

Systems Engineering Research Validation

by *Gerrit Muller* Buskerud University College and Embedded Systems Institute

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

Abstract

System Engineering research addresses methods, techniques, models and formalisms that should advance the engineering practice of systems. This type of research inherently addresses a mix of technological issues in relation to business, process, organization, and people aspects. We discuss the challenge of validating this type of research. We look at different research and validation methods.

Distribution

This article or presentation is written as part of the Gaudí project. The Gaudí project philosophy is to improve by obtaining frequent feedback. Frequent feedback is pursued by an open creation process. This document is published as intermediate or nearly mature version to get feedback. Further distribution is allowed as long as the document remains complete and unchanged.

October 20, 2017
status: draft
version: 1.0

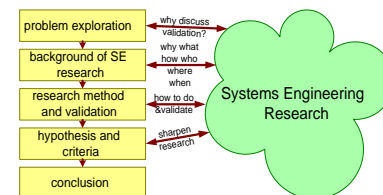
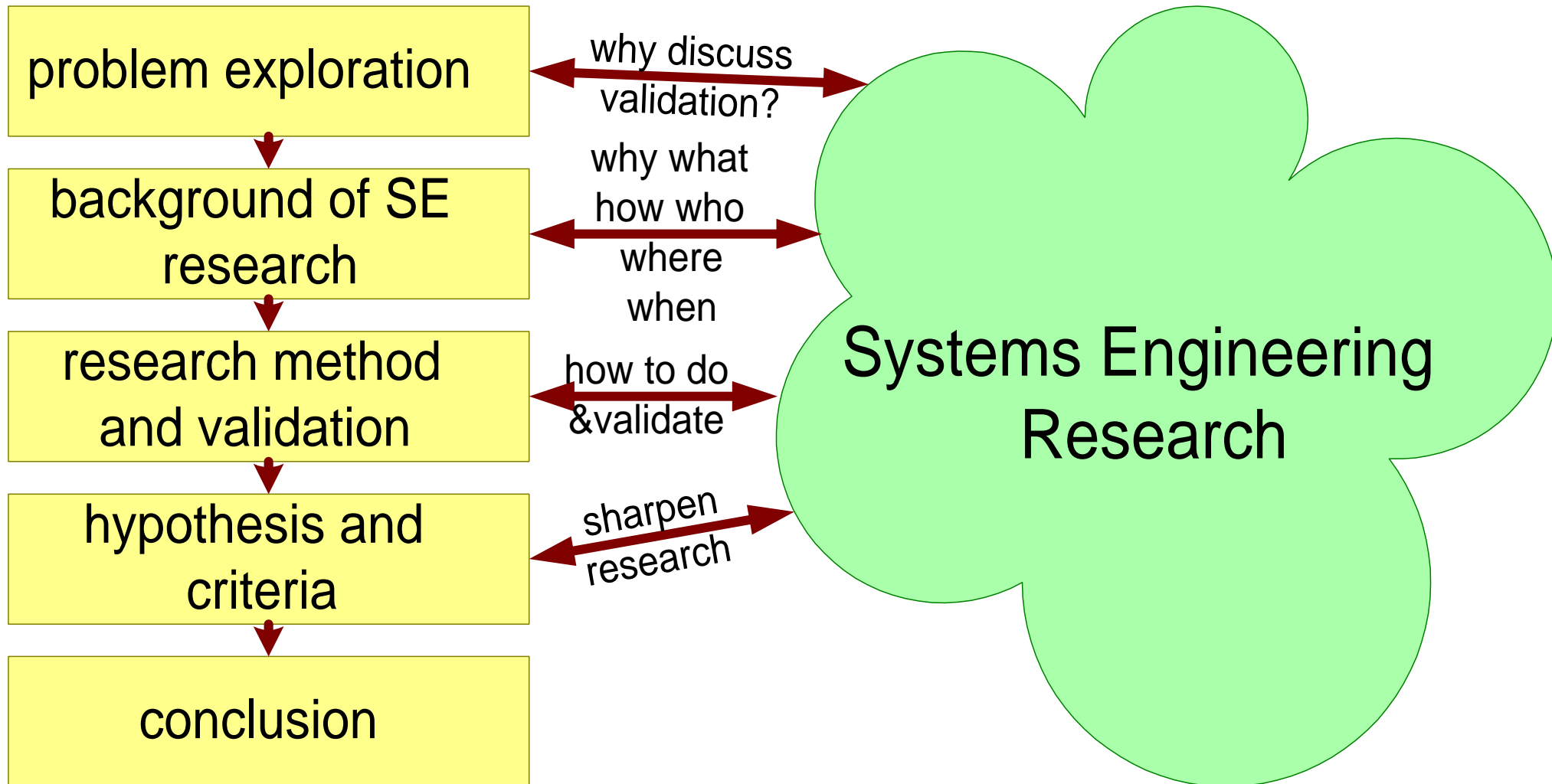
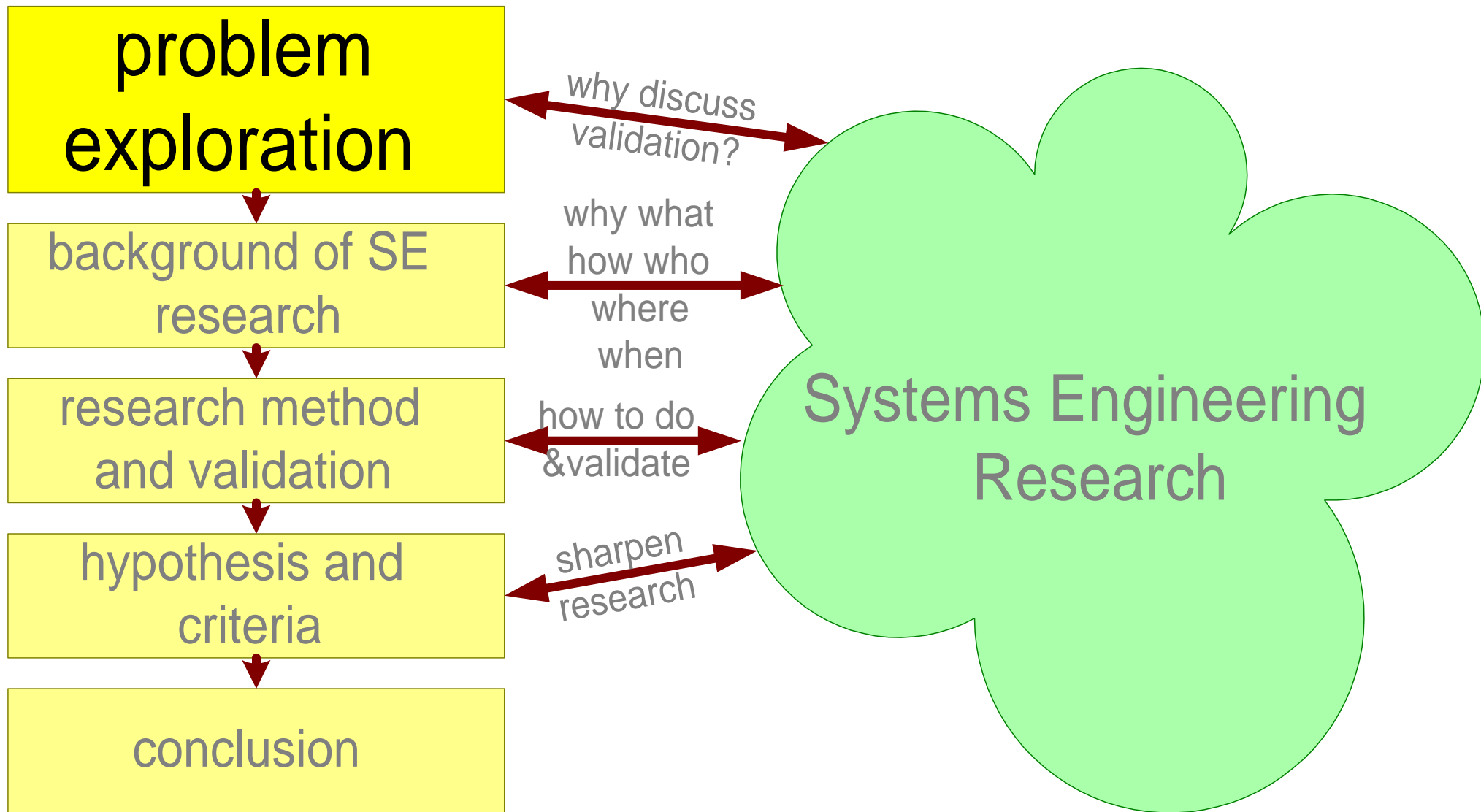
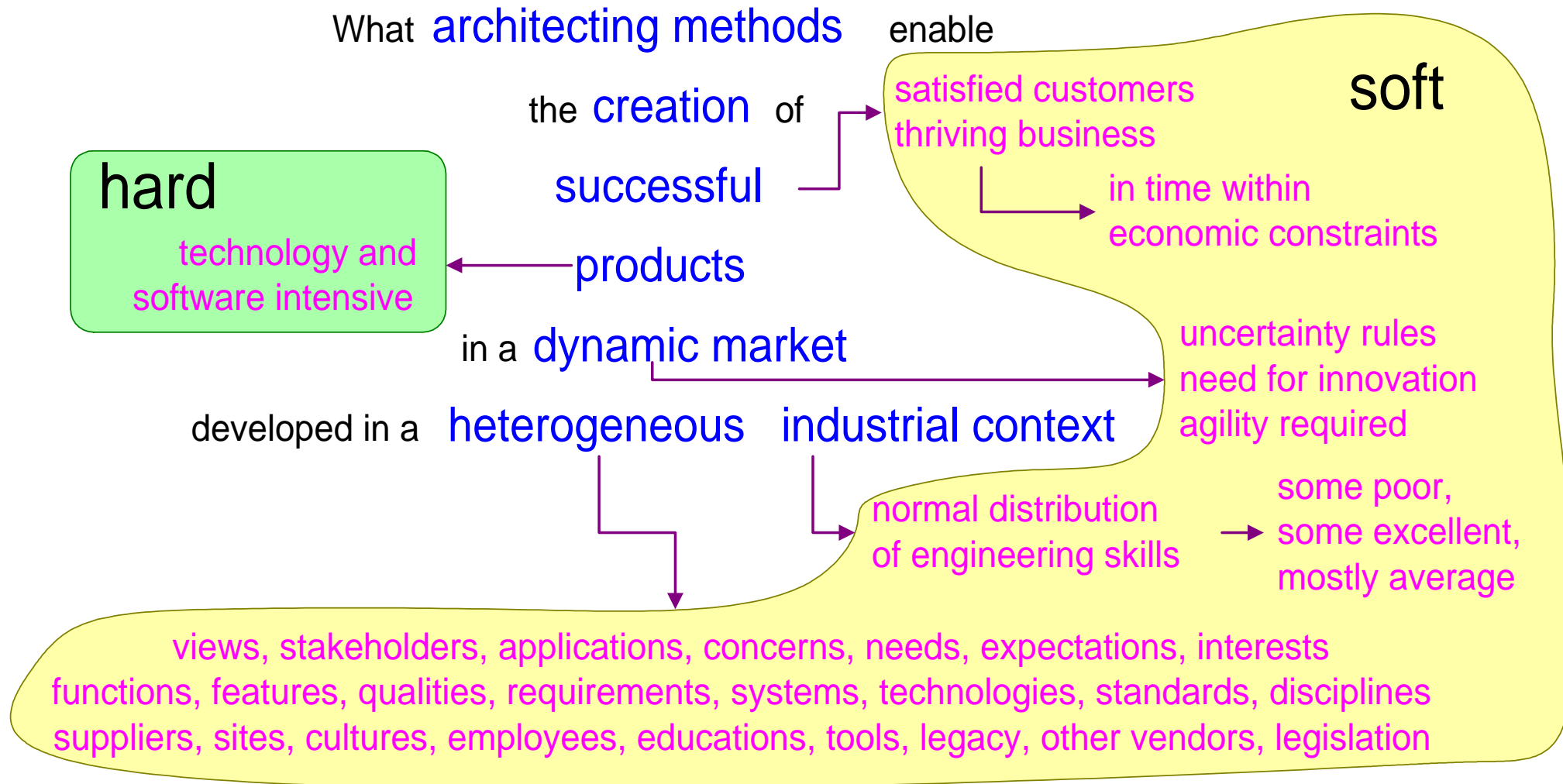


