
# Research Methodology: Introduction

Samuel Fricker | sfr@bth.se | 111031

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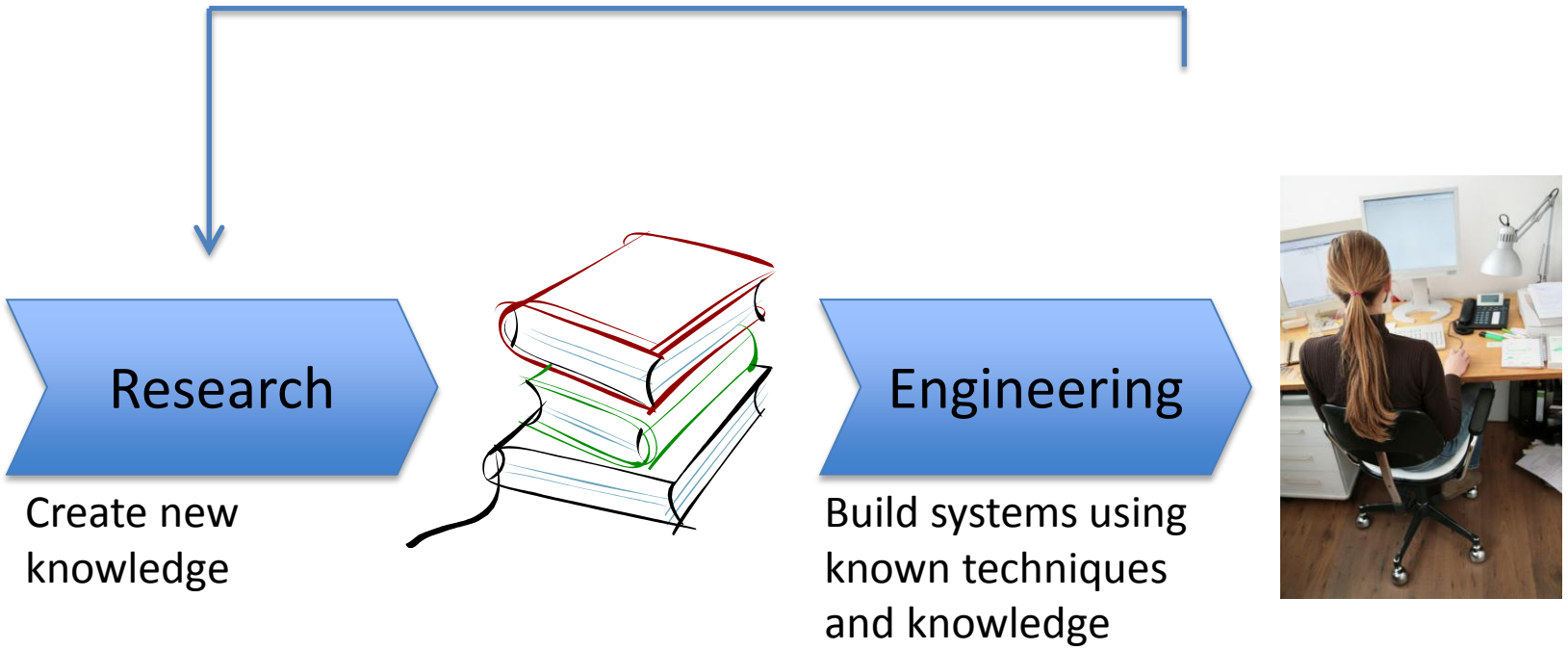
BLEKINGE INSTITUTE OF TECHNOLOGY

# What is Research?



# Dr. Samuel A. Fricker

- Blekinge Institute of Technology:
  Assistant Professor
- 10y+ in Industry:
  Product Manager, Global Process Owner,
  Senior Consultant, Scientific Advisor
- 6y+ in Research

UBS SIX swisscard AECS avaloq ABB IBM anforderungen.ch

Sunrise Qnective ERICSSON Schweizerische Eidgenossenschaft Confédération suisse Confederazione Svizzera Confederaziun svizra customedia zühlke empowering ideas

University of Zurich[UZH] n|w University of Applied Sciences Northwestern Switzerland

SPM International Software Product Management Association

IREB International Requirements Engineering Board

# Lecturers


SFR


SJL


BHE


ENO


SSW


TGO


HGR


LLU


SJA


NLA


KRO


CWO

# Contents

Objectives

- Know PA2404 course objectives, structure, and services
- Know your part of the learning process
- Understand research methodology
- Understand literature review

Agenda

- PA2404 Course
- A Primer in Research Methodology
- Modest Advices for Your Own Research Project
- Rules of Conduct
- Literature Review

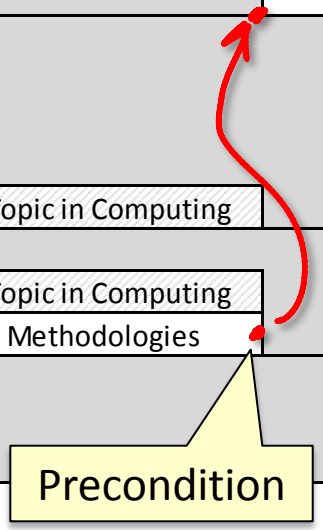
# Why Research Methodology?

- BSc degree
  - Goals: understand and apply knowledge
  - Inputs: course material
  - Examination: mostly written
- MSc degree
  - Goals: identify, combine, tailor, apply, and evaluate knowledge to solve problems
  - Inputs: literature, real world
  - Examination: small research project
- PhD degree
  - Goals: develop and evaluate new knowledge that improves today‘s technology
  - Inputs: not guided
  - Examination: doctoral thesis

# Why Research Methodology?

**Master of Science Program in Software Engineering 2011 (as an example)**

| | CS | SE | Research | Practice |
|---|---|---|---|---|
| Sem 4 | | | | MSc Thesis |
| Sem 3 | | Software Quality Management | | |
| | | Large Scale Requirements Engineering | | |
| | Software Security | Strategy and IT | | |
| | Product-line Architecture | Global Software Engineering | | |
| | Programming in UNIX Environment | Advanced Software Project Management | Advanced Topic in Computing | |
| Sem 2 | | Software Metrics | | |
| | | Software Quality Management | Advanced Topic in Computing | |
| | Server Architectures | Software Verification and Validation | Research Methodologies | |
| Sem 1 | | Practical Requirements Engineering | | |
| | | Advanced Software Project Management | | |
| | Software Architectures and Quality | Applied Software Project Management | | |




In addition: the learned is relevant in every course, where you write a report.

# PA2404: Learning Objectives

- PA204 enables you to do the MSc thesis research project.
- Be able to
  - conduct a research project from start to finish
  - find, read, and evaluate research articles
  - reference other peoples work according to academic standards
  - formulate a research question
  - design a research study
    - qualitative research
    - quantitative experiment
  - write a research article that
    - conforms to common academic practice
    - thoroughly describes a research study.
- Understand
  - the ethical implications involved in conducting a research project

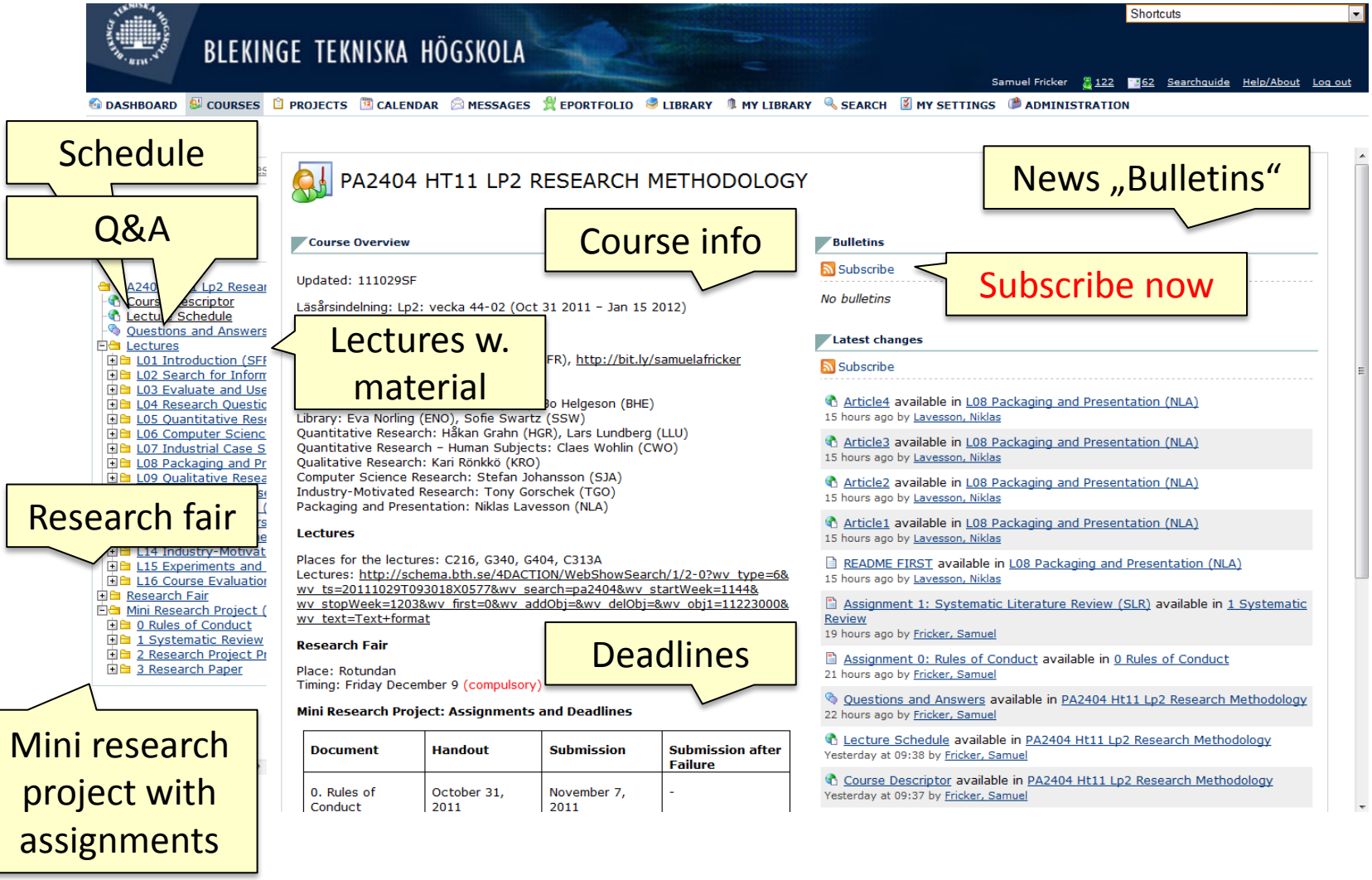
# PA2404: Services

- Learning is your task and your initiative.
  Learning cannot be delegated to the lecturers.

