usability and usefulness
  - How many industry practitioners read a scientific paper and implement changes based on it? Trust? Scalability? Usability? Usefulness? Exactly how do you implement it in your organization? Best alternative investment? etc...

    => VALIDATION is needed to refine / test the solution

Step 4 & 5: validation

- Academic (lab) validation
  - Validation in industry is expensive and limited at early stages
  - TOOLS: Experiments, Performance tests, Mock-tests etc, GOAL: Test Scalability, Effectiveness and Efficiency of proposed solution
    => Refinement of solution (even dismissal in worst case)
    => Evidence of scalability, efficiency and effectiveness (for both academia and industry)
- Static Validation (industry)
  - In parallel with academic validation
  - Low cost/low risk initial validation
  - In essence interviews, workshops, example cases, limited experiments
    => Refinement of solution (dismissal?)
    => Realism, acceptance (sowing a seed), feedback from practitioners
  - Prepare for Dynamic Validation (+ est. measurement plan)

Step 6: dynamic validation

- Dynamic validation happens after substantial refinement of solution
  - Pilot study (limited in time pending evaluation)
  - Action Research vs Piloting
  - PREPARATION:
    - Tool support (minor importance often)
    - Training and Manuals - example driven (paramount)
    - Plan it as a project (if its free, chances are its worthless)
    - Measurement plan (metrics + qualitative)(reuse what is there...)
  - GOAL:
    - Test Scalability, efficiency and effectiveness as well as acceptance
    - Learn how to refine the solution
    - Get support for future piloting and eventually roll-out

measurement

- Instantiation of measurement programs is expensive
  - Sometimes used as an excuse not to measure, but there are ways to use what is already present AND add qualitative evaluations based on expert opinion
  - Collecting evidence is important from both industry and academic perspective

Metrics

Defect density (phase dependent)
Cost/efficiency/effectiveness
Productiveness in general
=>
- Log information
- Est. traceability btw already present artifacts (e.g. defect to requirement using expert judgement)

Expert judgement

Subjective? => Yes, but so what..?
a) Selection of experts
b) Several data points
c) Cover multiple perspectives (efficiency, effectiveness, bang-for-the-buck)

example

- Implementation Proposal (ABB and DHR)
  - PROBLEM: Global (distributed) development caused problems (misunderstandings and defects not caught until product integration)
  - FORMULATION: Product management communicating requirements to R&D was not effective (PM and R&D spread over sites globally) - need for a tool/technology/process that made understanding explicit and enabling the catching of misunderstandings and defects early (optimally pre-project)
  - STUDY OF STATE OF THE ART (how could it be solved based on current solutions/research).

Formalization

E.g. modeling, formal specifications
=> Issues: cost, scalability, knowledge

Improving req. spec.