Figure Of Contents™

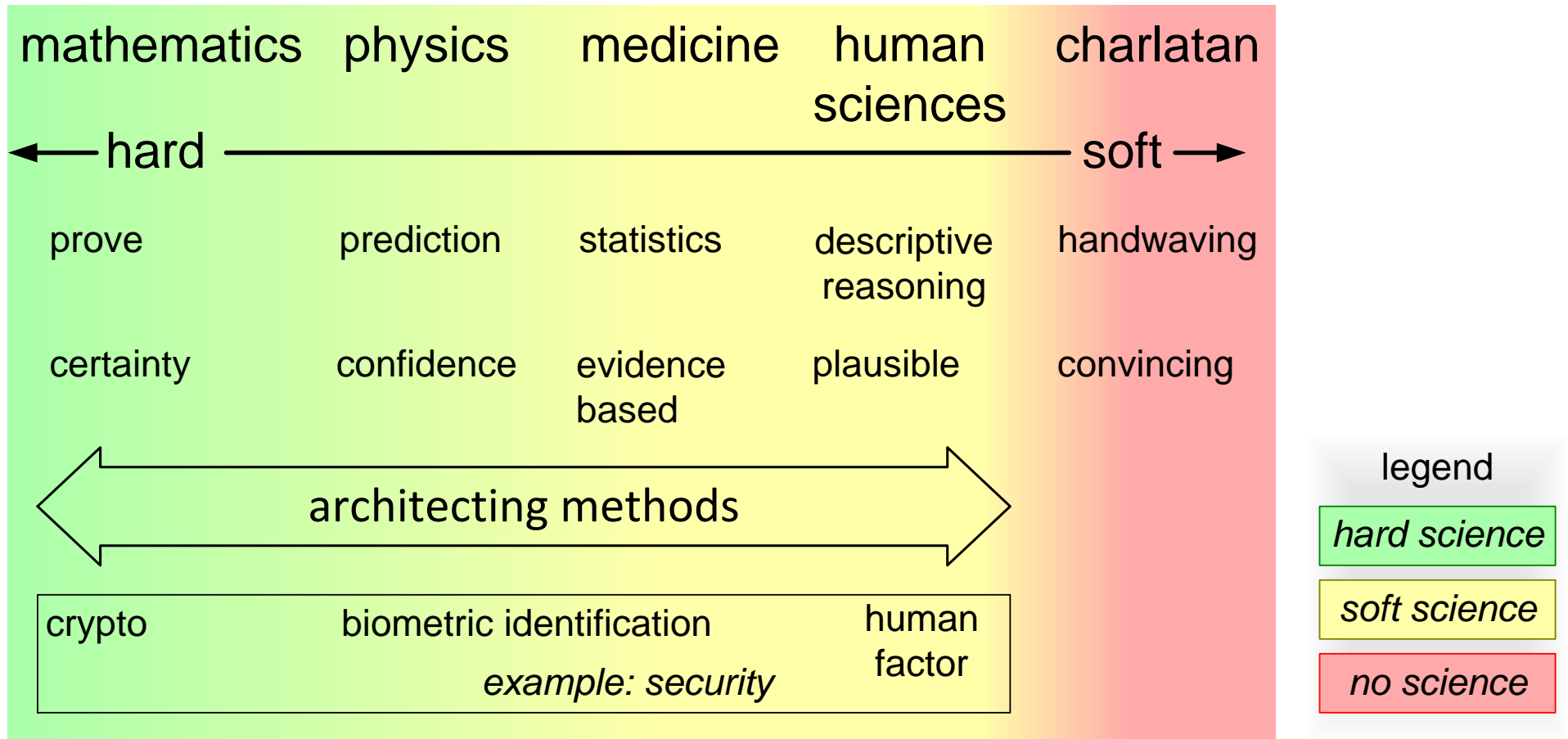




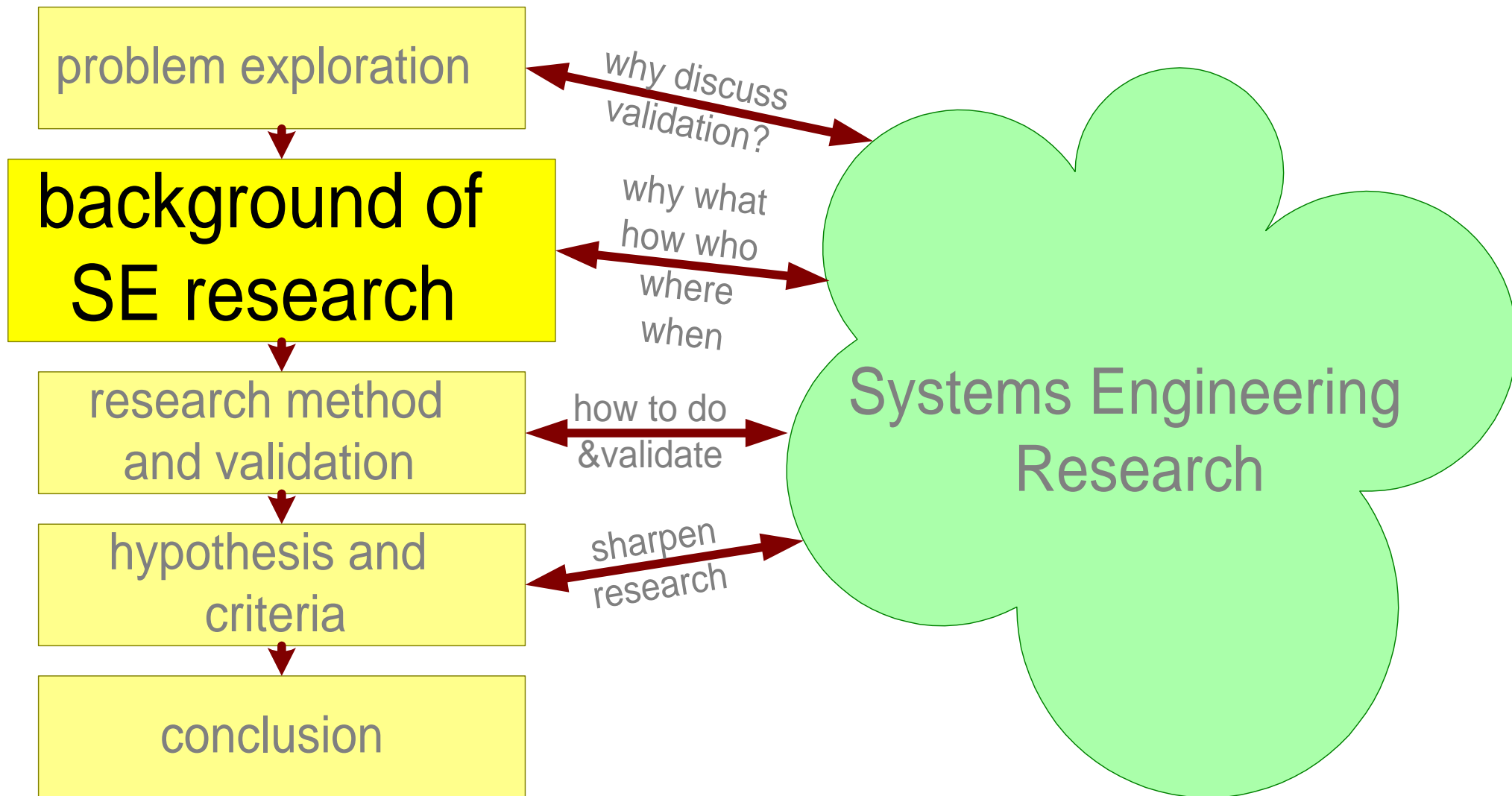
Reflection from my PhD thesis



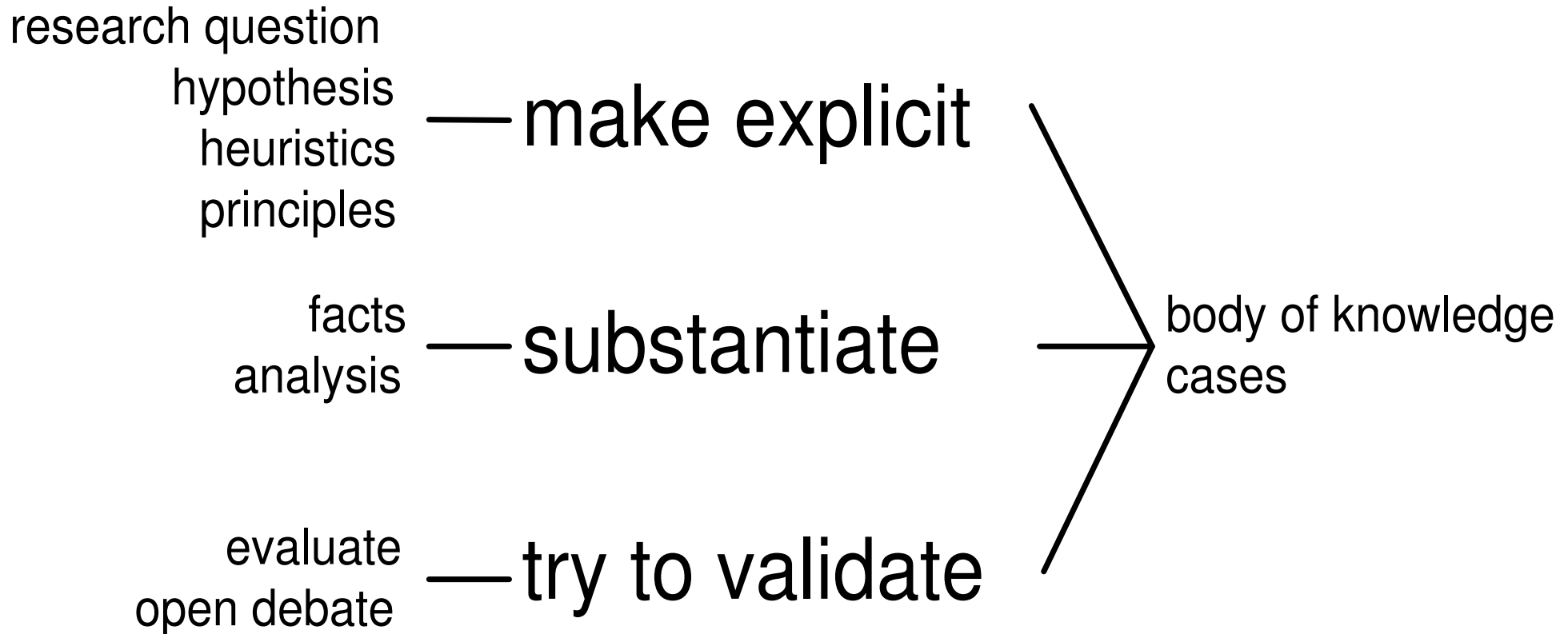
Spectrum of sciences



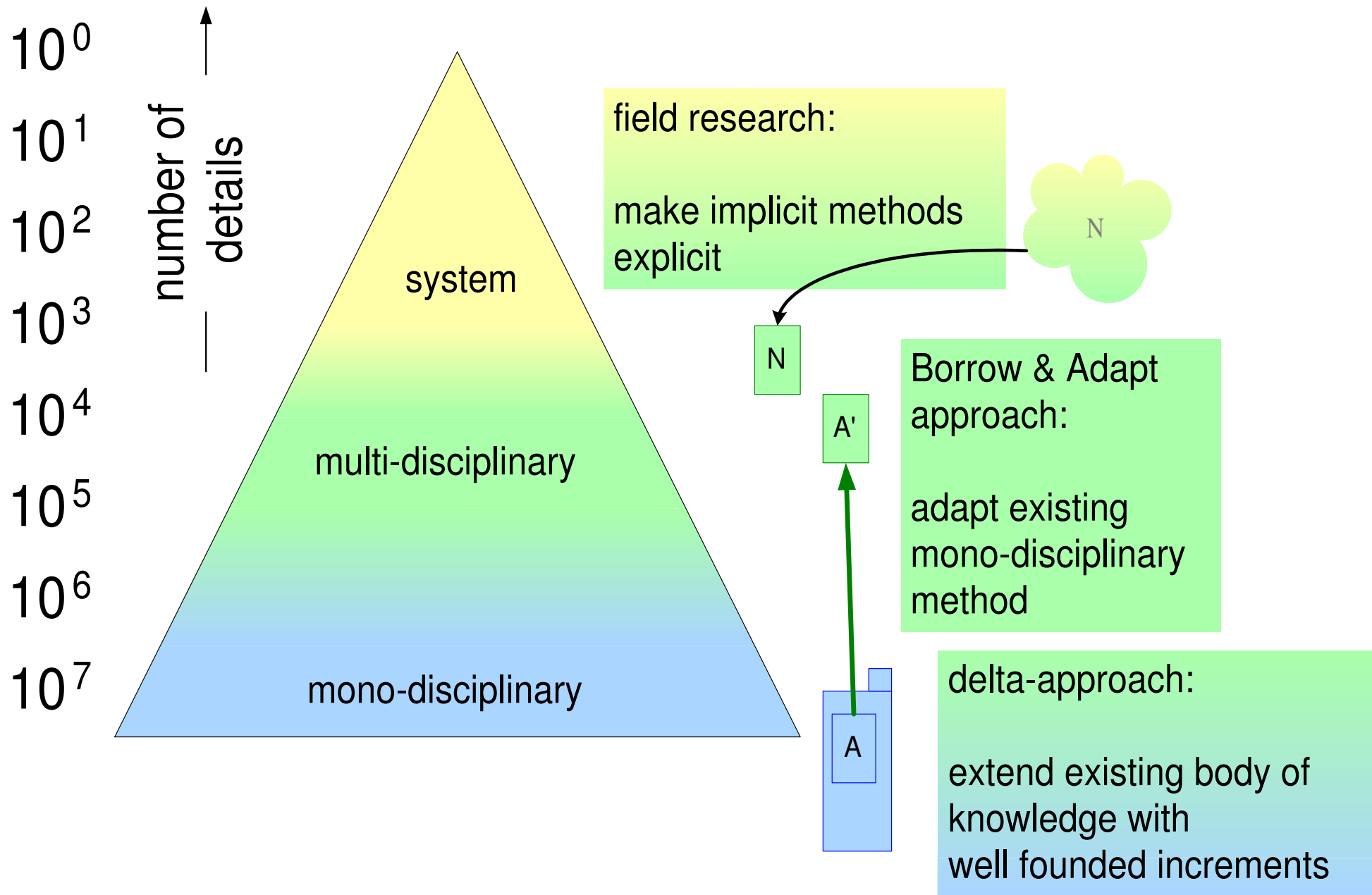
How do we **validate**
Systems Engineering
research
given that most **context** factors are
soft and uncontrolled?



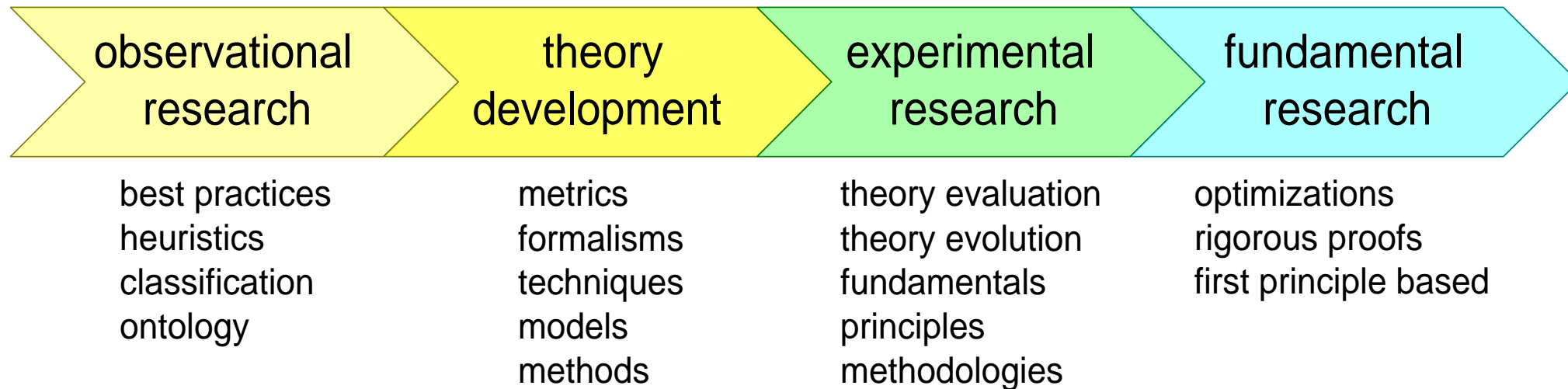
soft is not in conflict with scientific attitude