- Learning platform
  - https://bth.itslearning.com/Main.aspx?CourseID=3287
- Lectures given by leading researchers
  - Schedule on http://schema.bth.se
- Reviewed mini-research project
  - 4 assignments on itslearning
- Research fair
  - Get into contact with researchers for MSc thesis
- Literature
  - Books
  - Recommended publications

# PA2404: Learning Plattform

https://bth.itslearning.com/Main.aspx?CourseID=3287



Changes always on itslearning

# PA2404: Schedule Lp2 2011

2011

| Week 44, 2011 | | | | | Room | Staff | Course | Element | Remark |
|---|---|---|---|---|---|---|---|---|---|
| | i | Mon | Oct 31 | 08:00-12:00 | Gradängsal G340 (90) (fd 2304A) | SFR | PA2404 | Lecture | Introduction. |
| | i | Fri | Nov 4 | 10:00-12:00 | Gradängsal C216 (80) (tidigare 3248) | ENO, SSW | PA2404 | Lecture | Where & how to search for information |

| Week 45, 2011 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | i | Tue | Nov 8 | 13:00-15:00 | Gradängsal G404 (90) (fd 2404A) | ENO, SSW | PA2404 | Lecture | How to evaluate and use information |
| | i | Fri | Nov 11 | 08:00-12:00 | Gradängsal C216 (80) (tidigare 3248) | SFR | PA2404 | Lecture | Research Questions. |

| Week 46, 2011 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | i | Mon | Nov 14 | 13:00-15:00 | Gradängsal G340 (90) (fd 2304A) | HGR | PA2404 | Lecture | Quantitative Research. |
| | i | | | 15:00-17:00 | Gradängsal G340 (90) (fd 2304A) | SJA | PA2404 | Lecture | Computer Science Research. |
| | i | Thu | Nov 17 | 08:00-10:00 | Gradängsal C216 (80) (tidigare 3248) | SFR | PA2404 | Lecture | Industrial Case Studies. |
| | i | | | 10:00-12:00 | Gradängsal C216 (80) (tidigare 3248) | SFR | PA2404 | Lecture | Packaging & Presentation. |

| Week 47, 2011 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | i | Wed | Nov 23 | 13:00-15:00 | Gradängsal G340 (90) (fd 2304A) | KRO | PA2404 | Lecture | Qualitative Research. |
| | i | Thu | Nov 24 | 10:00-12:00 | Gradängsal C313A (80) | CWO | PA2404 | Lecture | Quantitative Research - Human Subjects. |

| Week 48, 2011 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | ed | Nov 30 | 13:00-15:00 | Gradängsal G340 (90) (fd 2304A) | SFR | PA2404 | Lecture | Validity Threats. |
| | | | | 15:00-17:00 | Gradängsal G340 (90) (fd 2304A) | SFR | PA2404 | Lecture | Research Posters and Research Fair. |

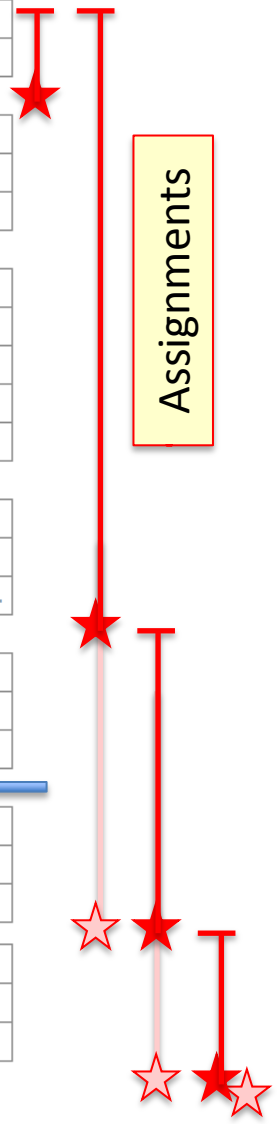
Research fair

| Week 50, 2011 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | i | Mon | Dec 12 | 08:00-10:00 | Gradängsal G340 (90) (fd 2304A) | TGO | PA2404 | Lecture | Introduction to MSc Thesis. |
| | i | | | 10:00-12:00 | Gradängsal G340 (90) (fd 2304A) | TGO | PA2404 | Lecture | Industry-Motivated Research. |

2012

| Week 2, 2012 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | i | Mon | Jan 9 | 13:00-15:00 | Gradängsal G340 (90) (fd 2304A) | SFR | PA2404 | Lecture | Experiments and Research Ethics |
| | i | | | 15:00-17:00 | Gradängsal G340 (90) (fd 2304A) | SFR | PA2404 | Lecture | Course Evaluation. |

Assignments



Changes always on itslearning

# PA2404: Mini Research Project

Individual

- Assignment 0: Rules of Conduct
  - October 31 → November 7
  - Ethically correct way of doing and reporting research

Groups of four students

- Assignment 1: Systematic Literature Review
  - October 31 → November 27
  - Identify state of knowledge
- Assignment 2: Research Project Proposal
  - November 28 → December 18
  - Plan the research project
- Assignment 3: Research Paper
  - December 19 → Janaury 15
  - Perform the research project
  - Report the research project and results

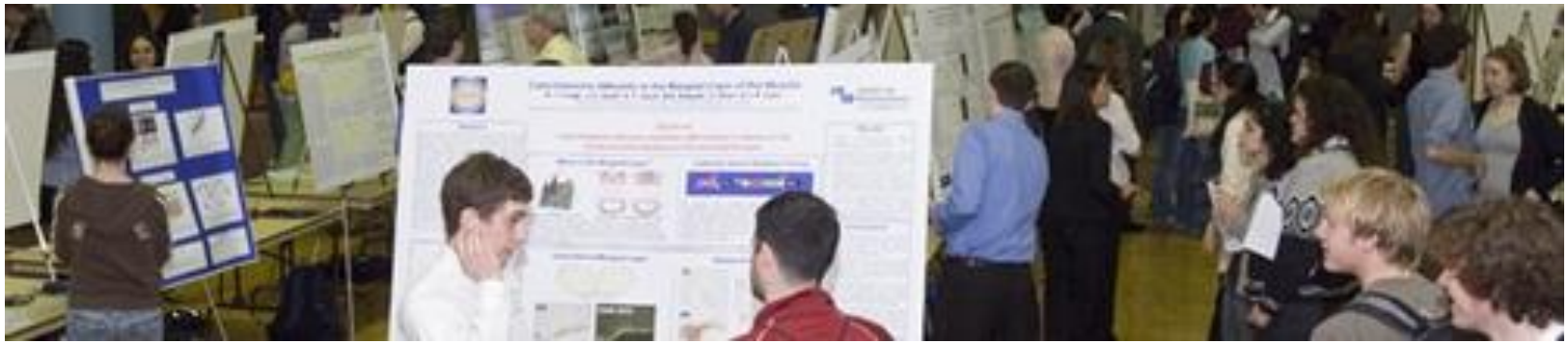
# Grading

- Exercise 0 (1 attempt): Pass / Fail
- Exercises 1-2 (2 attempts):
  - Evaluation Rubrics
  - Pass: „ok as-is“ and „needs minor revision“
  - Fail: „needs major revision“
    You have to resubmit the exercise
- Exercise 3 (3 attempts):
  - Evaluation Rubrics
  - Pass: A, B, C, D, E
  - Fail: F, FX Grades
    You have to resubmit the exercise
- Observe:
  - Your workload increases with every fail.
  - MSc thesis supervisors check as one of the first things on your grade in PA2404.

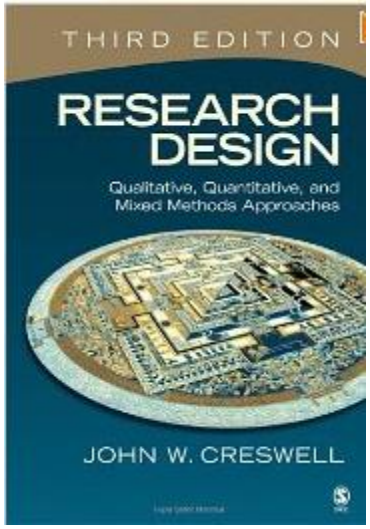
# PA2404: Research Fair on December 9 in Rotundan

Changes always on itslearning

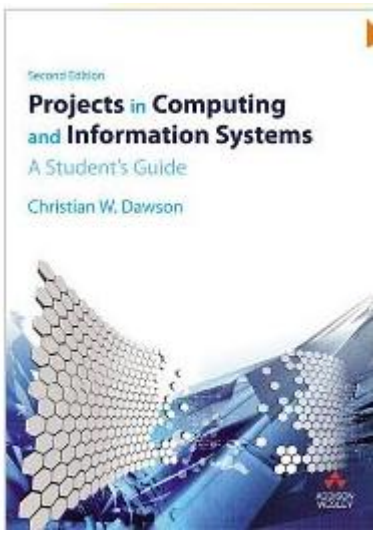
- Goal: find attractive supervisors for your future MSc thesis before their supervision slots have gone
- Cooperation with
  DV2508 Advanced Topics in Computing
  - PA2404: how to create a research poster
  - DV2508: exploration of research area
  - You: sell your ideas with a research poster



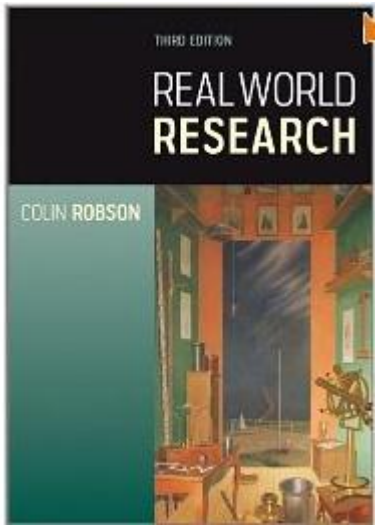
# Literature




Introduction




Software Projects




Empirical Projects


Experimentation

Plus: publications recommended by the lecturers.

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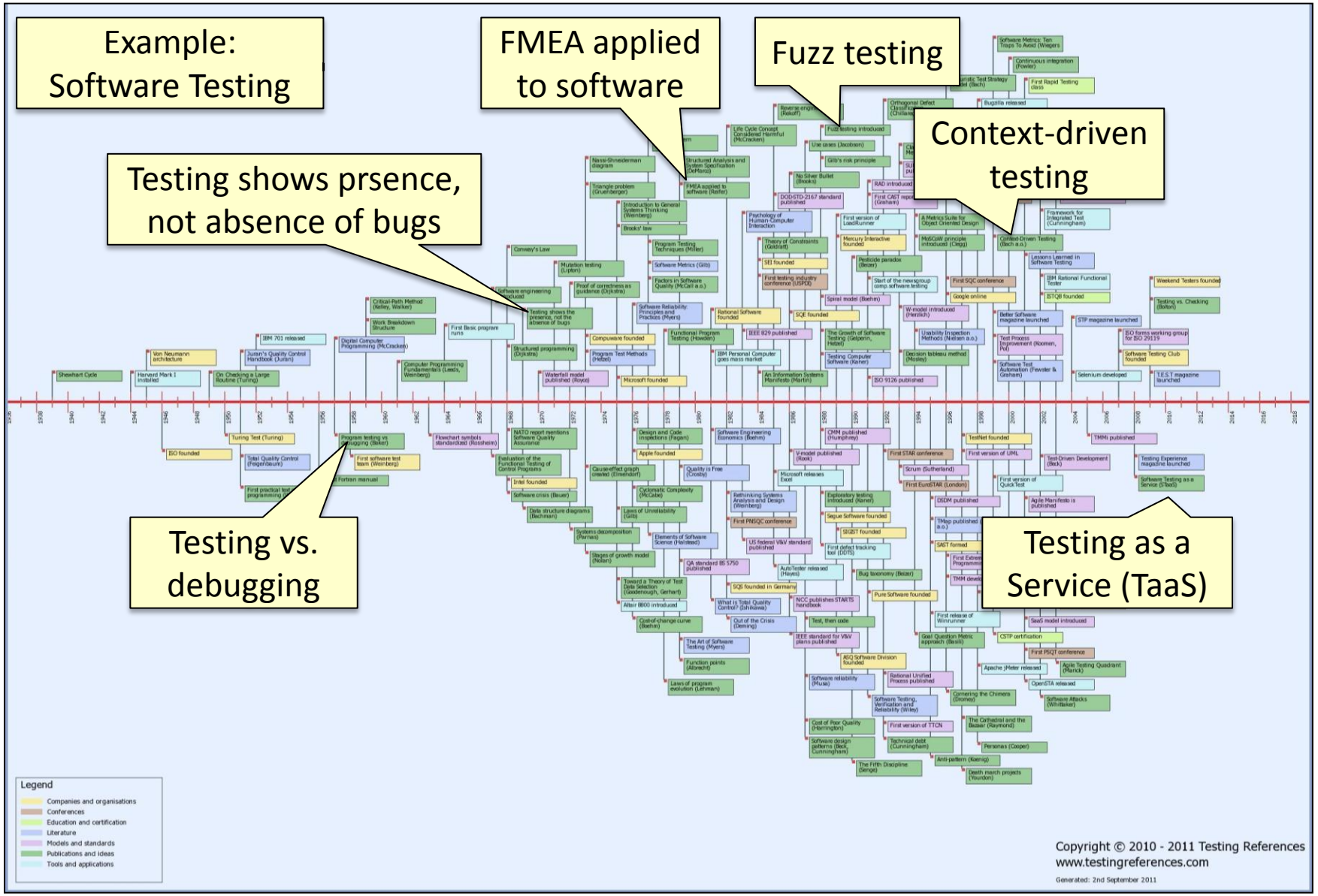
# Academia vs. Industry

We are primarily concerned with research projects conducted in an academic setting. This means that you should adhere to certain criteria regarding research methods and so forth.