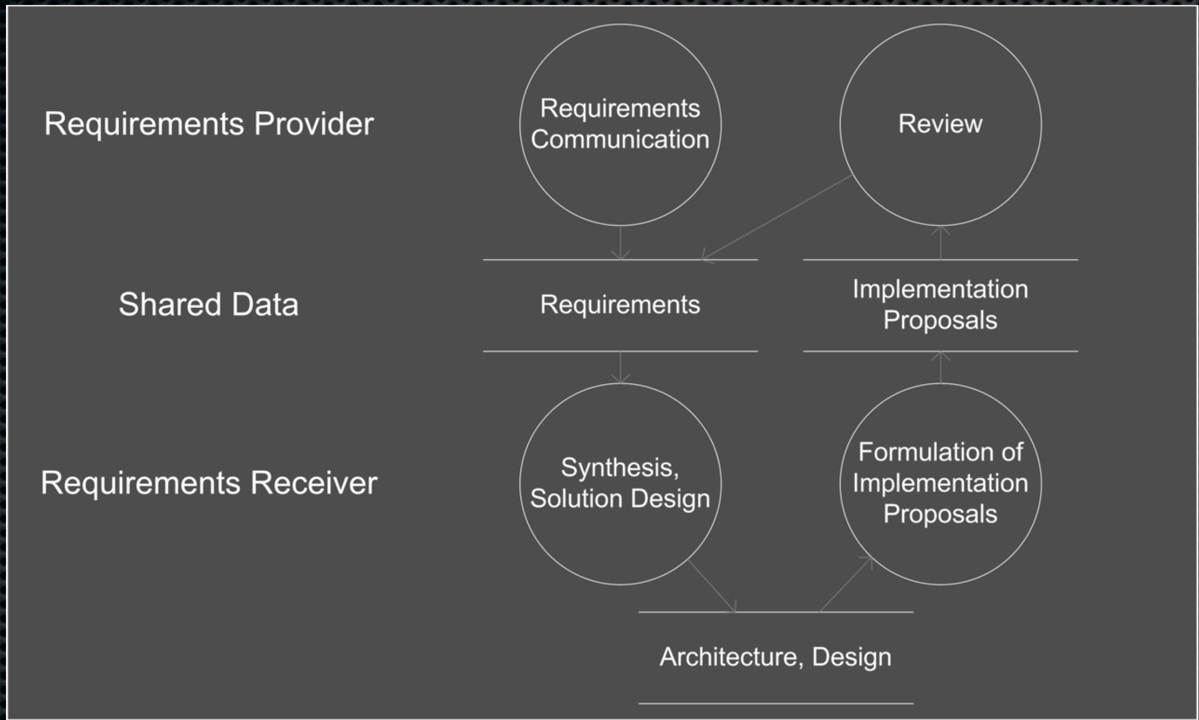
E.g. writing more extensive (and better requirements)
=> Issues: cost, scalability, knowledge, no solution agreement (interfaces to other components, architectural aspects hard to gauge)

Tools

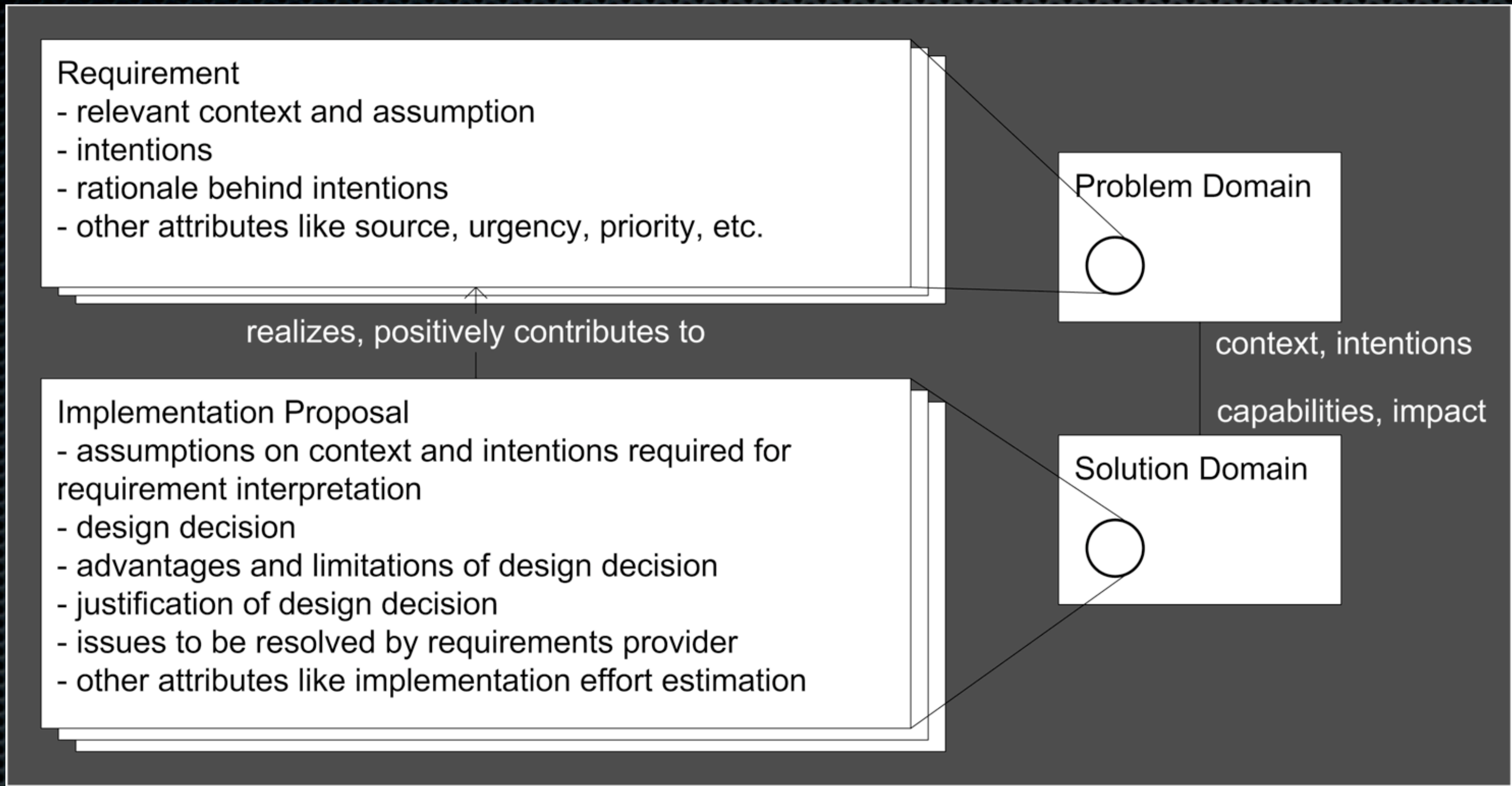
E.g. communication tools
=> Issues: culture, engineering tradition