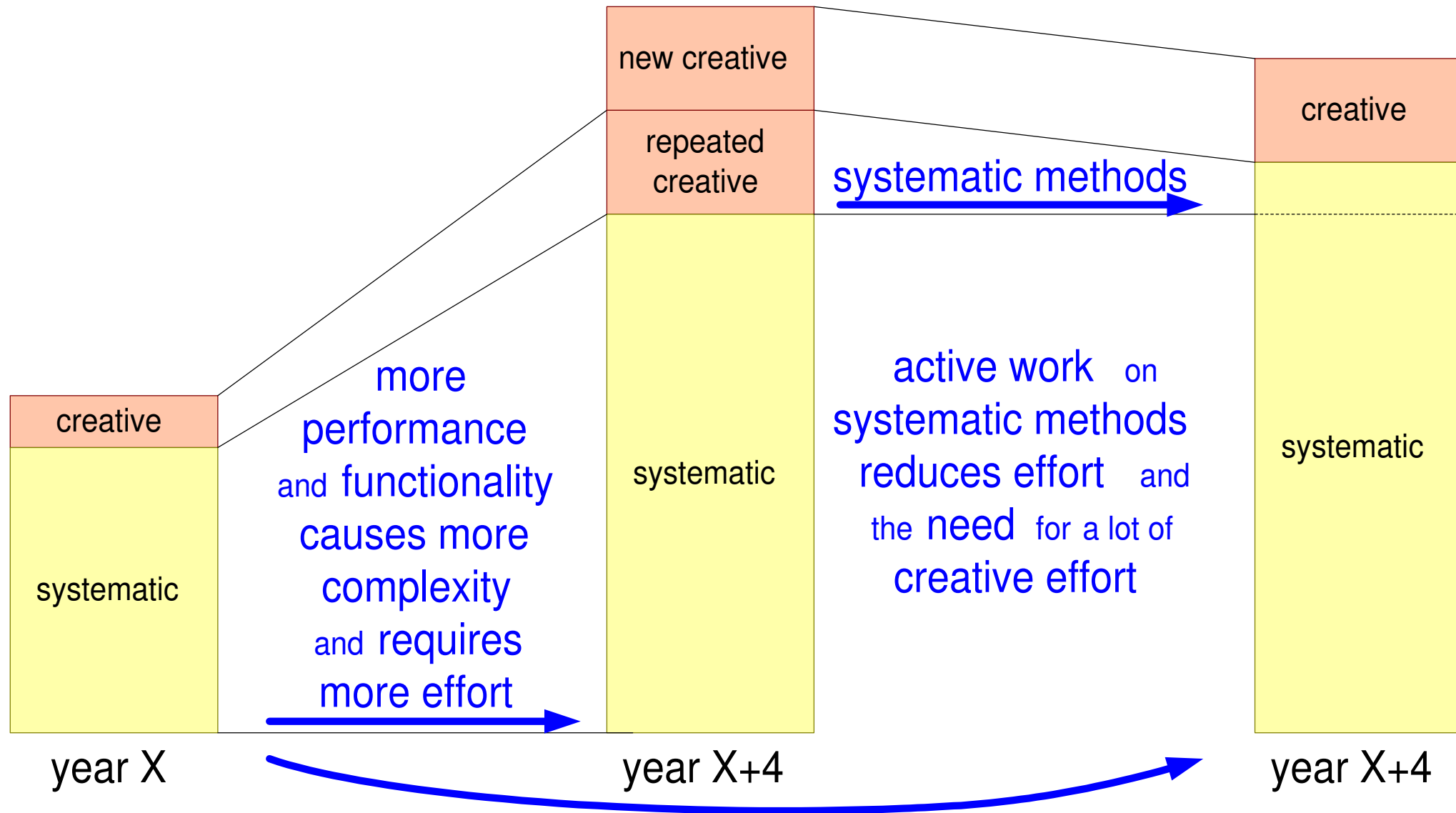
Different Types of Research



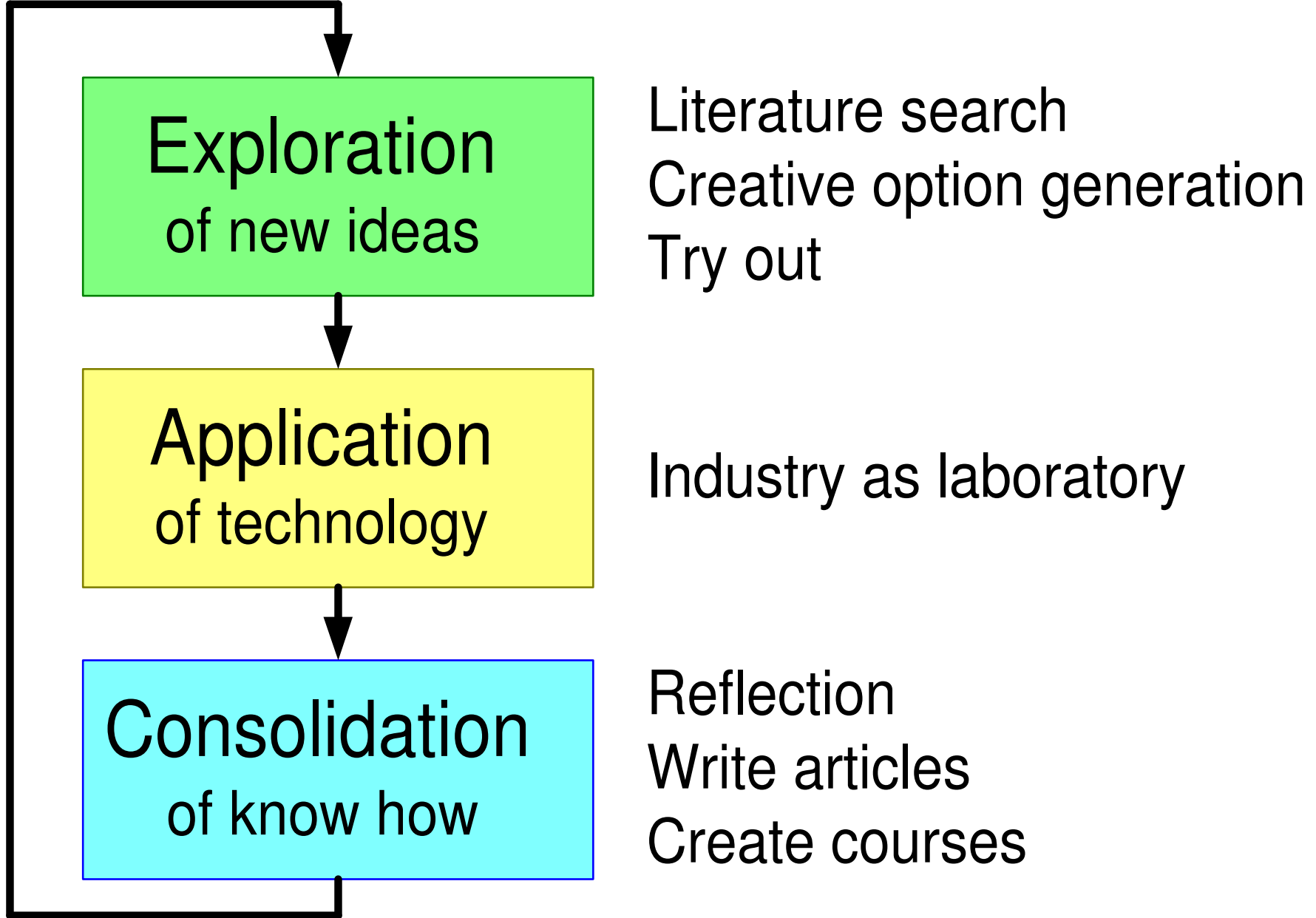
And another Dimension of Research Types



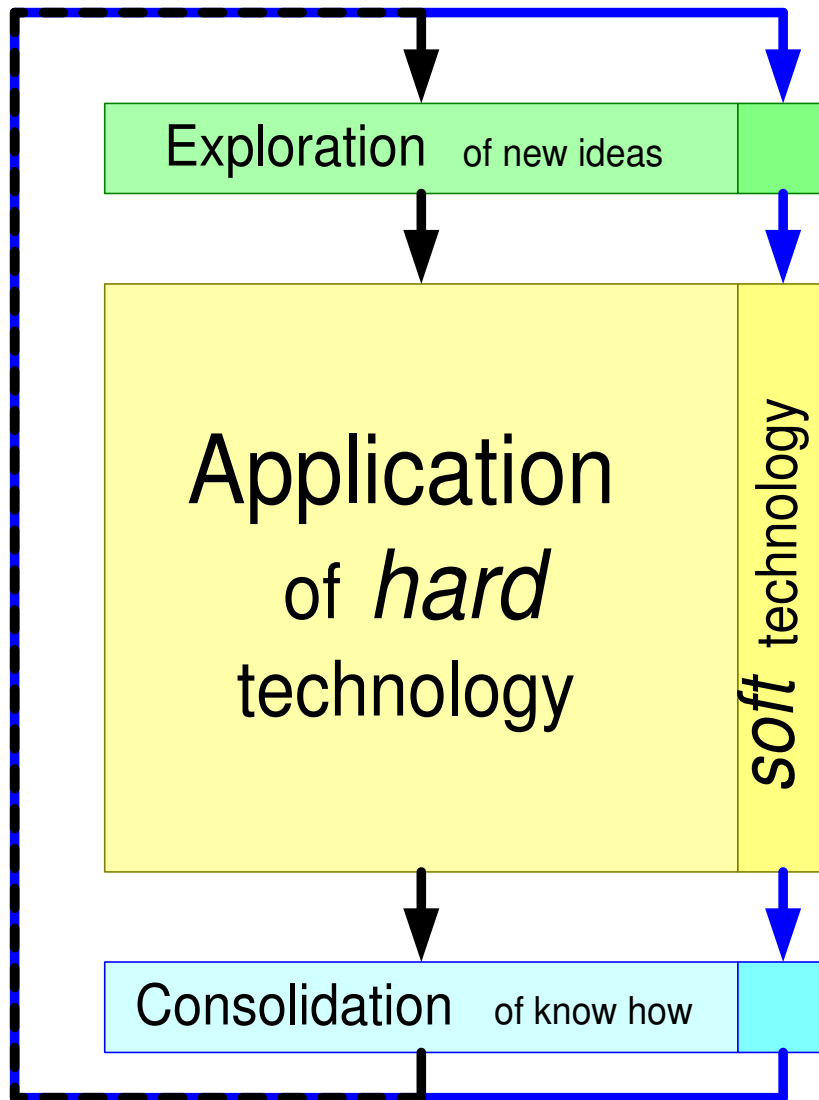
Systematic Know-how to cope with Growing Complexity