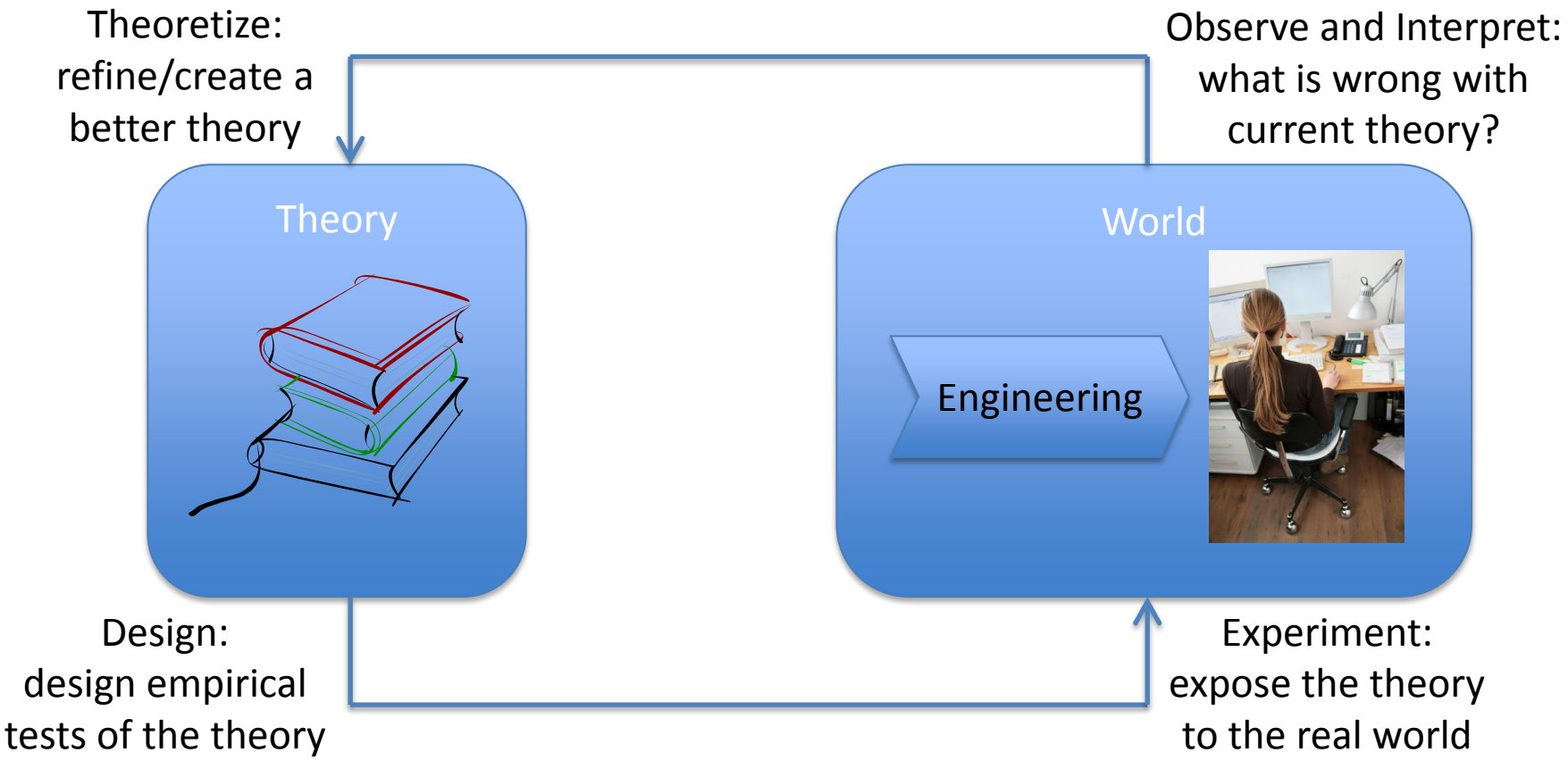
- Academia: oriented towards critical thinking, justification and develop your own thoughts, arguments, ideas and concepts.
- Industry: oriented towards developing a particular solution to a problem.
- You must balance these two views if doing your Master thesis in industry.

# Evolving Body of Knowledge



# Research

- No single „official“ scientific method



# Research

- Research seeks to improve our understanding of the world

- Empiricism: Explanations are based on observations
  - Scientific truths must stand up to empirical scrutiny
  - Sometimes „scientific truth“ must be thrown out in the face of new findings
- Interpretation: Theory and observation affect one another.
  - Our perceptions of the world affect how we understand it
  - Our understanding of the wolrd affects how we perceive it
- Creativity: new ideas are important to further knowledge
  - Theories, hypotheses, research designs
  - Search for elegance and simplicity

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Classifying Research

Three facets:

- Field (area of research)
- Approach (research method)
- Nature (of research)
  - Theoretical
  - Reviews and assess
  - Practical application or outcome

# Model, Theory, and Hypotheses

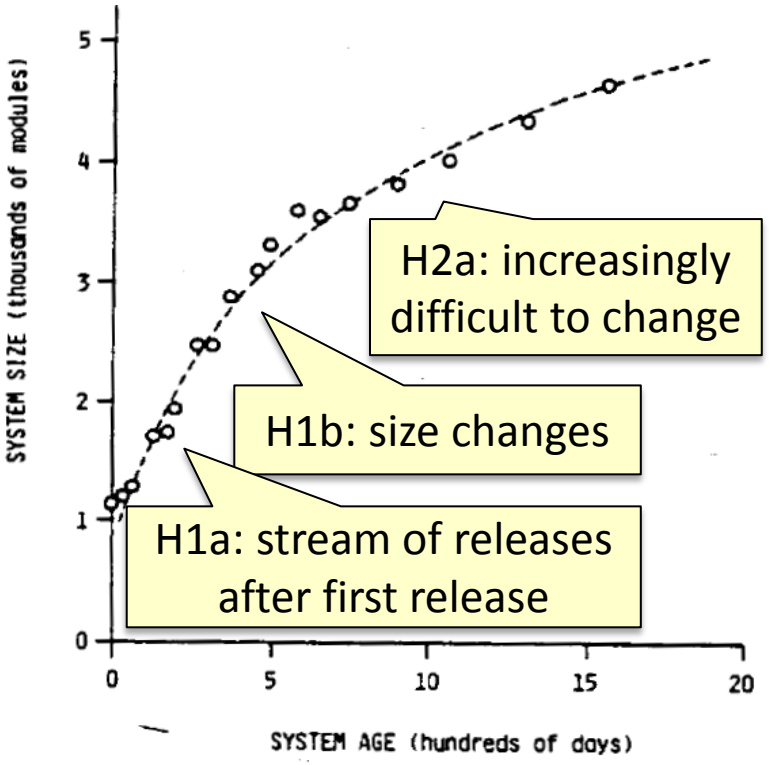
- Model: abstract representation of observable things
  - Precisely defined terminology
  - Concepts, relationships, causal inferences
- Theory: explanation of a set of observations
  - Logically complete, internally consistent, falsifiable
  - Simple and elegant
  - Used to predict and generalize
  - Guide observation and data collection
- Hypothesis: testable statement derived from theory

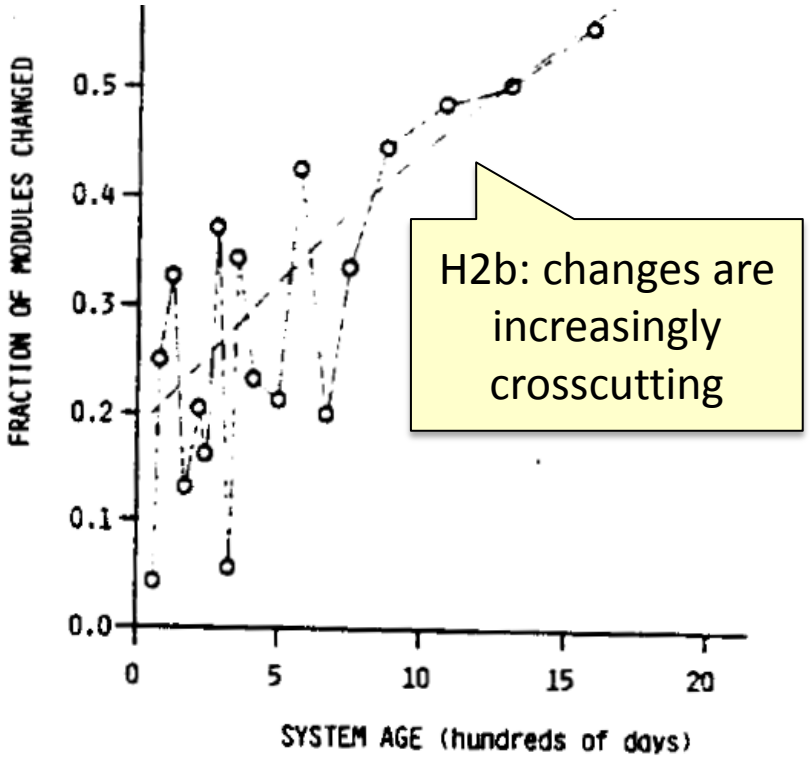
Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Example

Lehman‘s Laws of Software Evolution (selection)

- Model: a program that is used and reflects some reality for that purpose.
- 1 Theory of continuing change: the program undergoes continual change or becomes progressively less useful.
- 2 Theory of increasing complexity: the complexity of a continually changed program increases unless work is done to maintain or reduce it.




Lehman (1980): Programs, Life Cycles, and Laws of Software Evolution, Proceedings of the IEEE 68(9):1060-1076.