example 2

- SOLUTION: Implementation Proposal (formal handshaking pre-project to explicitly gauge understanding of requirements + suitability of solution in terms of interfaces and overall architecture)



example 3


Requirement
- relevant context and assumption
- intentions
- rationale behind intentions
- other attributes like source, urgency, priority, etc.
realizes, positively contributes to
Implementation Proposal
- assumptions on context and intentions required for requirement interpretation
- design decision
- advantages and limitations of design decision
- justification of design decision
- issues to be resolved by requirements provider
- other attributes like implementation effort estimation
Problem Domain
context, intentions
capabilities, impact
Solution Domain

example 4

- VALIDATION LAB: Experiment comparing IP vs Better Requirements
- STATIC VALIDATION INDUSTRY:
  - Refined IP template (scaled down some parts)
  - Developed good-examples (based on real requirements)
  - Showed that IPs can be reused for design = very little extra effort expended for creating IPs as design has to be performed in any case
  - Examples showed just how serious the misunderstandings were and at what level
  - Measurement plan established (defect measurement, defect tracing, expert opinion)
- DYNAMIC VALIDATION:
  - One pilot completed (very promising results)
  - Second pilot in progress

thoughts

- understanding goes both ways
  - Researchers working in collaboration with industry have two mistresses...
- collaboration is a continuous activity
  - process change and introduction of new tools take time and is not for free
  - treat your process improvement as a product development instance...
- politics is hard...
- one size does not fit all
- project focus is ultimately inadequate and short sighted
- start with low-hanging fruit

Q & A

- For detailed information about **Process Assessment**, **Improvement Issue Prioritization and Packaging**, and **Technology Transfer and Improvement Impact Measurement** see www.gorschek.com for references and publications as well as contact information in case of questions (all papers free for download).

- Research areas: Technical Product Management, Requirements Engineering, Process Assessment and Improvement, Global Product Development and Product Management, Market-driven Requirements Engineering