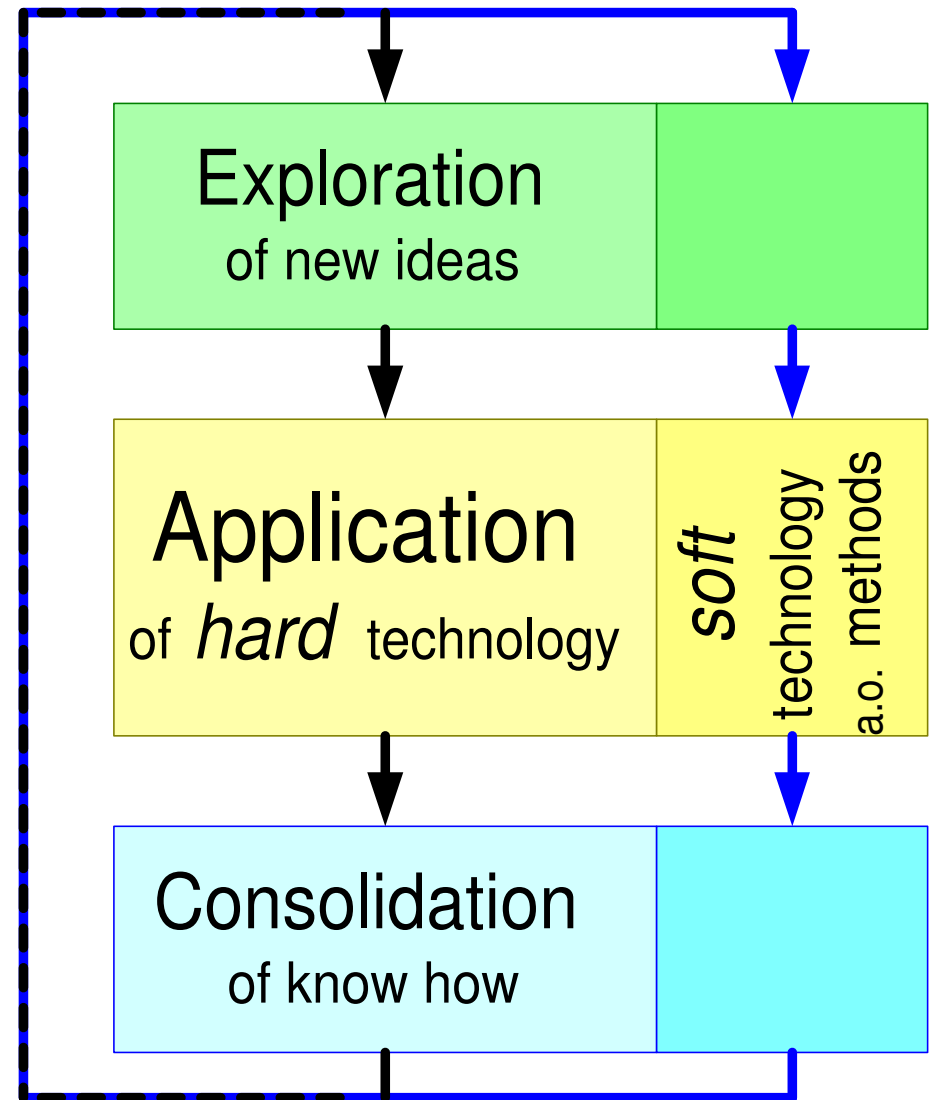
Technology Management Cycle



SE research requires application

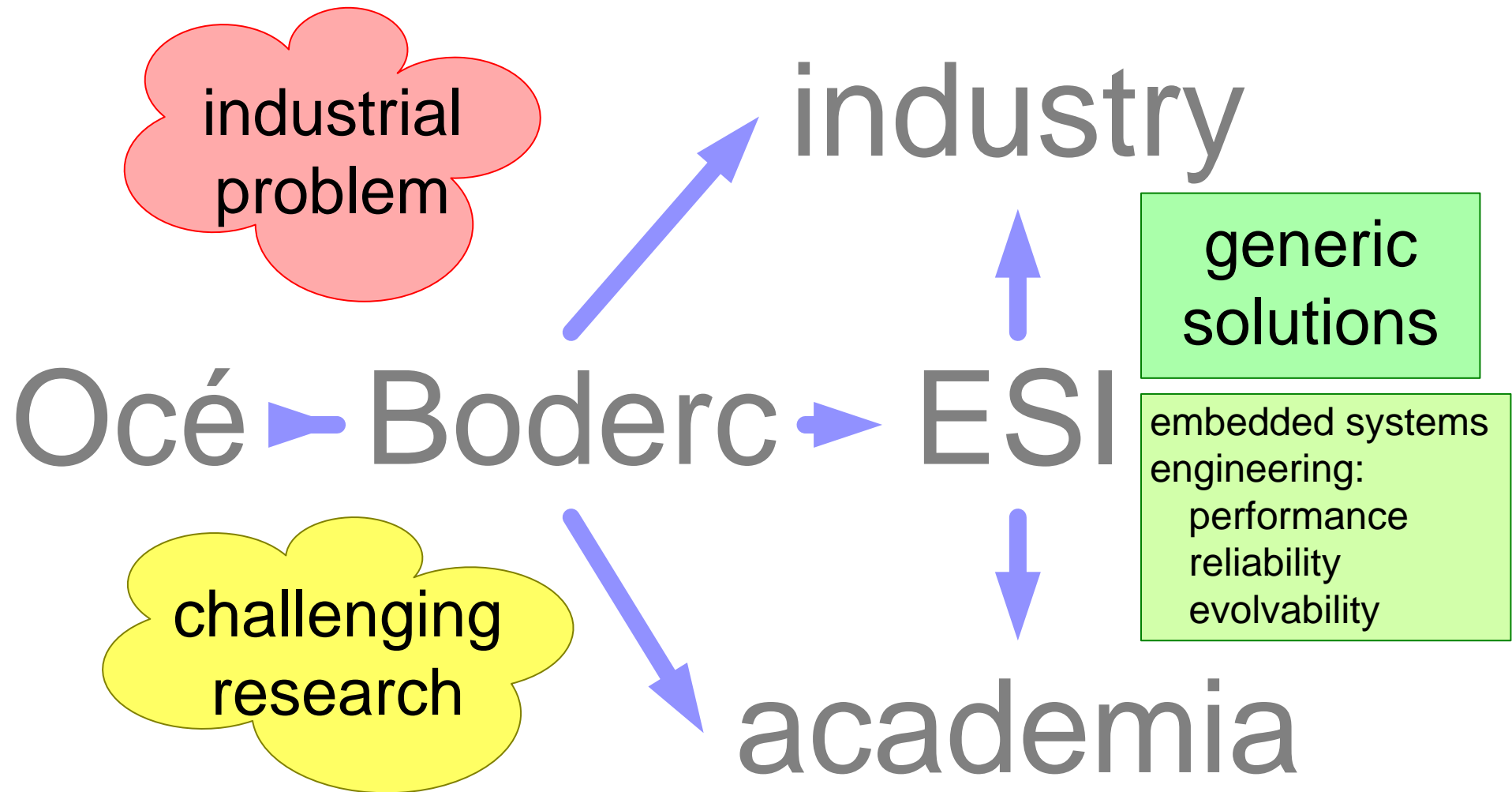


Product Development

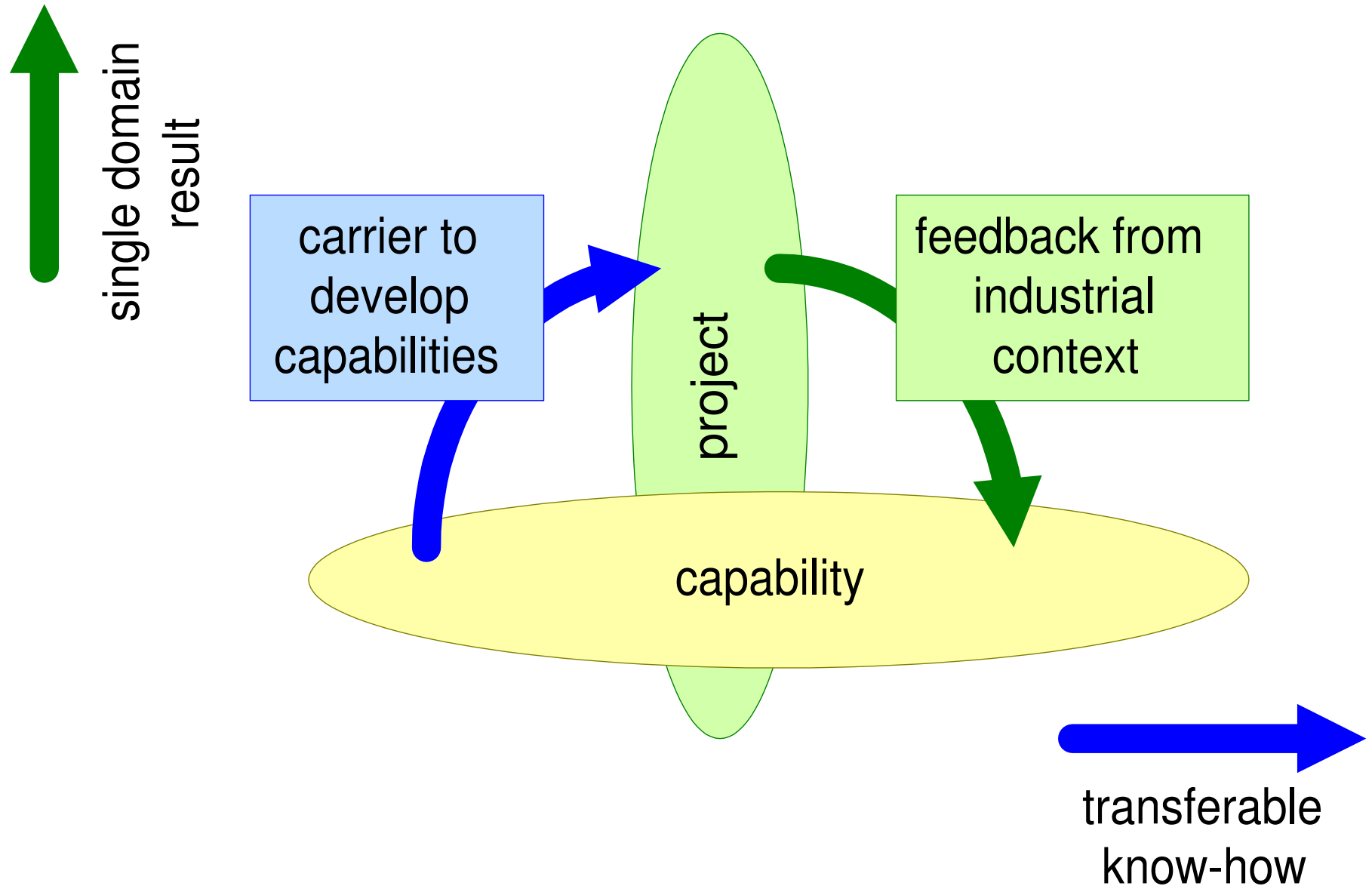


Research

Example Boderc Stakeholders



Project as Carrier for Capability Development



Formalisms languages/syntax: differential equations, timed or hybrid automata, finite state machines, et cetera

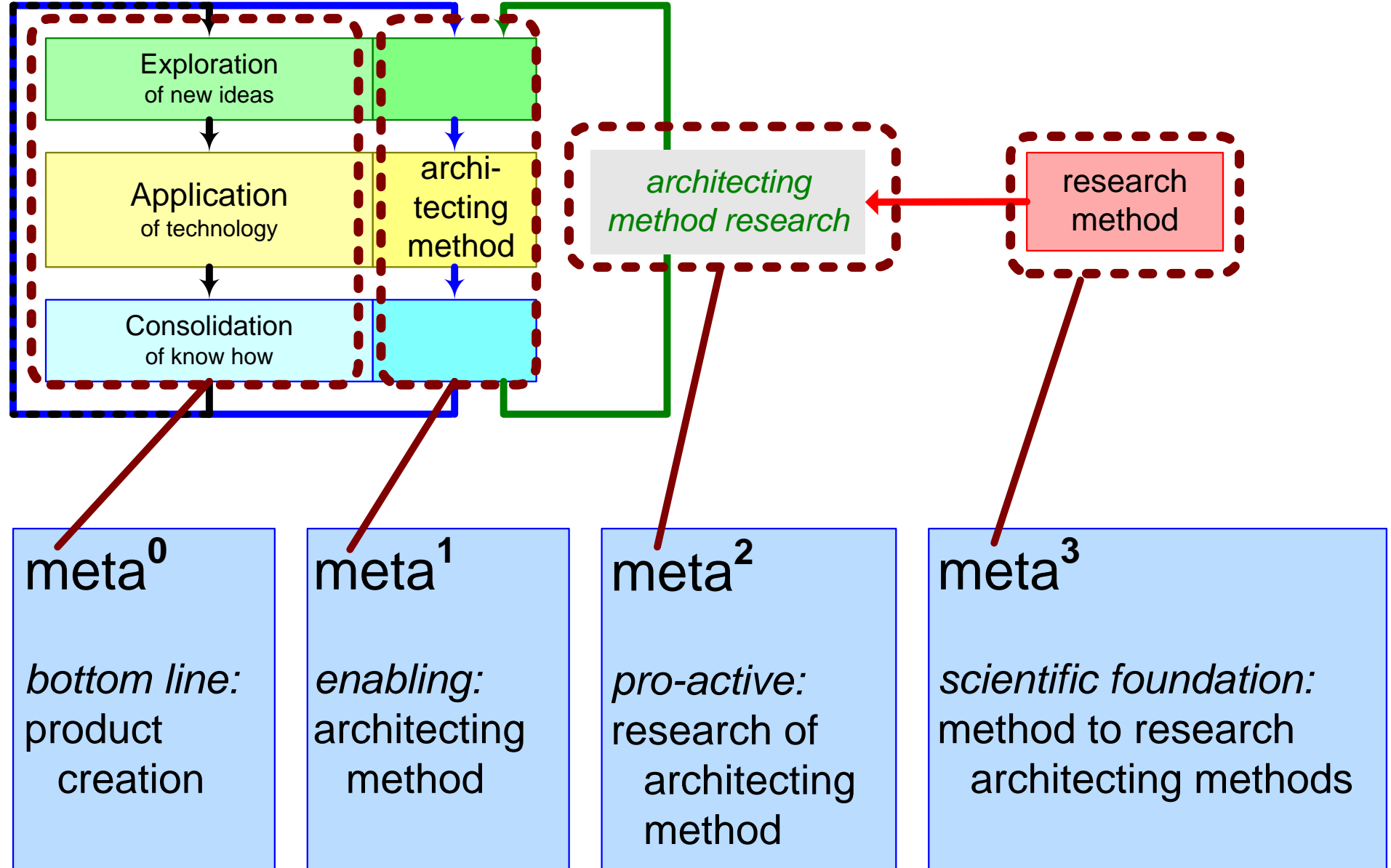