# Theories about Theory

- Logical positivism: scientific truth is absolute, cumulative, and unifiable
- Feyerabend: all scientific methods are limited; any method offering new insight is ok
- Popper: theories can be refuted, not proved
- Quine: terms used in scientific theories have contingent meanings (have a scope of validity)
- Toulmin: scientific theories describe ideals, and explain deviations
- Laudan: negative evidence is not so significant in evaluating theories; new theories seldom explain everything the previous theory did.
- Kuhn: science is characterized by dominant paradigmes, punctuated by revolution

# Simplistic Research Process

- Prepare a study
  - Pick a topic
  - Identify the research questions
  - Check the literature
- Plan the study
  - Identify your philosophical stance
  - Identify appropriate theories
  - Choose the research method(s)
  - Design the study
  - Evaluate the design for threats to validity
- Perform the study
  - Recruit subjects and field sites
  - Conduct the study
  - Analyze the data
- Write up the results and publish them

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Research Questions

The research question ties together the following perspectives

- Contribution:
  - Existing knowledge: relations to established literature
  - New knowledge: the novel perspectives for the field
- Philosphical context:
  - what is accepted as truth
- Methodological choices:
  - empirical method,
  - data collection techniques, and
  - data analysis techniques to be used

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

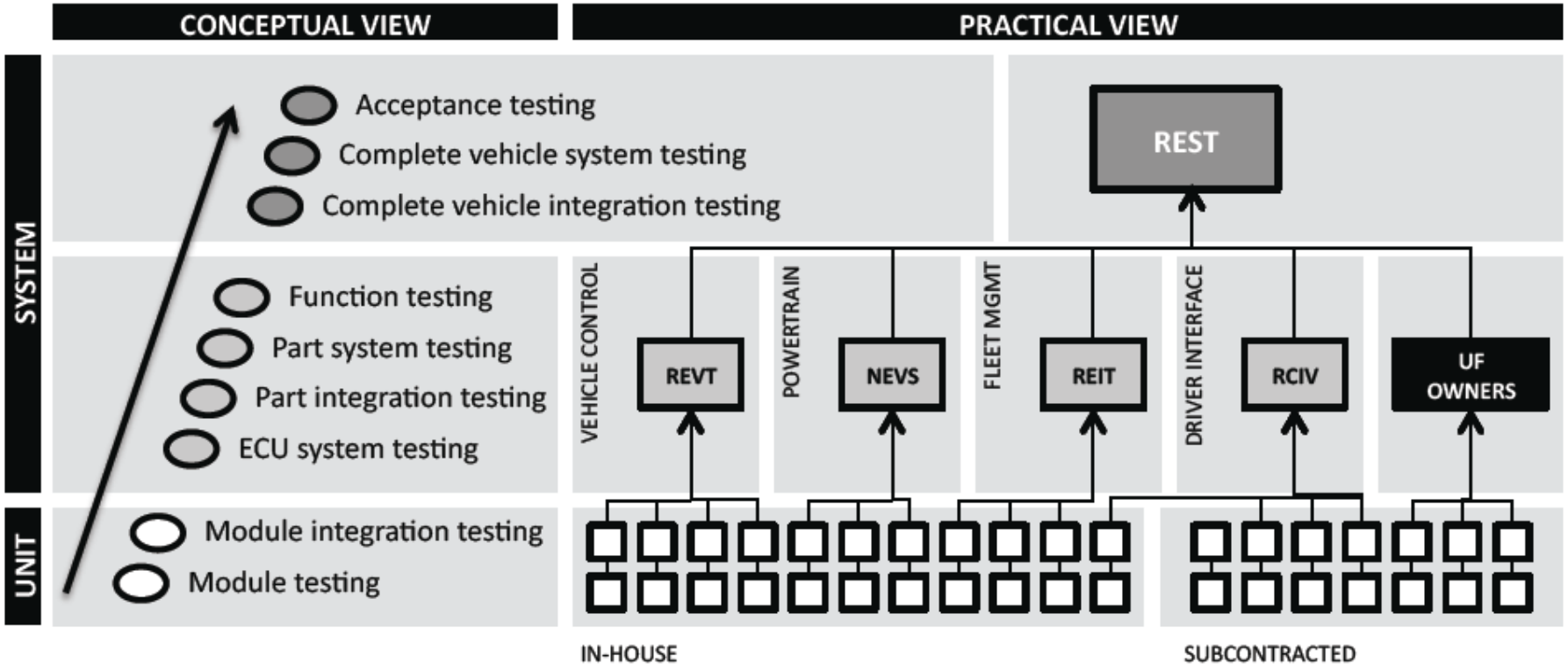
# Types of Research Questions

- Exploratory
  - Does X exist?
  - What are the properties of X?
  - How does X differ from Y?
- Baserate
  - How often does X occur?
  - How does X normally work?
- Correlation
  - Are X and Y related?
- Causal Relationship
  - Does X cause Y?
  - Does X cause more Y than does Z?
- Design
  - What is an effective way to achieve X?

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Exploratory Research

- How is a large-scale embedded system tested?

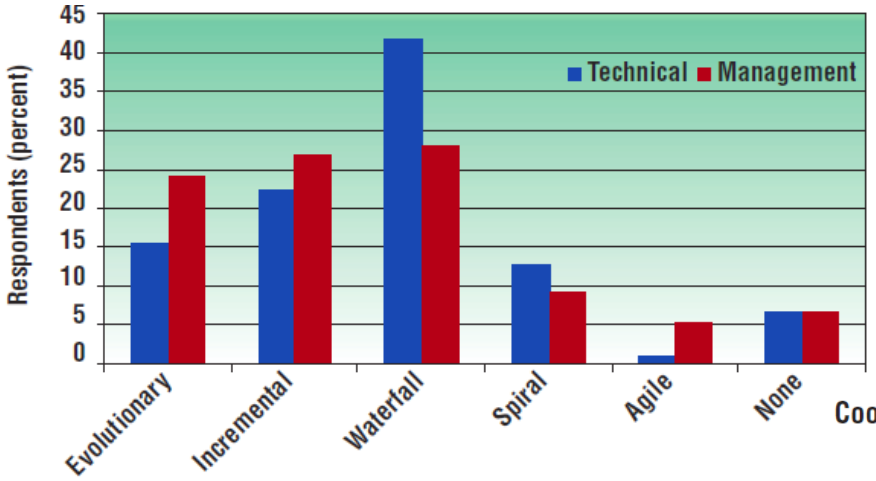


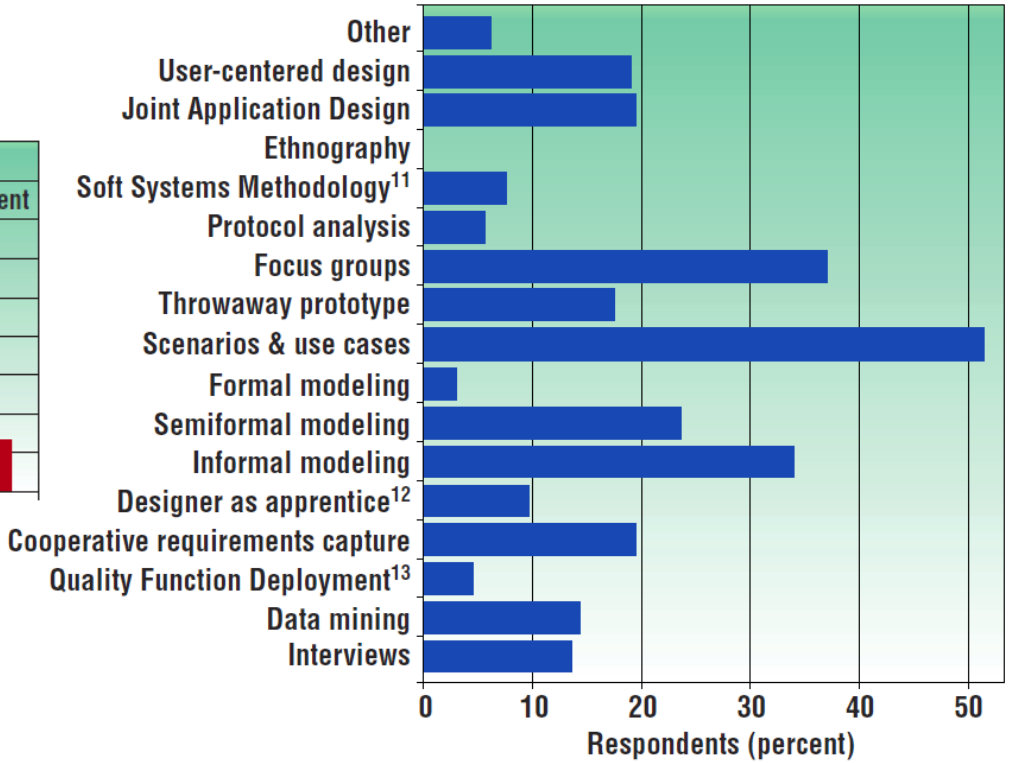

Case: testing at Scania

Sundmark, Peterson, Larsson (2011): An Exploratory Case Study of Testing in an Automotive Electrical System Release Process. SIES 2011.

# Baserate Research

- Which development processes are used?
- Which requirements elicitation methods are used?

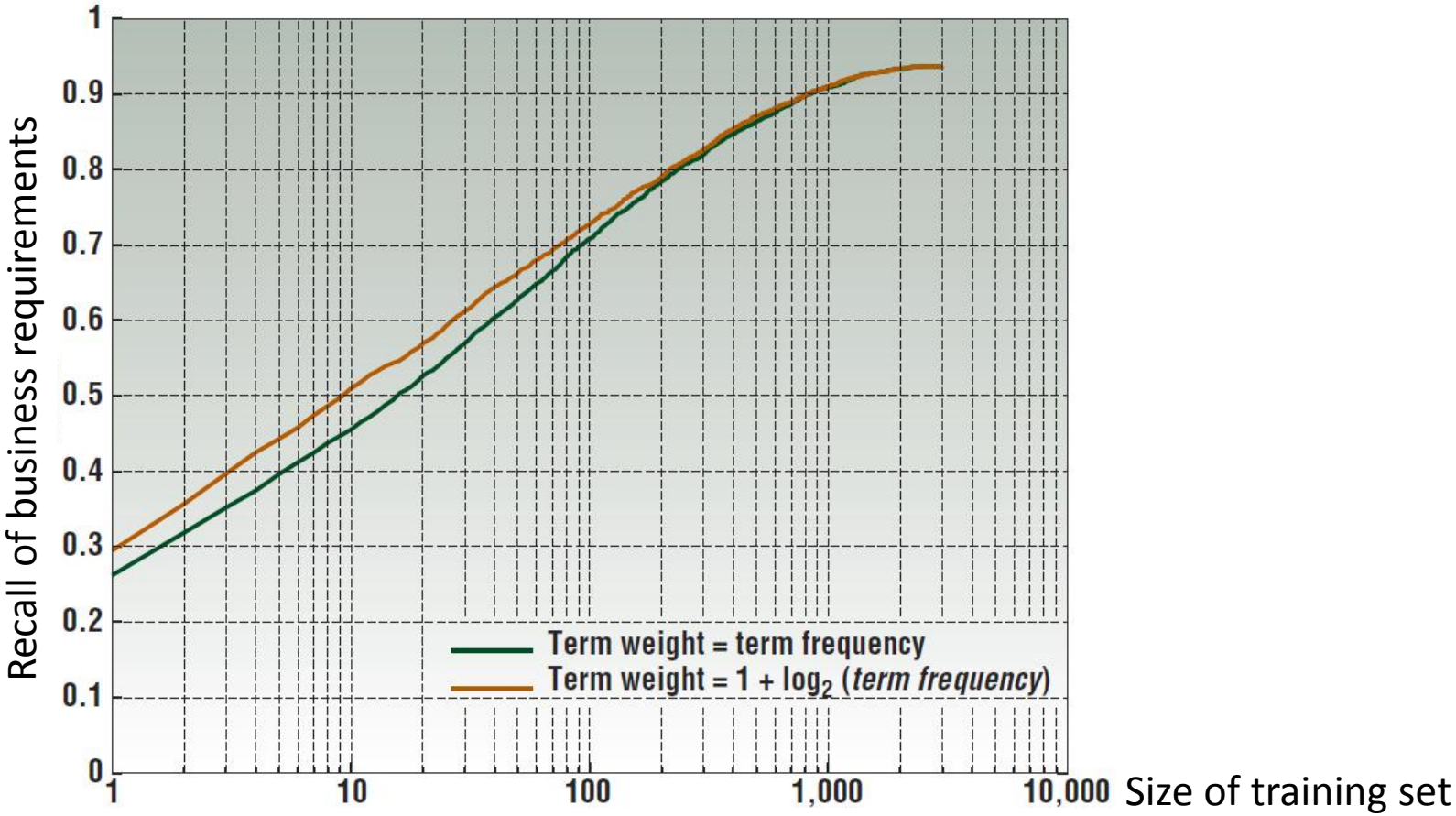



Neill, Laplante (2003): Requirements Engineering: The State of the Practice. IEEE Software 20(6):40-45.

# Correlation Research

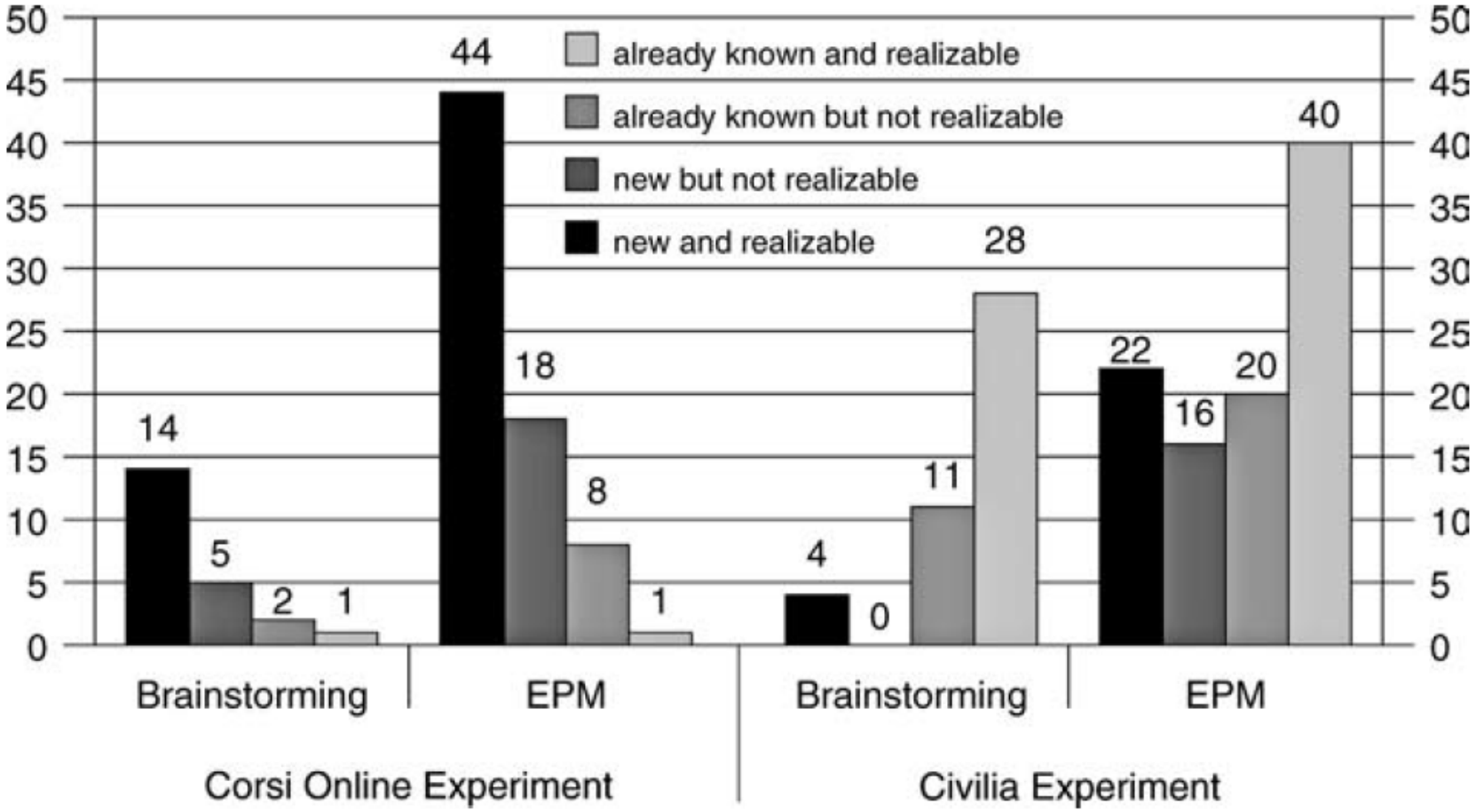
- Does training set size affect recall?




Natt och Dag et al (2005): A Linguistic-Engineering Approach to Large-Scale Requirements Management. IEEE Software 22(19:32-39.

# Causality Research

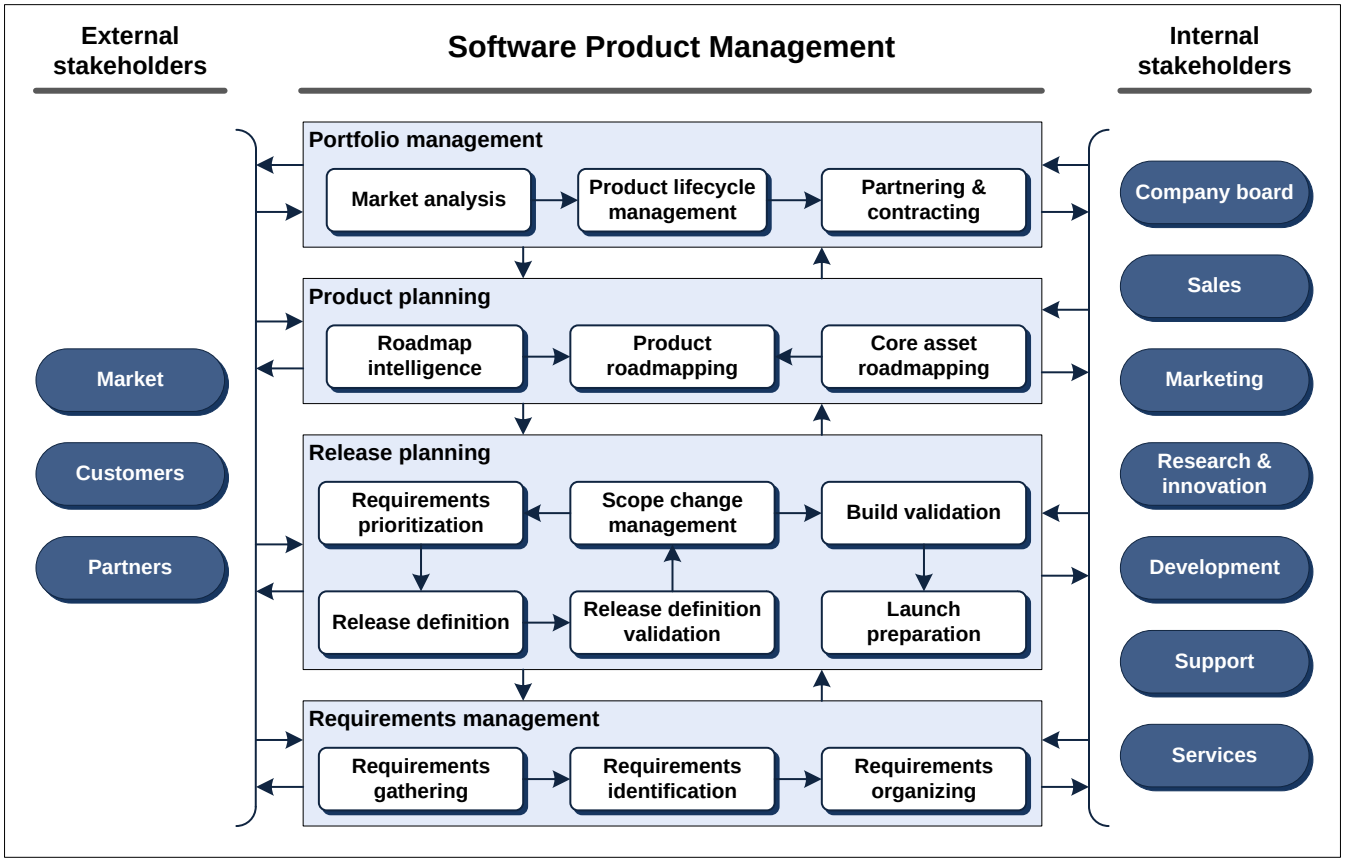
- Does Brainstorming generate more good ideas than EPM?




Mich, Anesi, Berry (2005): Applying a Pragmatics-Based Creativity-Fostering Technique to Requirements Elicitation. RE 10:262-275.

# Design Research

- What is an effective way to assess an organization‘s product management capability?



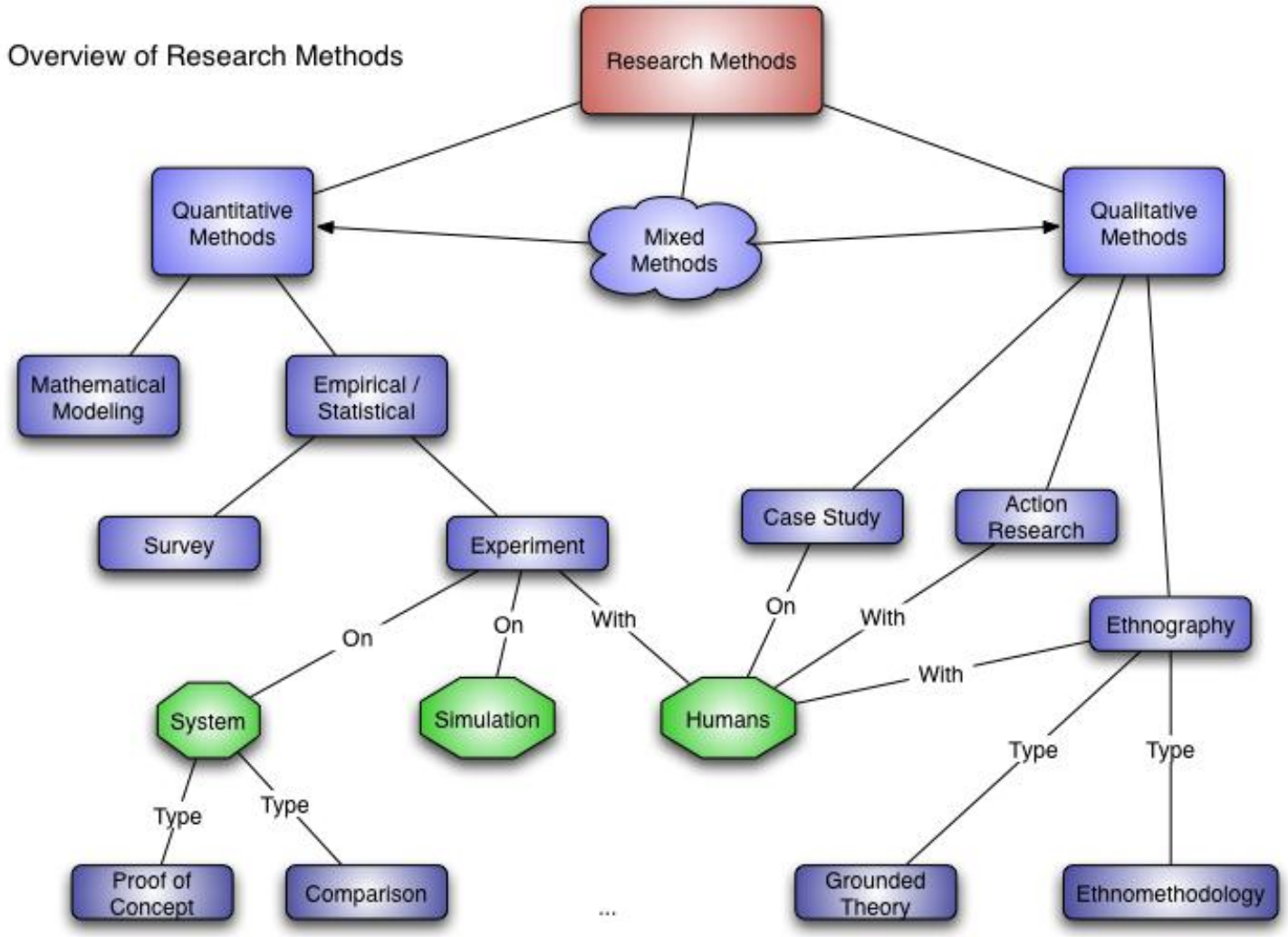

Bekkers et al (2010): A Framework for Process Improvment in Software Product Management. EuroSPI 2010.