Models instantations of formalisms to understand, explore, optimize or verify specification or design

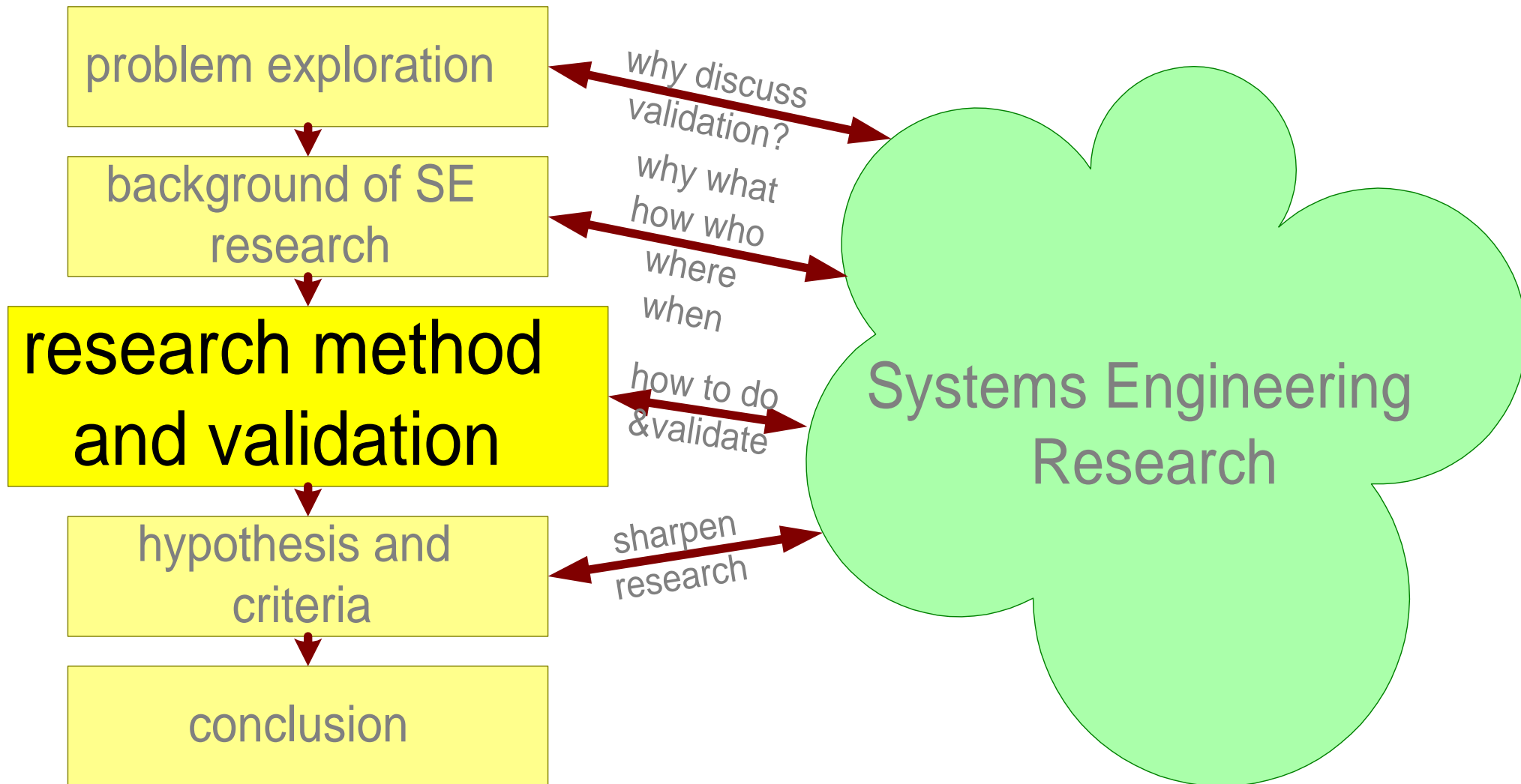
Techniques to get the required information from models: e.g. performance

Methods to provide guidelines how to use formalisms, create models, use techniques and apply tools

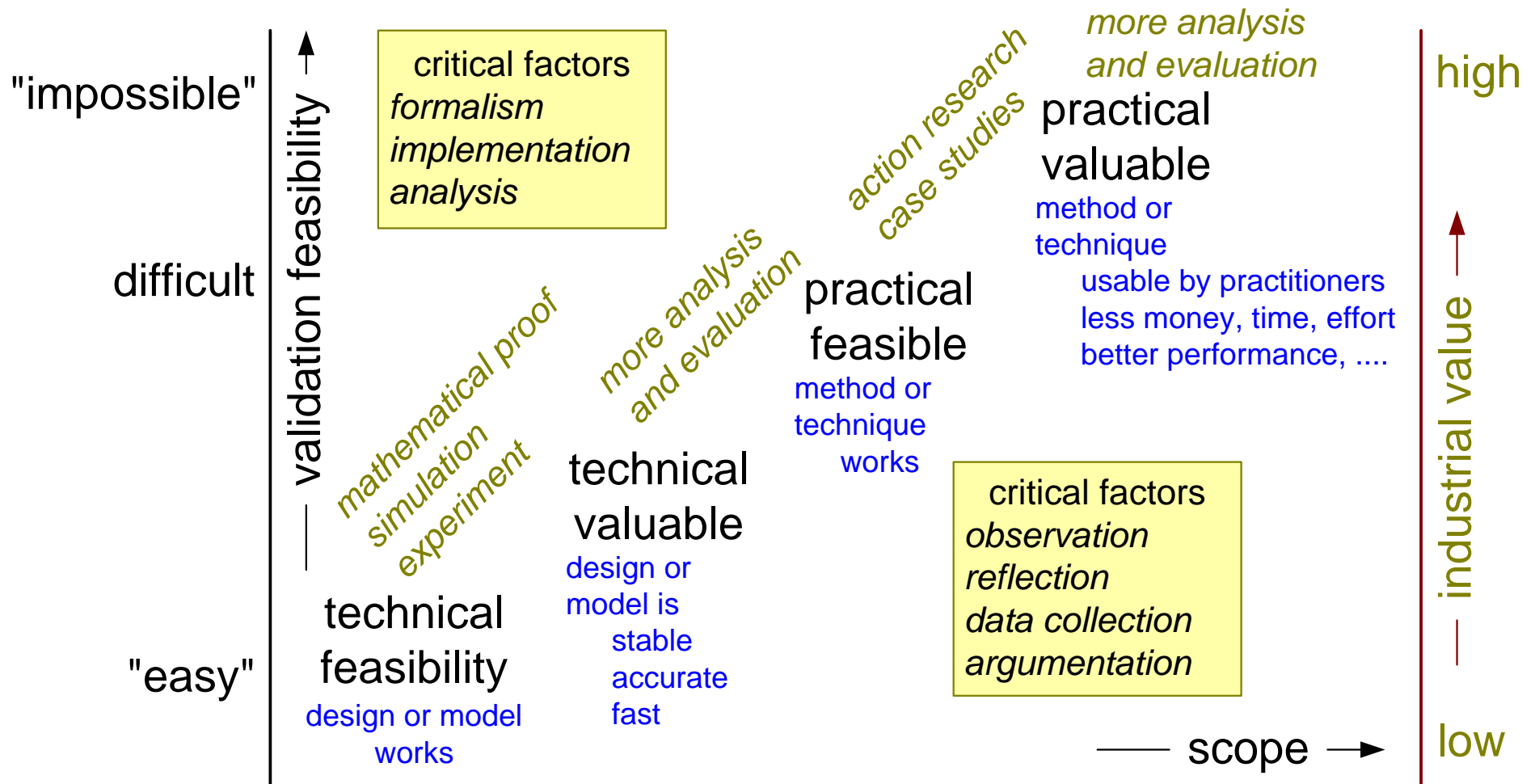
Tools to support efficient application of formalisms, techniques and methods