# What is Acceptable Knowledge?

- Positivist ✓
  - Knowledge is objective: cases determine effects
  - Prefer quantitative approaches to verify (by trying to falsify) theories
- Constructivist ✓
  - Knowledge is socially constructed: truth is relative to context
  - Prefer qualitative approaches to generate „local“ theories
- Critical Theorist ✗
  - Research is a political act: knowledge is created to empower groups or individuals
  - Research based on who will help to generate change in society
- Pragmatist ✗
  - Research is problem-centered: truth is what works at the time
  - Prefer multiple methods and perspectives to identify practical solutions to problems

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Overview of Research Methods



# Common Empirical Methods

In the laboratory

- Controlled experiments
- Exemplars
- Simulations

In the real world

- Quasi experiments
- Case studies
- Surveys
- Ethnographies
- Action research

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Some Data Collection Techniques

Direct Techniques

- Brainstorming
- Focus groups
- Interviews
- Questionnaires
- Conceptual modeling
- Work diaries
- Think-aloud sessions
- Observation

Indirect Techniques

- Instrumenting systems
- Fly on the wall

Independent Techniques

- Analysis of work databases
- Analysis of tool usage logs
- Documentation analysis
- Static and dynamic analysis

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Some Data Analysis Techniques

Quantitative

- Data set creation
- Descriptive and exploratory data analysis
  - Data visualization
  - Summary (descriptive) statistics
  - Data manipulating and scaling
- Analyzing relationships between variables
  - Analysis of correlation
  - Analysis of covariance
  - Regression analysis
- Analysing differences between variables

Qualitative

- Quasi-statistical methods
  - Discovery of regularities
- Template approaches
  - Categorization and modeling
- Editing approaches
  - Grounded theory
- Immersion approaches
  - Expert interpretation

Robson (2002): Real World Research.

# Originality

Two original things you may do:

- You can be original in the way you do things.
  - Tools, techniques, procedures, and methods
- You can be original by developing or producing something new.
  - Exploring the unknown (rare)
  - Exploring the unanticipated
  - The use of data

# Generalization

- Statistical Generalization
  - Generalize from sample to population
  - Only feasible with quantifiable variables
  - Based on random sampling

- Analytical Generalization
  - Generalize from finding (a confirmed/rejected hypothesis) to theory
  - Feasible with quantitative and qualitative studies
  - Compares findings with theory
  - Evidence builds if subsequent studies also support the theory

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Limitations of Research

- All methods are flawed
  - Laboratory experiments: hard to study large-scale software development
  - Case studies: hard to generalize from one case to others
  - Surveys: self-selection of respondents biases the study
- Strategies to overcome weaknesses
  - Theory-building: testing a hypothesis is pointless unless it builds evidence for a clearly stated theory
  - Empirical induction: series of studies, each designed to test alternative hypotheses, build evidence for a theory
  - Mixed methods research: the use of a different methods to investigate the same theory compensates for the flaws of the other used methods.

Easterbrook (2007): Empirical Research Methods in Requirements Engineering. RE 2007 Tutorial.

# Results of Research

It is often both:

- New results
- New questions

# What is Good Research?

Some key characteristics:

- Open minds (not limited)
- Critical analysis (trustworthy)
- Generalisations (validity and hence interest)
- Honest (of course)

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# You and Your MSc Thesis Advisor

When it comes to thesis writing:

- You always need an advisor in academia, and you may have an advisor in industry.
- The university is responsible for approving the thesis.
- However, you are responsible for
  - The design of your thesis project
  - The progress of the thesis project
  - The results of the thesis project

# Different Project Types

Five types:

- Research-based project
- Development project
- Evaluation project
- Industry-based project
- Problem solving

- The five types are not mutually exclusive.

# Expectation on Research Contents

- Some departments may be happy for you to pursue highly technical programming projects.
  - Targets the BSc level
- Other departments require more academic content which emerges from critical evaluation, analyses and literature surveys.
  - Targets the MSc level

# Your Project

- Capability to do it in time
- Interesting project
- Serious purpose (related to impact)
- Clear outcome
- Project suitably linked to your degree
- Sufficient scope and quality
- Not a personal issue
- Make a risk assessment

# Finding a Project

Several ways of identifying a project:

- Search
  - List of projects
- Own initiative
  - Brainstorming
  - Past projects
- Mini projects
- Research Fair
  - Reading around
  - Talking with the university staff

# Testing Your Idea

Sketch report

- Chapter breakdown of the thesis report

Importance of research

- ”So what” test (impact)
- Justification (importance)
- Numerating your understanding (knowledge of topic, this is related to risk)

# Preparing a Project Proposal

Four key areas to address:

- Introduction to the subject area
- Current research in the field
- Identify a gap
- Identify how your work fills that gap

- These should at least implicitly be addressed briefly.

# Explicit Sections in Proposal

- Background
- Aims and Objectives
- Research Questions
- Expected Outcomes
- Research Methodology
- Risks
- Time Plan
- References

# Two Examples

- Two examples of project proposals are shown on page 34-35 in Dawson. The proposal should not be long; it should be thought through and clear.
- Proposals may also be viewed through the home pages of on-going master theses, e.g. /www.bth.se/com/dv2512

- And, template available through for assignment 2 in this course.

# Chapter 3: Project Planning

- This will be handled fairly briefly since many of you are quite used to conducting projects.
- Key issue is to realize that research projects need to be planned as any development project.

# Objectives

- Describe the typical stages of an academic computing project
- Define a project in terms of aims and objectives
- Discuss the activities performed during the initial planning of a project
- Understand the use of project management techniques for project planning.

# Some Hints

In all research projects:

- Start writing your report when your project starts and write continuously throughout the project.
- Divide the total time in the project among different tasks (how large should different tasks be relatively each other, relative time).
  - This is actually a good piece of advice also when it comes to working with different assignments in courses in general.

# Objectives and Work Breakdown

- The objectives are closely related to the work breakdown. Thus, to set clear objectives of the work is important to be able to plan the research project.

# Project Planning

This is among the first things you have to do when the project has been approved.

- Work breakdown
- Time estimates (lead time and effort)
- Milestone identification
- Activity sequencing
- Scheduling
- Re-planning

# Contents

Objectives

- Know PA2404 course objectives, structure, and services
- Know your part of the learning process
- Understand research methodology
- Understand literature review

Agenda

- PA2404 Course
- Research Methodology
- Rules of Conduct
- Literature Review

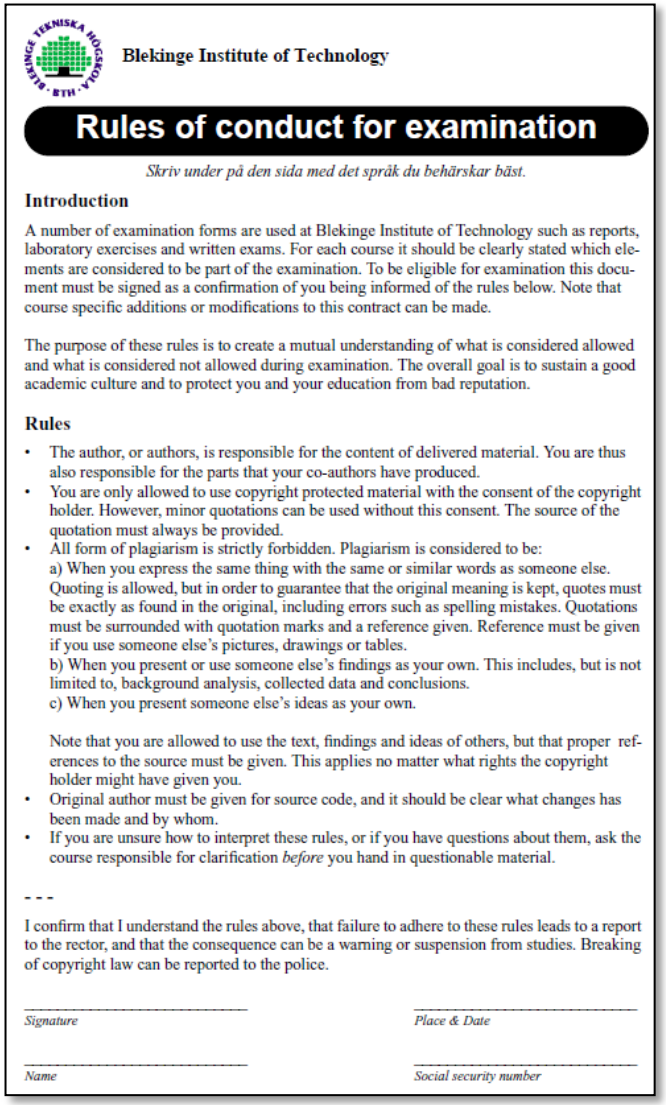
# Crediting Others

- Original work
  - Anything you have written or invented yourself.
- Referencing
  - Anything else must be referenced by crediting the authors.
  - Example: Employees can be involved in product innovation with auditions (Gorschek et al., „A Lightweigt Innovation Process for Software Intensive Product Development," IEEE Software 27(1), pp. 37-45, 2009).
- Citation
  - Surround sentences, paragraphs or sections copied from another source with quotation marks "…".
  - Example: „The product development environment facing most companies today requires not only having an ear to the ground to react to market trends ahead of competitors but also keeping a close eye on key customers to assure financial security" (Gorschek et al., „A Lightweigt Innovation Process for Software Intensive Product Development," IEEE Software 27(1), pp. 37-45, 2009).
- Plagiarism
  - Deviation from these rules has immediate and long-term consequences.
  - Example: plagiarism costed German defense minister his title and career, http://www.nytimes.com/2011/03/02/world/europe/02germany.html
  - http://www.bth.se/bib/eng/teach.nsf/pages/plagiarism

# Assignment 0: Rules of Conduct

Failure to reference material is not acceptable.

- "I did not know that I had to add a reference."
  - Anything that you have not written or invented yourself must be referenced.
- "I added the reference at the end of the paragraph that I copied."
  - You have not used "…".
  - Try to avoid using quotes, however. More interesting is to see your interpretation of what you have read (with proper referencing).



Blekinge Institute of Technology

**Rules of conduct for examination**

*Skriv under på den sida med det språk du behärskar bäst.*

**Introduction**

A number of examination forms are used at Blekinge Institute of Technology such as reports, laboratory exercises and written exams. For each course it should be clearly stated which elements are considered to be part of the examination. To be eligible for examination this document must be signed as a confirmation of you being informed of the rules below. Note that course specific additions or modifications to this contract can be made.

The purpose of these rules is to create a mutual understanding of what is considered allowed and what is considered not allowed during examination. The overall goal is to sustain a good academic culture and to protect you and your education from bad reputation.

**Rules**

- The author, or authors, is responsible for the content of delivered material. You are thus also responsible for the parts that your co-authors have produced.
- You are only allowed to use copyright protected material with the consent of the copyright holder. However, minor quotations can be used without this consent. The source of the quotation must always be provided.
- All form of plagiarism is strictly forbidden. Plagiarism is considered to be:
  a) When you express the same thing with the same or similar words as someone else. Quoting is allowed, but in order to guarantee that the original meaning is kept, quotes must be exactly as found in the original, including errors such as spelling mistakes. Quotations must be surrounded with quotation marks and a reference given. Reference must be given if you use someone else's pictures, drawings or tables.
  b) When you present or use someone else's findings as your own. This includes, but is not limited to, background analysis, collected data and conclusions.
  c) When you present someone else's ideas as your own.

  Note that you are allowed to use the text, findings and ideas of others, but that proper references to the source must be given. This applies no matter what rights the copyright holder might have given you.
- Original author must be given for source code, and it should be clear what changes has been made and by whom.
- If you are unsure how to interpret these rules, or if you have questions about them, ask the course responsible for clarification *before* you hand in questionable material.

---

I confirm that I understand the rules above, that failure to adhere to these rules leads to a report to the rector, and that the consequence can be a warning or suspension from studies. Breaking of copyright law can be reported to the police.

_____ _____

*Signature* *Place & Date*

_____ _____

*Name* *Social security number*

# Assignment 0: Tasks

This assignment is performed individually.

1. Print and study the rules of conduct.
2. Approach the course responsible in case of questions.
3. Sign, scan, and submit the rules of conduct.

Information

- https://bth.itslearning.com/essay/read_essay.aspx?EssayID=318427
- Deadline: November 7 at 23:55 CET

Evaluation

- Pass / fail
- 1 attempt

# Contents

Objectives

- Know PA2404 course objectives, structure, and services
- Know your part of the learning process
- Understand research methodology
- Understand literature review

Agenda

- PA2404 Course
- A Primer in Research Methodology
- Modest Advices for Your Own Research Project
- Rules of Conduct
- Literature Review

# Systematic Literature Review

”What has been done on topic X?”

- Where to search for publications?
- Which search questions?
- Which criteria for inclusion/exclusion?
- Synthesis: what is known, and what not?

Your report:

- Shall be a recipe for replicating your systematic review, so that it is possible to repeat the process and come to the same conclusions.
- Shall include
  - The references found
  - A discussions on why you include or exclude references, according to your inclusion/exclusion criteria
  - Synthesis of the articles in the final inclusion set.

# Example: RE Technology Transfer SLR

- Date: October 22, 2008
- Context: research results need to be transferred to industry
- Problem: promotion requires tangible evidence for advantages of using RE techniques
- Goal: SLR of all papers in Requirements Engineering journal containing some evaluation based on an evaluation scheme to check technology transfer support
- Result: very few evaluations offer full technology transfer support

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Related Work

- Glass et al (2002)
  - What is state of software engineering (SE) research?
  - SLR on six leading SE journals
  - Results: SE research is diverse regarding topic, narrow regarding research approach and the method inwardly focused regarding reference discipline and technically focused regarding the level of analysis
- Wieringa and Heerkens (2006)
  - What is the methodological soundness of RE papers?
  - (no S)LR on papers of RE‘03 conference
  - Results: L
  - lack of problem investigation and solution validation
- Davis et al (2006)
  - How effective are requirements elicitation techniques?
  - SLR on empirical studies found through SCOPUS, IEEEXPLORE, and ACM DigitalLibrary
  - Results: interviews appear to be one of the most effective elicitation techniques. Analyst experience does not appear to be a relevant factor
- Parviainen and Tihinen (2007)
  - What RE techniques are known and how far do they cover the RE discipline?
  - (no S)LR on ???
  - Results: an overview of available technology support for RE

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

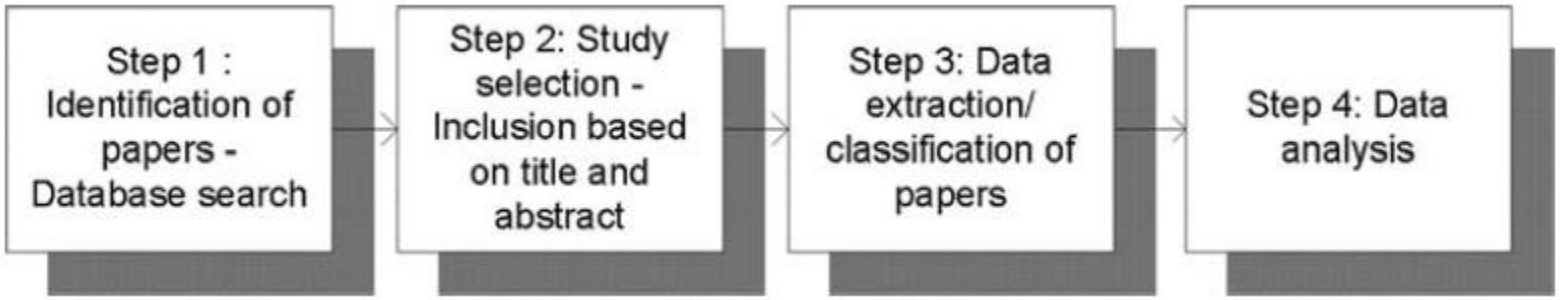
# Research Questions for SLR

- RQ1: What RE technologies exist?
  - To provide an inventory of all RE technologies that have been subjected to some sort of evaluation
- RQ2: What is the state of technology evaluation?
  - Most common evaluation methods?
  - Context of evaluation?
  - Subjects used in evaluation?
  - Scale of the evaluation?
  - Degree of realism?
- RQ3: To what extent does the state of research support the actual adoption of technologies?
  - To support adoption of technologies, evaluations need to present plausible evidence of the benefit of using technologies

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Review Method

- Research Process




- Data source: Requirements Engineering Journal (Inspec database)
- Search terms:

OR

**Population**: Requirement*, specification

AND

**Intervention**: empiric* OR experience* OR "lesson learned" OR "lesson learnt" OR "lessons learned" OR "lessons learnt" OR evaluat* OR validation* OR experiment* OR stud* OR case* OR example* OR survey OR analys* OR investig* OR demonstrate*

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Review Method

- Inclusion criteria
  - Paper presents an evaluation (of any sort) of a technology that has bearing on requirements engineering
  - The inclusion procedure was applied to the title and abstract
- No exclusion of papers due to quality aspects
  - Quality evaluation was part of the SLR:
- Data extraction
  - Technology — from the reviewed literature
  - Project focus — pre-project, in-project, post-project, N/A
  - Sub-process area — elicitation, analysis and negotiation, management, validation, specification
  - Research method — action research, conceptual analysis, lessons learned, conceptual analysis/mathematical, case study, field study, laboratory experiment (human subject), laboratory experiment (software), interview, descriptive/exploratory survey, other, N/A
  - Context described — strong, medium, weak
  - Study design described — strong, medium, weak
  - Validity discussed — strong, medium, weak
  - Subjects — practitioner, researcher, student, not mentioned
  - Context — academia, industry
  - Scale of evaluation — toy example, down-scaled real example, industrial, not mentioned

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# Execution

- Date: June 23, 2008
  - REj issues 1:1 – 12:2.
  - online first articles included
- Statistics
  - Search string: 181 papers identified
  - Inclusion criteria: 99 papers included
  - Exclusion during data extraction: 2 papers did not evaluate an RE technology
  - Data extraction: out of 97 papers covering 125 studies
  - Quality assurance: 10% of randomly selected REj issues fully read. No relevant paper found to be excluded.
- Problems
  - Inspec did not index all REj issues: manual search of non-indexed REj issues

# Threats to Validity

Publication and selection bias

- REj is not the only forum where RE research is published: chance of missing RE technologies and evaluations
  - Limits generalizability of results
  - REj is the premier forum for RE, however (hence expected to include most mature research results)
- Key word-based search of papers: papers could be missed
  - Only 27 papers removed
- Inclusion based on reading abstract: abstracts might not represent papers
  - Threat was controlled

Data extraction

- Judgments used to include/exclude and to classify papers may be biased
  - Classification scheme was pilot tested prior to the study
- Classification may be of the presentation (ie. the paper) instead of the actual research performed (ie. the real research project)
  - Support for technology transfer is dependent on the descriptions of the work in the publications
- Research papers are written for researchers and not practitioners
  - RE is an engineering field, speaking towards application: research presented should not be too far from reality
- There may be several plausible classifications for one paper
  - The papers were classified favorably with respect to the subsequent analysis

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Results and Analysis

**Table 5** Requirements engineering sub-process areas addressed

| Sub-process area | Number |
|---|---|
| Analysis and negotiation | 44 |
| Elicitation | 23 |
| Management | 9 |
| N/A | 3 |
| Specification | 30 |
| Validation | 19 |

**Table 6** Timeline focus of the technologies

| Timeline focus | Number |
|---|---|
| Pre-project | 9 |
| In-project | 64 |
| Post-project | 0 |
| N/A | 24 |

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# Results and Analysis

**Table 7** Research method used in evaluations

| Research method | Number | Percentage |
|---|---|---|
| Action research | 5 | 5 |
| Case study | 34 | 35 |
| Conceptual analysis/Assertion | 38 | 39 |
| Interview | 2 | 2 |
| Laboratory experiment (human subjects) | 14 | 14 |
| Laboratory experiment (software) | 2 | 2 |
| Lessons learned | 2 | 2 |
| Other | 0 | 0 |
| Descriptive exploratory survey | 0 | 0 |
| Field study | 0 | 0 |
| Conceptual analysis/mathematical | 0 | 0 |
| N/A | 0 | 0 |
| Total | 97 | 100 |

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Results and Analysis

**Table 8** Context of evaluation

| Context | Number | Percentage |
|---|---|---|
| Academia | 61 | 63 |
| Industry | 36 | 37 |
| Total | 97 | 100.00 |

**Table 9** Subjects in the evaluations

| Subjects | Number | Percentage |
|---|---|---|
| Not mentioned | 1 | 1 |
| Practitioner | 18 | 19 |
| Researcher | 66 | 68 |
| Student | 12 | 12 |
| Total | 97 | 100 |

**Table 10** Scale of the evaluations

| Scale | Number | Percentage |
|---|---|---|
| Down-scaled real example | 12 | 12 |
| Industrial | 40 | 41 |
| Toy example | 45 | 46 |
| Total | 97 | 100 |

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Results and Analysis

| Research method | Context | Subjects | Scale | # | Percentage |
|---|---|---|---|---|---|
| Action research | Academia | Researcher | Toy example | 1 | 1% |
| Action research | Industry | Practitioner | Industrial | 2 | 2% |
| Action research | Industry | Researcher | Industrial | 2 | 2% |
| Conceptual analysis | Academia | Researcher | Toy example | 20 | 21% |
| Conceptual analysis | Academia | Researcher | Down-scaled | 7 | 7% |
| Conceptual analysis | Academia | Researcher | Industrial | 3 | 3% |
| Conceptual analysis | Academia | Student | Toy example | 1 | 1% |
| Conceptual analysis | Industry | Practitioner | Industrial | 1 | 1% |
| Conceptual analysis | Industry | Researcher | Down-scaled | 2 | 2% |
| Conceptual analysis | Industry | Researcher | Industrial | 4 | 4% |
| Lessons learned | Industry | Practitioner | Industrial | 1 | 1% |
| Lessons learned | Industry | Researcher | Industrial | 1 | 1% |
| Case study | Academia | Researcher | Toy example | 8 | 8% |
| Case study | Academia | Researcher | Down-scaled | 1 | 1% |
| Case study | Academia | Researcher | Industrial | 6 | 6% |
| Case study | Academia | Student | Toy example | 2 | 2% |
| Case study | Industry | Practitioner | Industrial | 8 | 8% |
| Case study | Industry | Researcher | Down-scaled | 2 | 2% |
| Case study | Industry | Researcher | Industrial | 6 | 6% |
| Case study | Industry | NM | Industrial | 1 | 1% |
| Laboratory experiment (HS) | Academia | Practitioner | Toy example | 1 | 1% |
| Laboratory experiment (HS) | Academia | Researcher | Toy example | 1 | 1% |
| Laboratory experiment (HS) | Academia | Student | Toy example | 9 | 9% |
| Laboratory experiment (HS) | Industry | Practitioner | Industrial | 3 | 3% |
| Laboratory experiment (SW) | Academia | Researcher | Toy example | 1 | 1% |
| Laboratory experiment (SW) | Industry | Researcher | Industrial | 1 | 1% |
| Interview | Industry | Practitioner | Toy example | 1 | 1% |
| Interview | Industry | Practitioner | Industrial | 1 | 1% |
| | | | **Total** | **97** | **100%** |

A

most frequent: conceptual analysis applied to a toy example by the researcher in academia

B

only 8 of 34 case studies are carried out in a real setting, utilizing industrial applications and practitioners as subjects