Moving in the *meta* direction

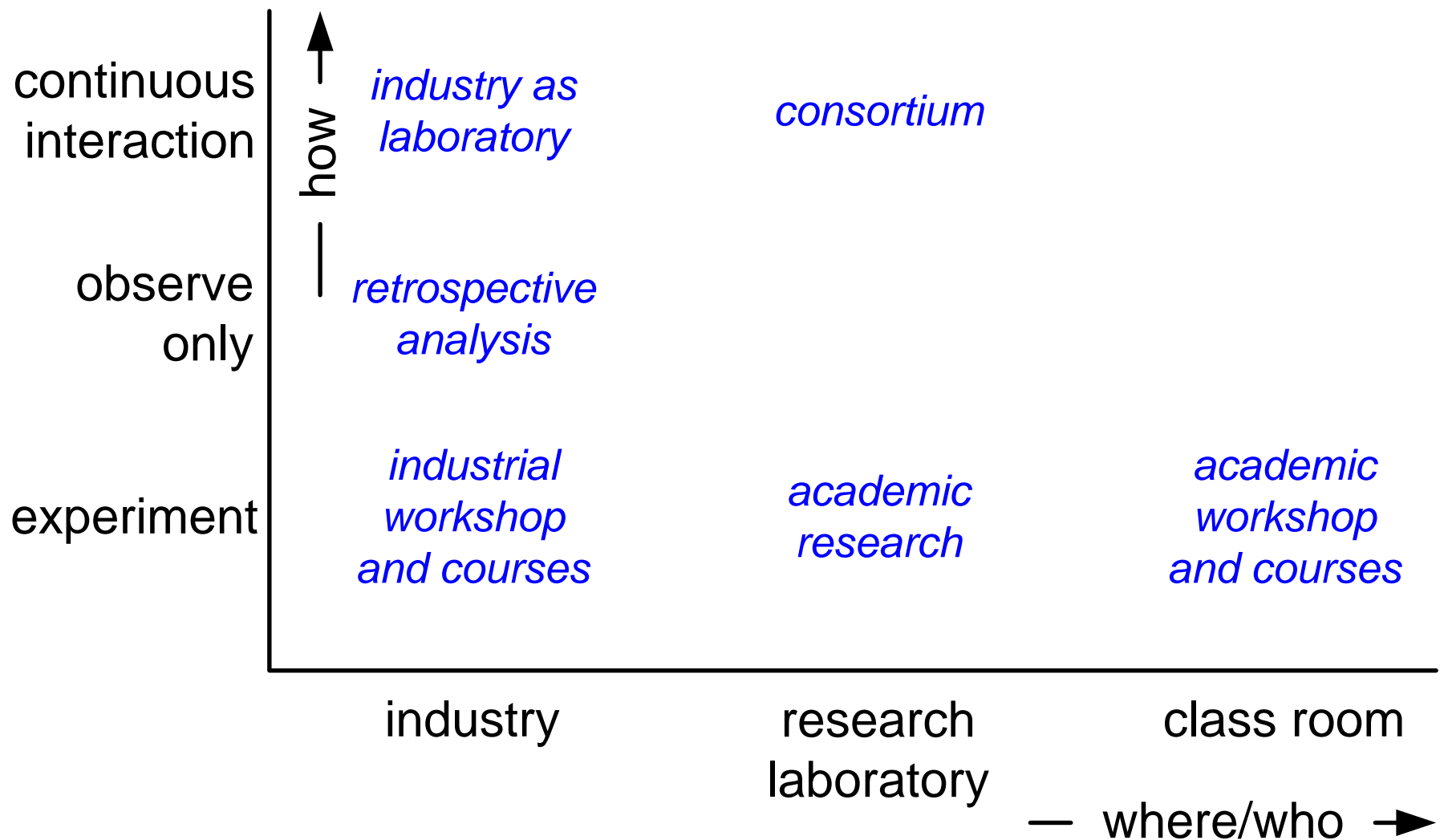




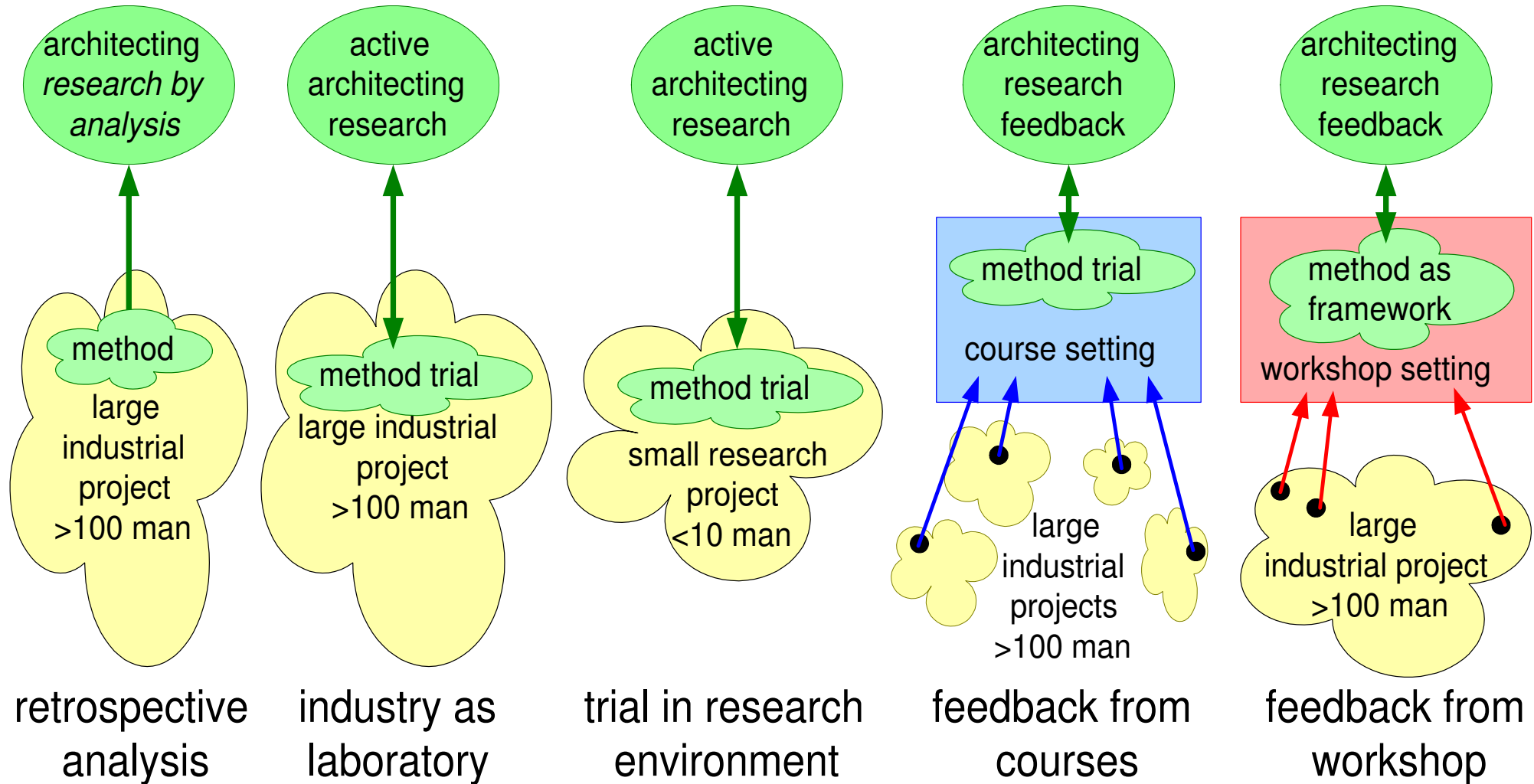
Scope versus Feasibility and Value



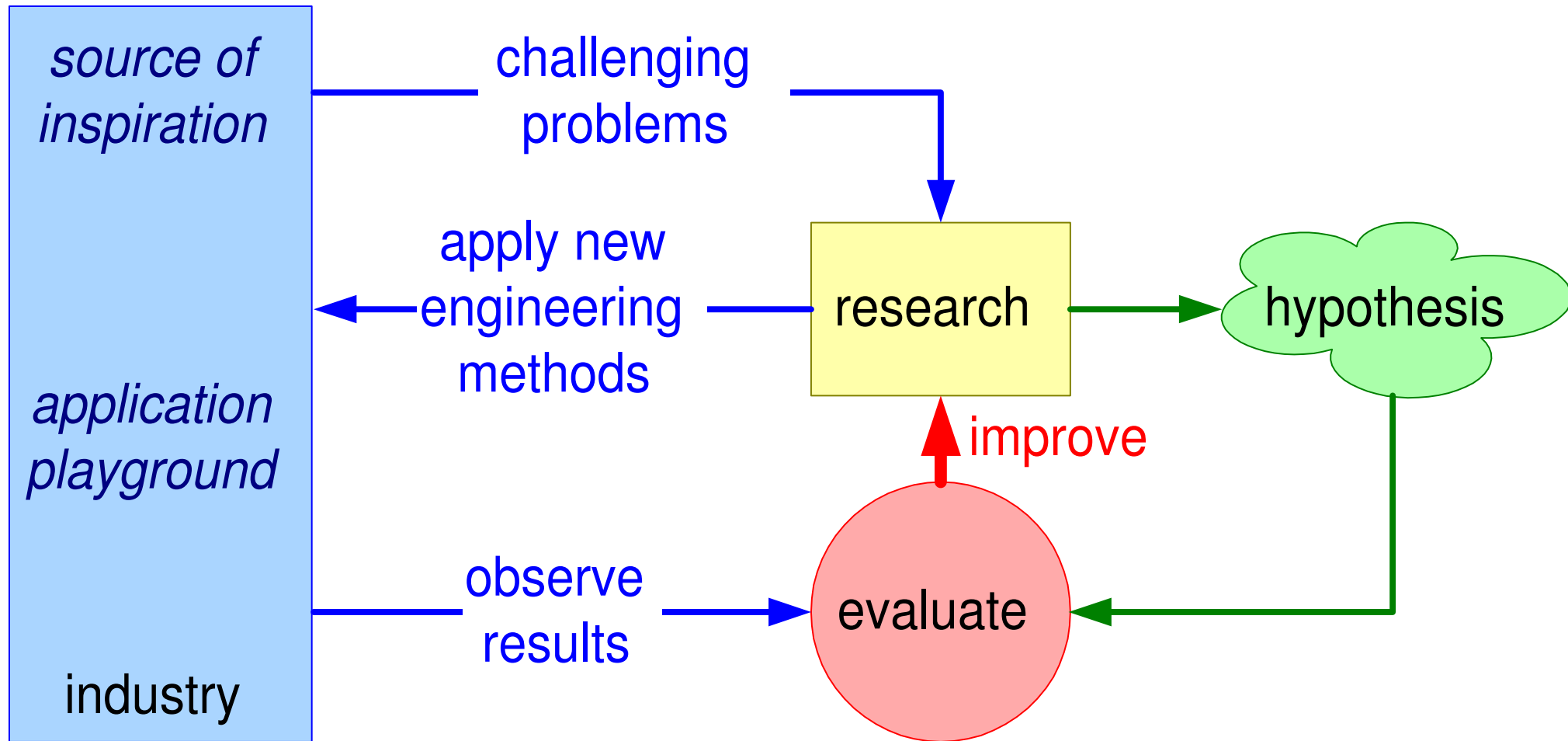
Different Research Methods

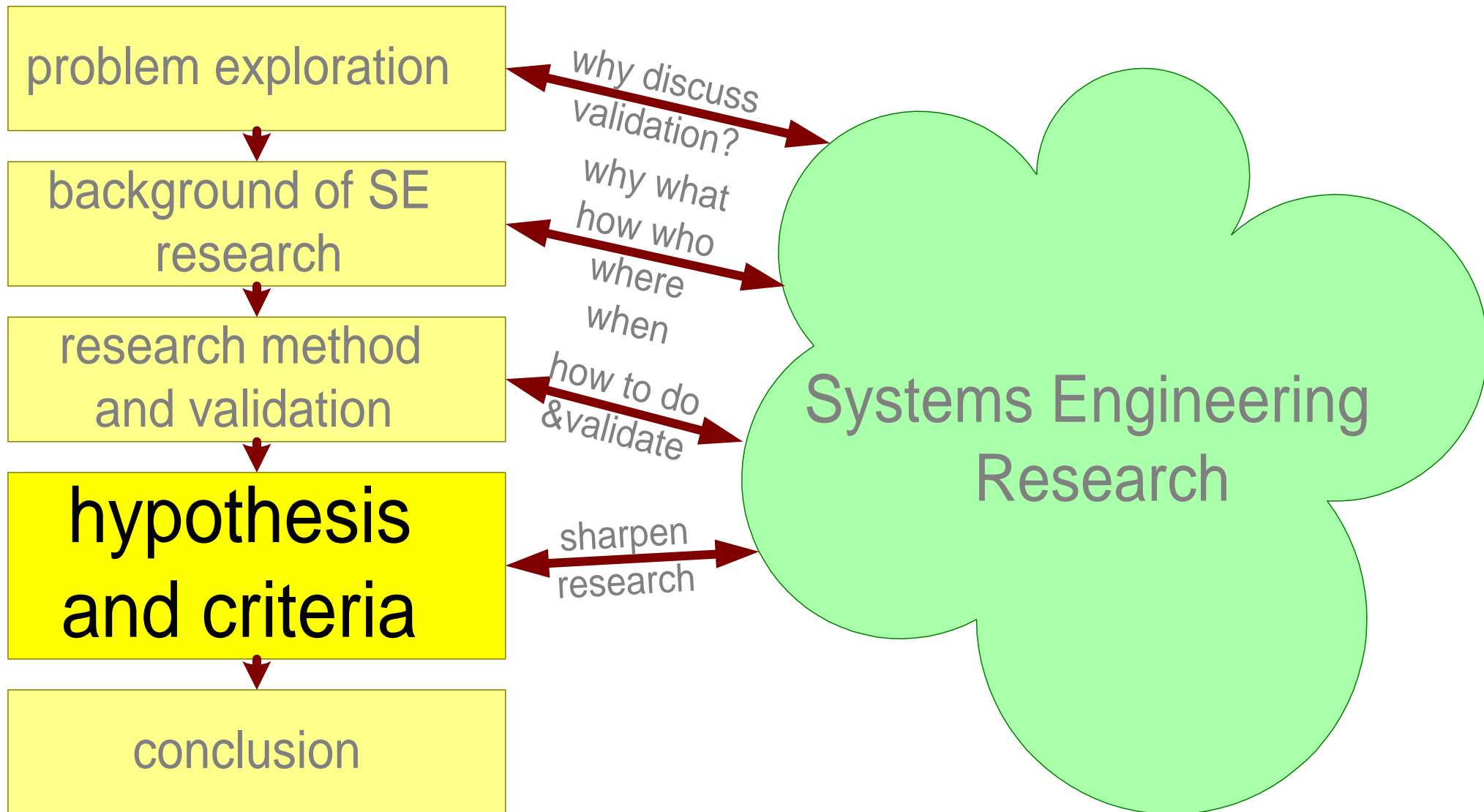


Different Research Methods (2)

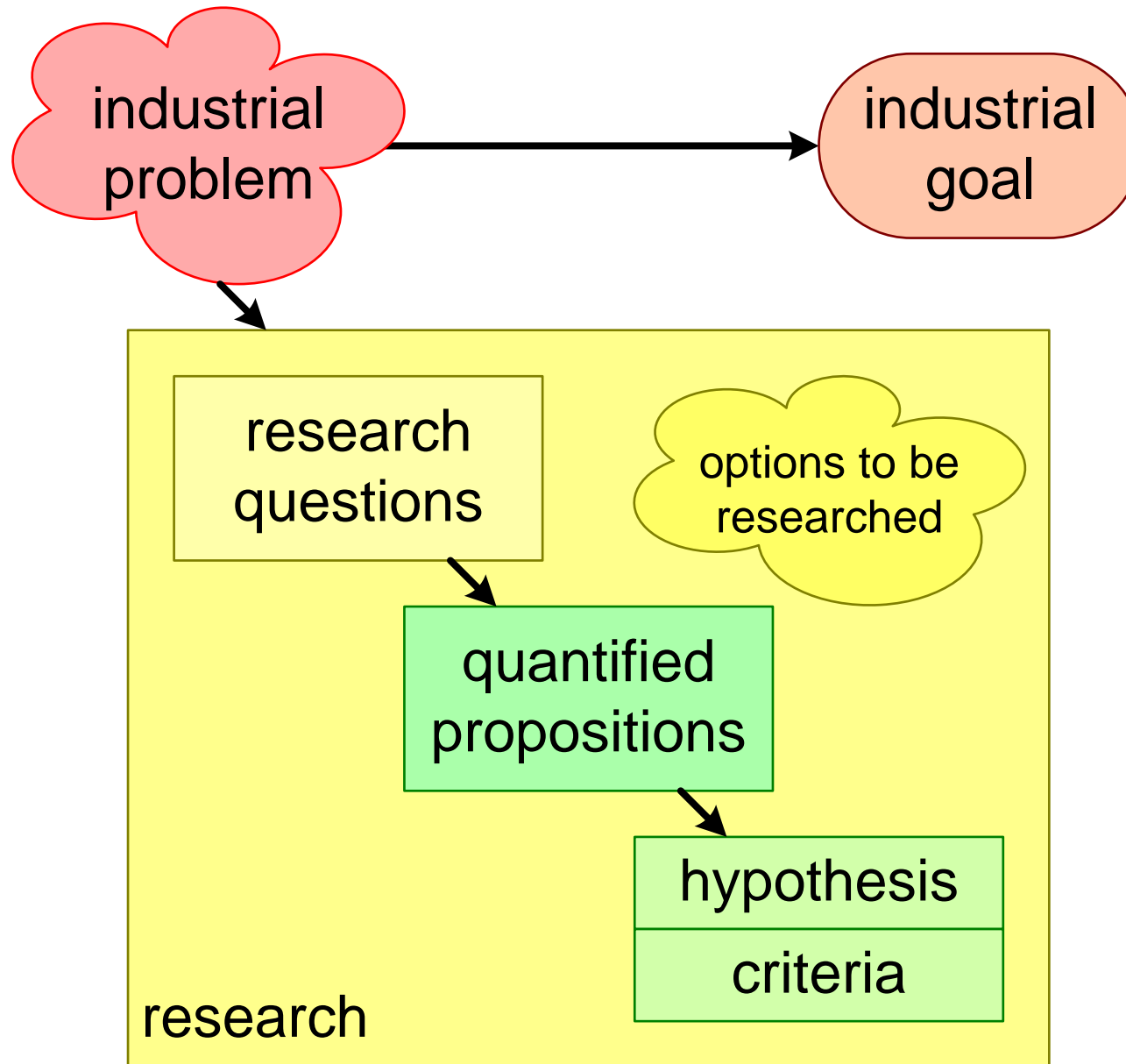


Industry as Laboratory

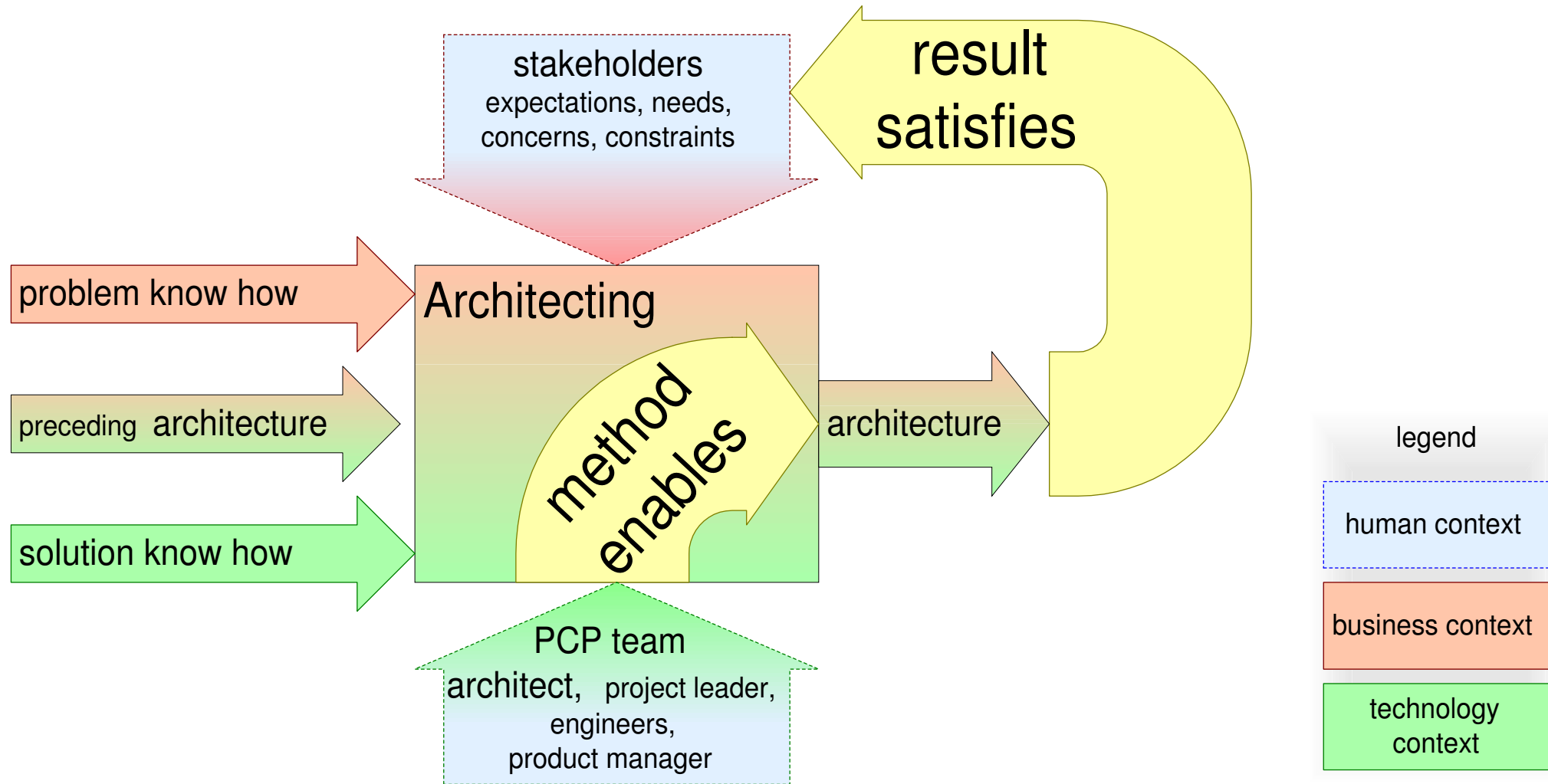




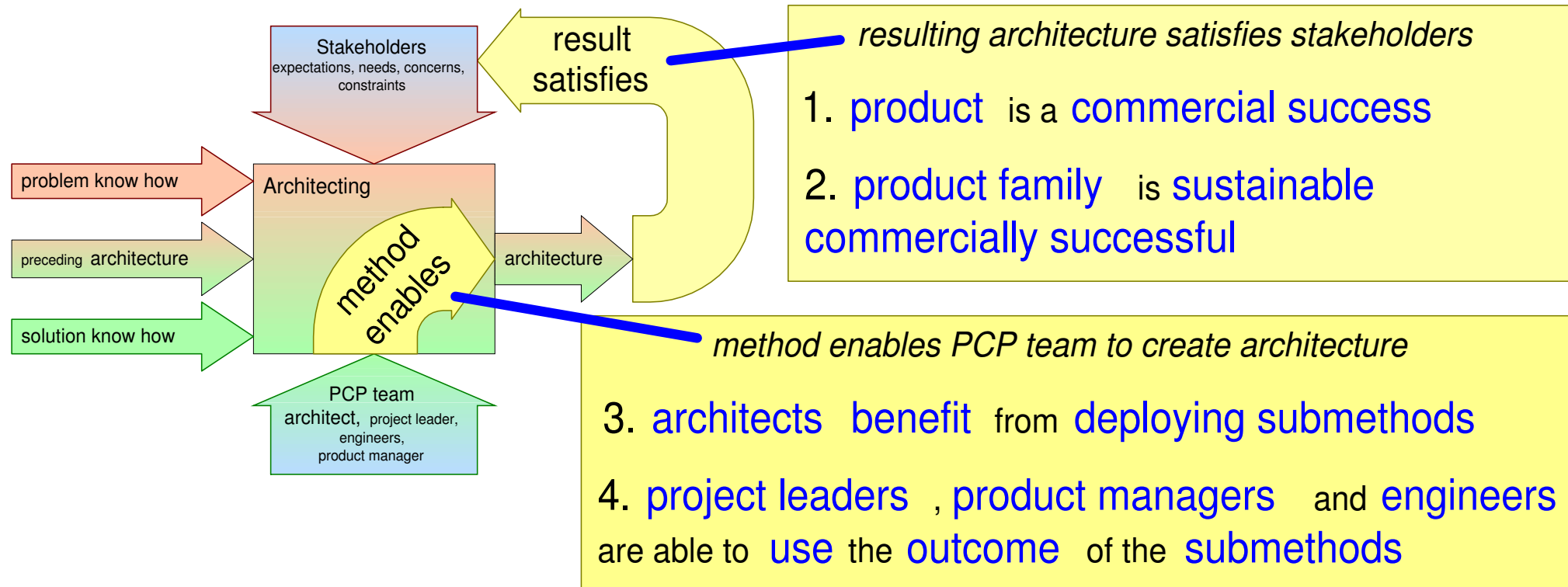
From Industrial Problem to Validated Research

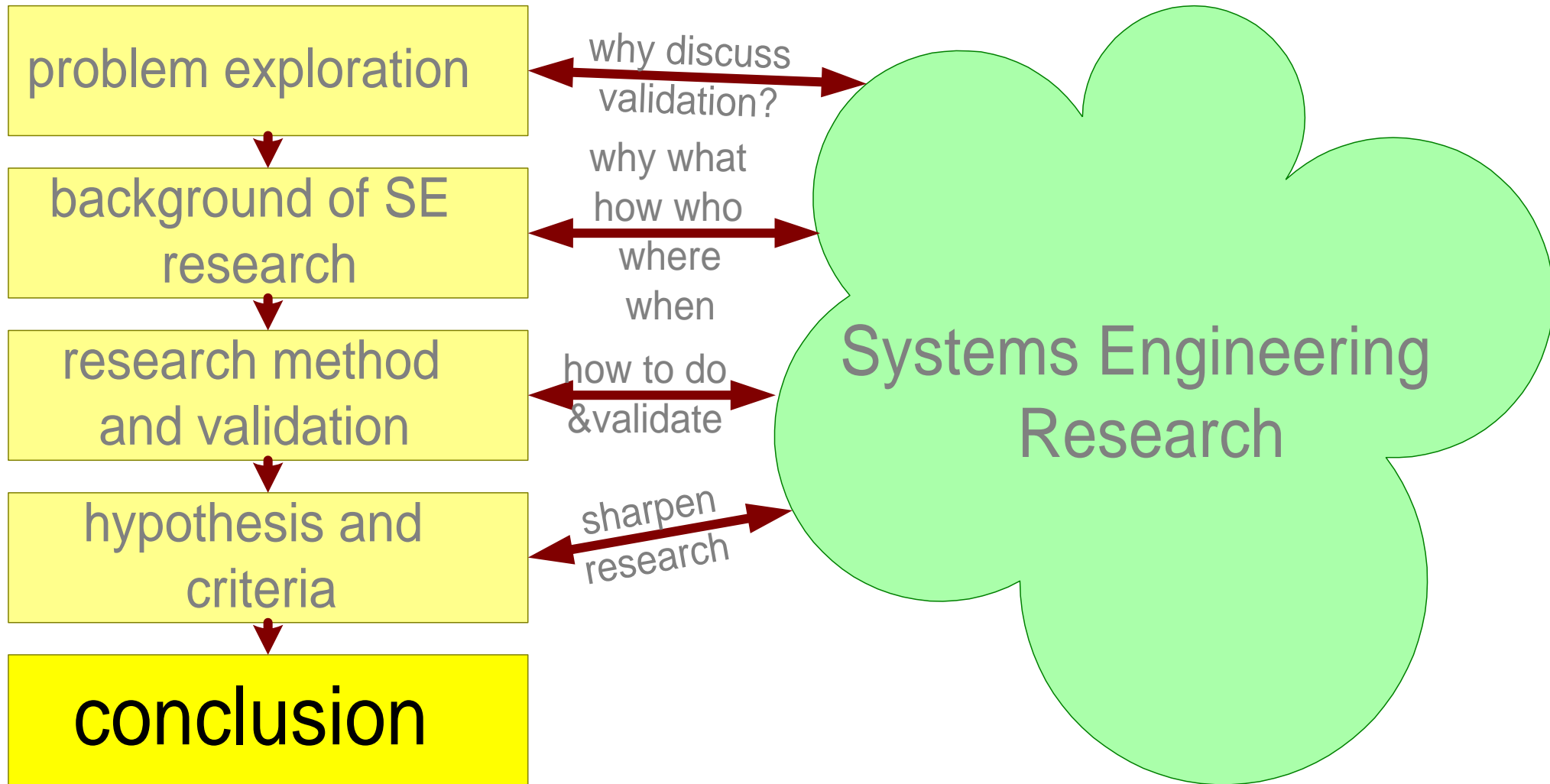


Successful architecting and architecting method



From hypothesis to criteria





The Final Result

research question, hypothesis, criteria, method
research positioning *opening*

theory

casus (problem, goal, context)

experiment

analysis

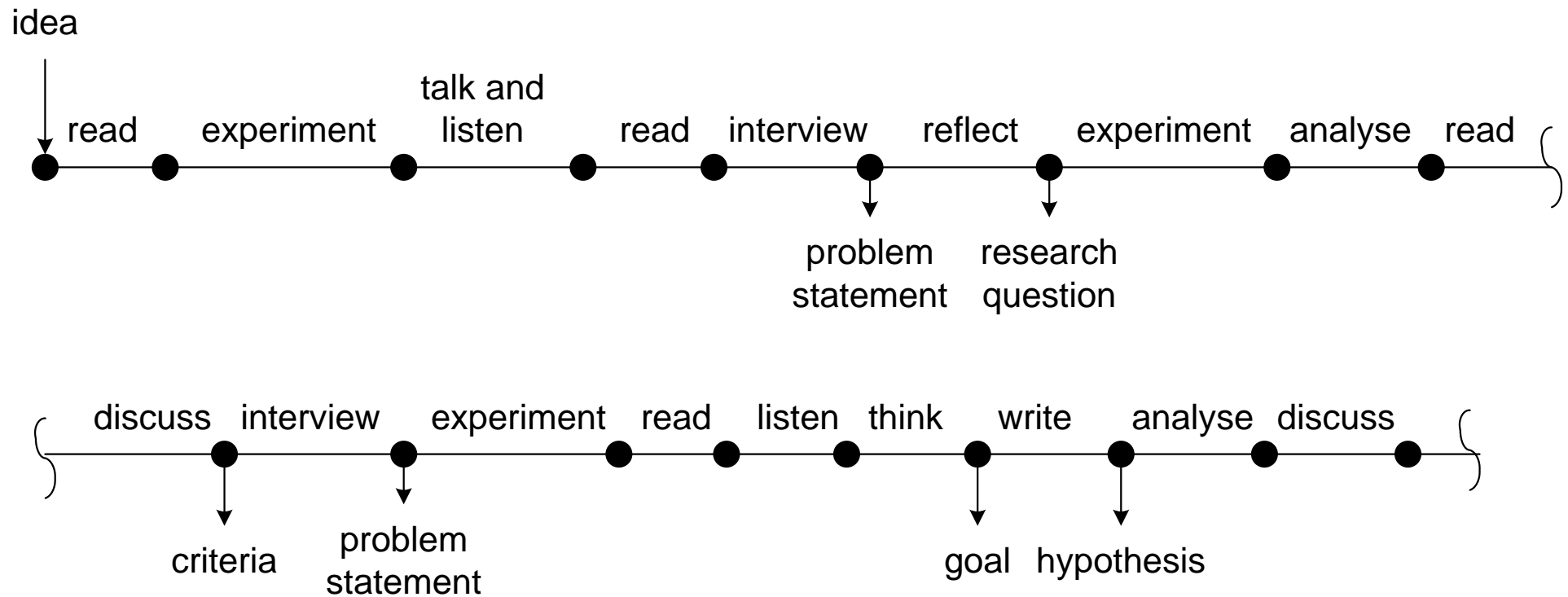
core

evaluation, validation

conclusion, recommendations

closing

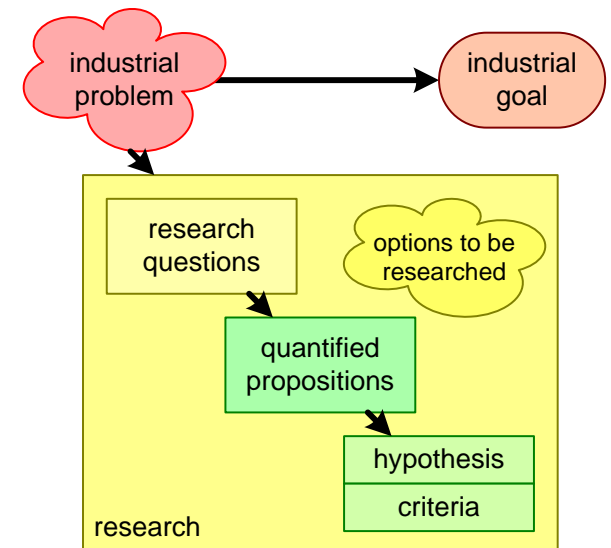
and the Chaotic Route



et cetera et cetera

Recommendations

- time-box research reflection, e.g. one day per half year
- be sharp in industrial problem and goal,
research question, proposition and hypothesis
- does your claim address the original needs?
- does your validation address the claim?
- be modest with claim
- be critical in evaluation
- test claim and evaluation
with others



Further Reading; chapters from PhD thesis:

- “Research in Systems Architecting”

<http://www.gaudisite.nl/ArchitectingResearchMethodPaper.pdf>

- “Research Question and Hypothesis”

<http://www.gaudisite.nl/CriteriaForArchitectingMethodsPaper.pdf>

- “Evaluation of the Architecting Method”

<http://www.gaudisite.nl/AREvaluationPaper.pdf>

- “Reflection on Research Method to Study Architecting Methods”

<http://www.gaudisite.nl/ReflectionOnResearchMethodPaper.pdf>

Further Reading; other related Gaudisite documents

- “A Multi-Disciplinary Research Approach, Illustrated by the Boderc Project”

<http://www.gaudisite.nl/MultiDisciplinaryResearchApproachPaper.pdf>

- “Industry and Academia: Why Practioners and Researchers are Disconnected.”

<http://www.gaudisite.nl/GapIndustryAcademicsPaper.pdf>

- “How to Characterize SW and HW to Facilitate Predictable Design?”

<http://www.gaudisite.nl/PerformanceEngineeringPaper.pdf>

- “The Informal Nature of Systems Engineering”

<http://www.gaudisite.nl/InformalNatureSystemsEngineeringSlides.pdf>