C

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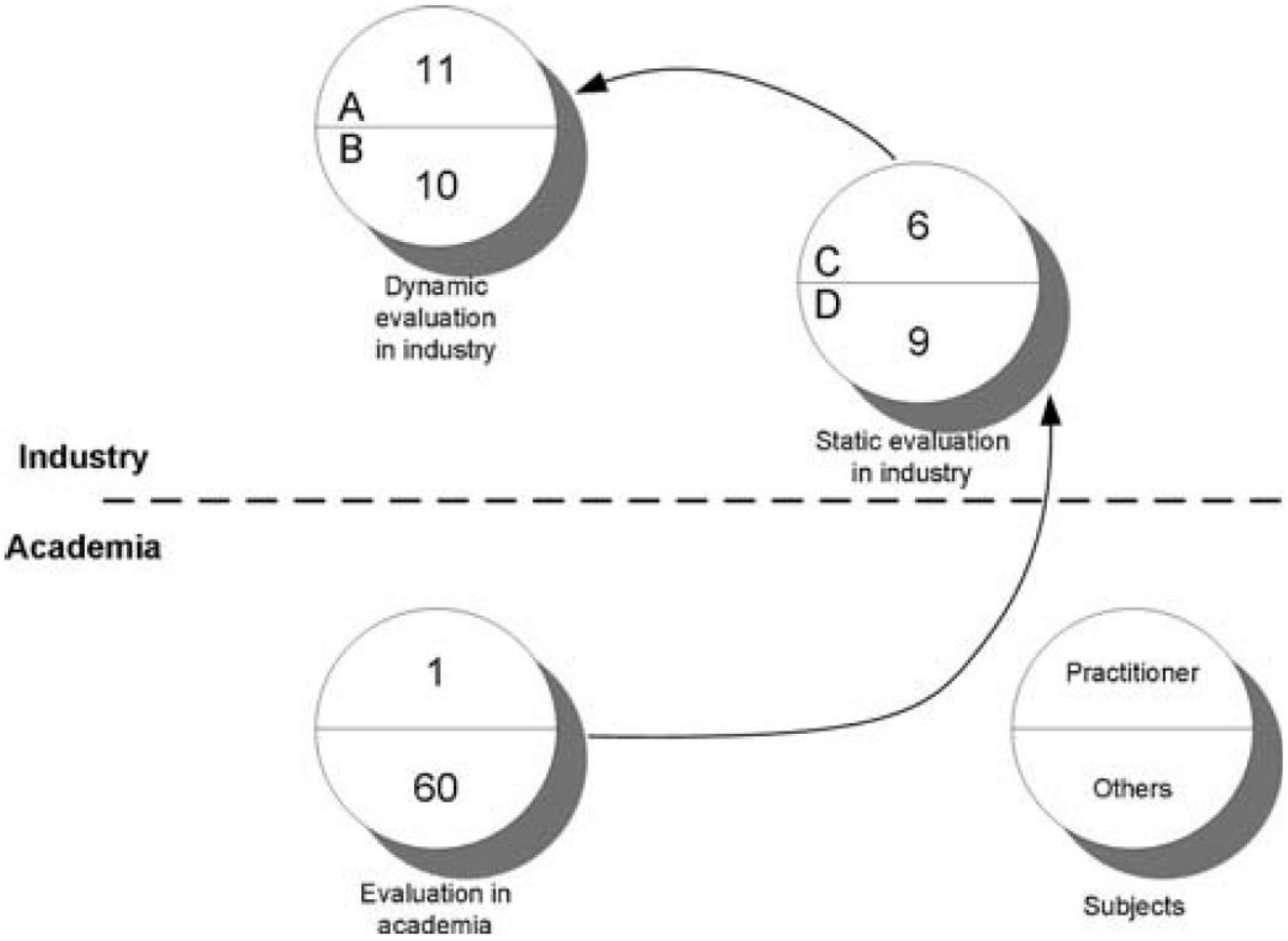
# Results and Analysis




Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Results and Analysis

Strong support for technology transfer

**Table 12** Dynamic validation in industry (depicted A in Fig. 3)

| Article | Technologies | Research method | Context described | Study design | Validity discussed |
|---|---|---|---|---|---|
| [50] | Scenarios, usability tests | Action research | Strong | Strong | Strong |
| [51] | Finite state machine | Action research | Strong | Medium | Weak |
| [45] | Requirements Abstraction Model (RAM) | Lessons learned | Strong | Strong | Medium |
| [52] | Participatory design | Case study | Medium | Weak | Weak |
| [44] | AHP, Disagreement charts, Distribution charts, Influence charts, Satisfaction charts | Case study | Strong | Strong | Strong |
| [36] | Language extended lexicon (LEL) | Case study | Strong | Medium | Weak |
| [53] | RM-Tool | Case study | Weak | Medium | Weak |
| [54] | MAGERIT, SIREN | Case study | Weak | Weak | Weak |
| [55] | Misuse oriented quality requirements engineering (MOQARE) | Case study | Weak | Medium | Weak |
| [43] | Requirements Abstraction Model (RAM) | Case study | Strong | Strong | Strong |
| [56] | Knowledge based Approach for the Selection of Requirements Engineering Techniques (KASRET) | Case study | Strong | Strong | Strong |

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Results and Analysis

**Table 13** Brief description of papers found to support technology transfer

| | Context | # of cases | Brief description of technologies | Results in short |
|---|---|---|---|---|
| [50] | A Danish manufacturer of sound and vibration measurement | 1 | Scenarios, including description of user tasks and usability tests with daily user tasks based on screen mock-ups | The number of usability problems per screen is reduced by 70% and the number of implementation defects per month is reduced by more than 20%. Sales figures showed that the product sells twice as many units and at twice the unit price |
| [44] | A Swedish CASE tool developer. Geographically distributed stakeholders that take part in prioritizing high-level requirements | 1 | Four different charts for visualizing and interpreting prioritization data | The distributed prioritization is useful and the visualization charts are a valuable decision support |
| [43] | A Swedish software and hardware developer of navigation, control, fleet management and service for automated guided vehicles. An international developer of power and automation technologies | 2 | Requirements Abstraction Model (RAM), a model for working with requirements on several levels of abstraction | Indications of that implementation of RAM has yielded substantial increases in both the accuracy of practices performed in requirements engineering and in requirements quality |
| [56] | A company developing real-time supply chain management solutions to optimize power networks | 1 | Knowledge-based Approach for the Selection of Requirements Engineering Techniques (KASRET), a decision support system for the selection of requirements engineering techniques for a specific software project | The majority of the projects members appreciated the high quality requirements gained from using the recommended techniques. The techniques selected were very helpful in reducing the delay of the project and improving the overall quality of the software specification |

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Results and Analysis

**Table 14** Research method combined with the description of the evaluation

| Research method | Context described | Study design | Validity discussed | # | Percentage |
|---|---|---|---|---|---|
| Action research | Strong | Strong | Strong | 1 | 1% |
| Action research | Strong | Medium | Weak | 1 | 1% |
| Action research | Medium | Strong | Weak | 1 | 1% |
| Action research | Weak | Strong | Weak | 1 | 1% |
| Action research | Weak | Weak | Medium | 1 | 1% |
| Conceptual analysis | Medium | Weak | Medium | 1 | 1% |
| Conceptual analysis | Medium | Weak | Weak | 5 | 5% |
| Conceptual analysis | Weak | Weak | Weak | 32 | 33% |
| Lessons learned | Strong | Strong | Medium | 1 | 1% |
| Lessons learned | Medium | Weak | Weak | 1 | 1% |
| Case study | Strong | Strong | Strong | 4 | 4% |
| Case study | Strong | Medium | Weak | 1 | 1% |
| Case study | Strong | Weak | Medium | 1 | 1% |
| Case study | Medium | Medium | Weak | 2 | 2% |
| Case study | Medium | Weak | Medium | 2 | 2% |
| Case study | Medium | Weak | Weak | 10 | 10% |
| Case study | Weak | Medium | Medium | 1 | 1% |
| Case study | Weak | Medium | Weak | 3 | 3% |
| Case study | Weak | Weak | Weak | 10 | 10% |
| Laboratory experiment (HS) | Strong | Strong | Strong | 7 | 7% |
| Laboratory experiment (HS) | Strong | Strong | Medium | 3 | 3% |
| Laboratory experiment (HS) | Strong | Medium | Weak | 1 | 1% |
| Laboratory experiment (HS) | Medium | Strong | Weak | 1 | 1% |
| Laboratory experiment (HS) | Medium | Medium | Medium | 1 | 1% |
| Laboratory experiment (HS) | Weak | Medium | Weak | 1 | 1% |
| Laboratory experiment (SW) | Strong | Strong | Medium | 1 | 1% |
| Laboratory experiment (SW) | Medium | Strong | Weak | 1 | 1% |
| Interview | Strong | Strong | Strong | 1 | 1% |
| Interview | Weak | Weak | Weak | 1 | 1% |
| **Total** | | | | **97** | **100%** |

Strong

A

B

Strong

C

D

Strong

Strong

Ivarsson, Gorschek (2009): Technology transfer decision support in requirements engineering research: a systematic review of REj. RE 14:155-175.

# Conclusions

- SLR: all papers published in Requirements Engineering journal that contain any type of technology evaluation.
  - Aim: gauge the support for technology transfer
- Results
  - Only 4 of the 97 papers investigated provide strong technology transfer support
  - The majority of evaluations were performed by the researcher him/herself
  - As concerns the technologies presented, few have a pre-project timeline focus
  - Experiments with human subjects are well described
  - 41% had industrial context
- Limitations
  - Many aspects not covered: getting management support, overcoming initiation threshold…
- Implications
  - Not using industrial practitioners as subjects excludes several important aspects of an evaluation: convincing industry, training practitioners
  - Mainstream research may not reflect the actual needs in industry: half of the strong papers have a pre-project view, and not only an in-project
  - Empirical evidence from realistic evaluations in industry are scarce: limits value of research
  - Scale of the evaluation is predominantly toy or down-scaled examples: hard to judge whether the technology scales in relation to applicability in practice
- A combination of methods (e.g. experiment for control and case study in industry for scalability and realism) would offer a combination of evaluation results superior to any single evaluation.

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# Assignment 1: Tasks

This assignment is performed in groups of four.

1. Build or join a group of four students.
2. Study Kitchenham [4] and examples of SLR [1-3].
3. Plan your SLR by defining and documenting your review protocol. Ensure that the research question(s) is narrow enough to make your SLR feasible within the time available (ideally 10-30 articles, but the actual number will depend upon your topic).
4. Conduct the SLR.
5. Report the SLR in paper format (3-4 pages plus references) and submit the report. The report shall be based on the template (adjust the template if necessary).

Information

- https://bth.itslearning.com/essay/read_essay.aspx?EssayID=318445
- Deadline: November 27 at 23:55 CET

Evaluation

- Pass: „ok as-is“ and „needs minor revision“
  Fail: „needs major revision“; you have to resubmit the exercise
- 2 attempts

# Rubrics: Evaluation Criteria

- Adequacy of literature searching
  (match research question – literature review → 100-200 papers)
- Full description of a repeatable process
  (most important)
- Appropriate evaluation/appraisal criteria
  (inclusion/exclusion criteria with rationale → 10-30 papers)
- Satisfactory evaluation/appraisal
  (kind of data extracted)
- Satisfactory synthesis and conclusions
- Discussion of limitations
  (no validity threats discussed)
- Complete references
  (syntactic completeness)

# Assignment Resubmission

- Resubmission requirements in case of fail (”needs major revision”)
- Deadline: together with next regular submission.

Tasks

1. Read and understand the received comments
2. Fix assignment
3. Write rejoinder, i.e. a document where you list each original comment, together with your answer.
   For each comment, state:
   - Whether and how you have addressed the commend
   - What you changed in the report
   - Where you changed the report

*Comment: There is no connection between the aims and objectives and your research questions.*

Answer: RQ1 is a direct consequence of the third objective (no change). We have rewritten the remaining research questions (section XY), and the subsequent research methodology section (section YZ) to better reflect the aims and objectives.

# Contents

Objectives

- Know PA2404 course objectives, structure, and services
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Agenda

- PA2404 Course
- A Primer in Research Methodology
- Modest Advices for Your Own Research Project
- Rules of Conduct
- Literature Review