

# Systems Engineering Research Validation

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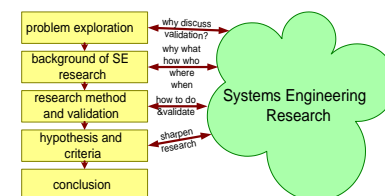
## Abstract

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.

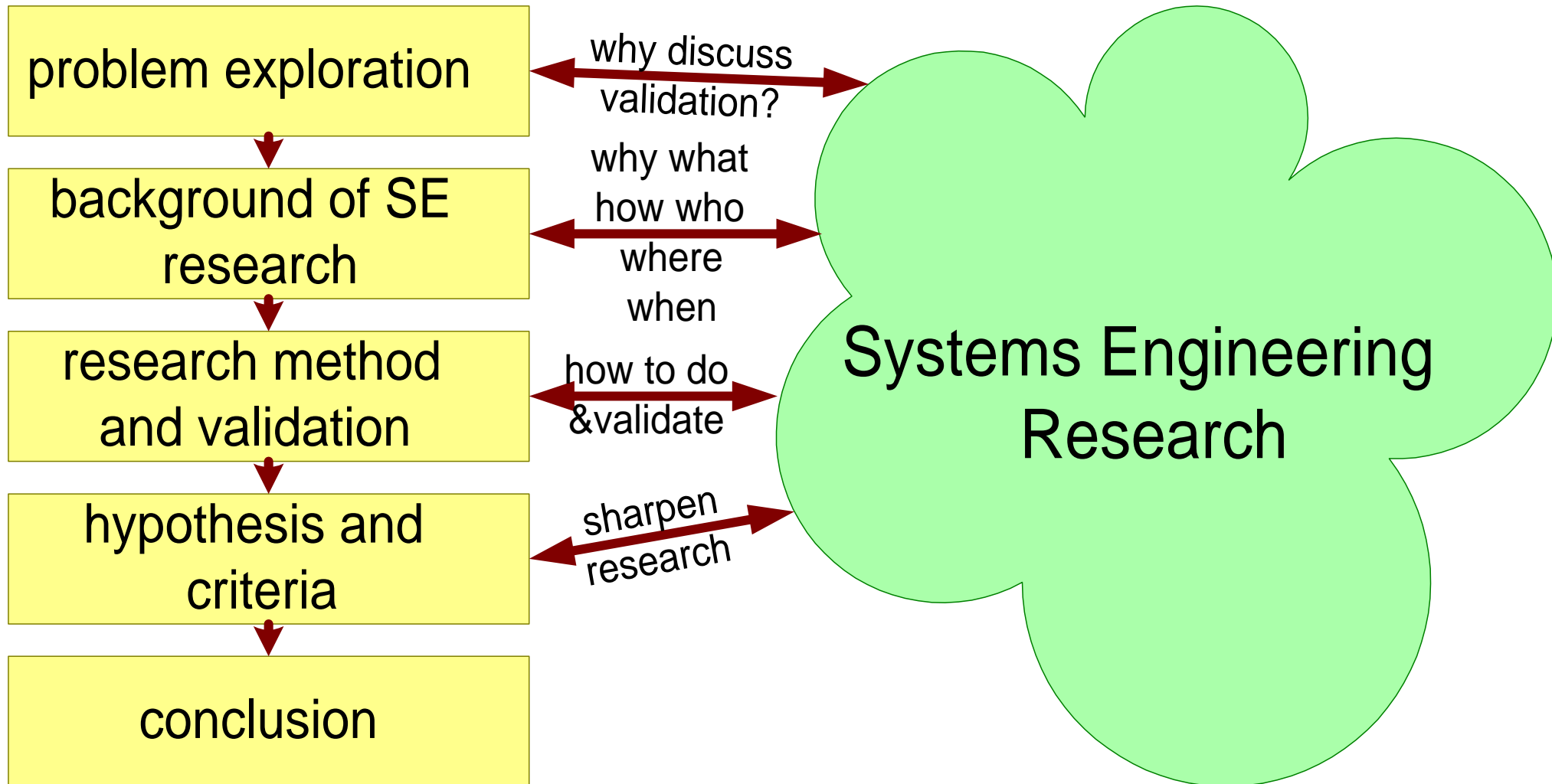
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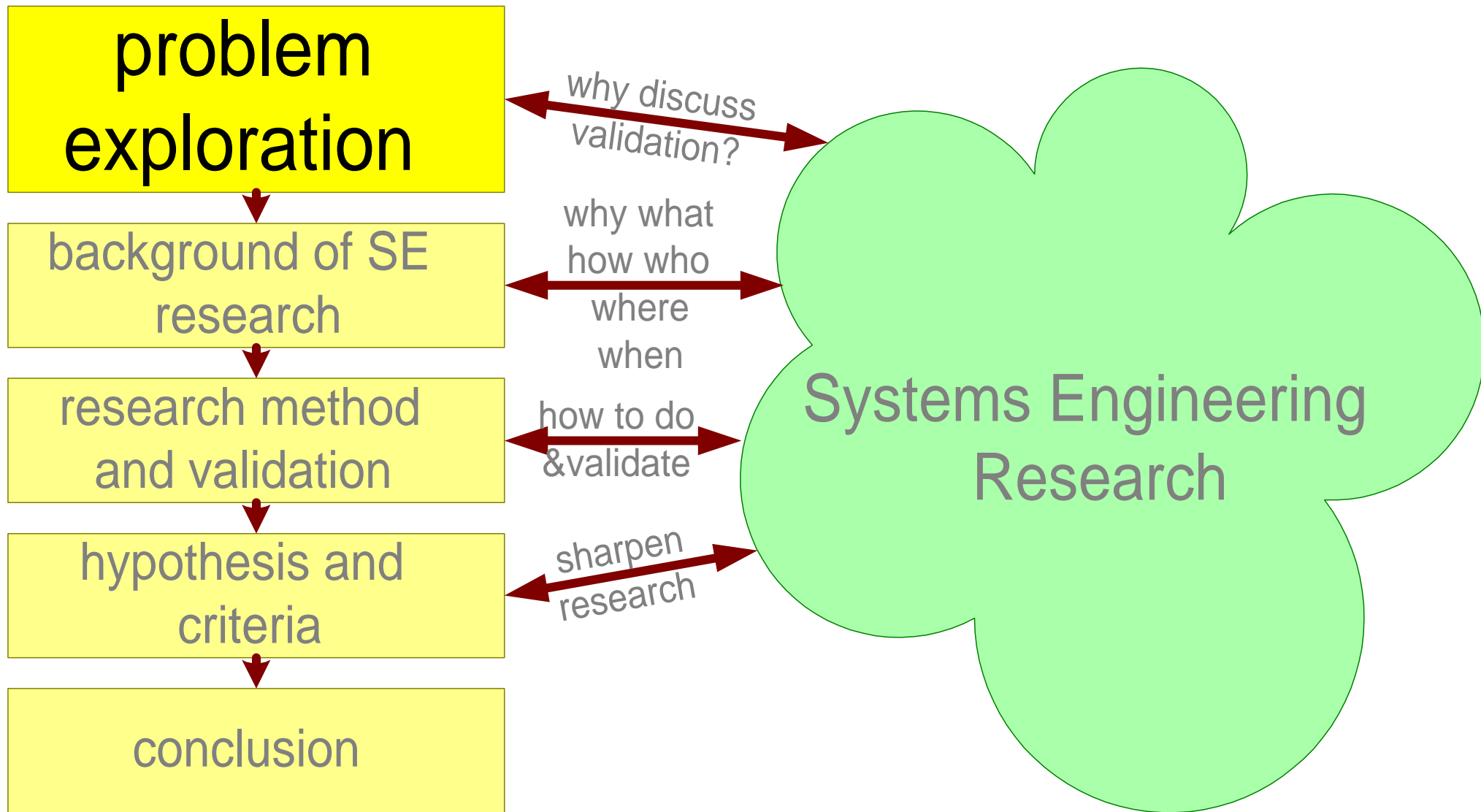
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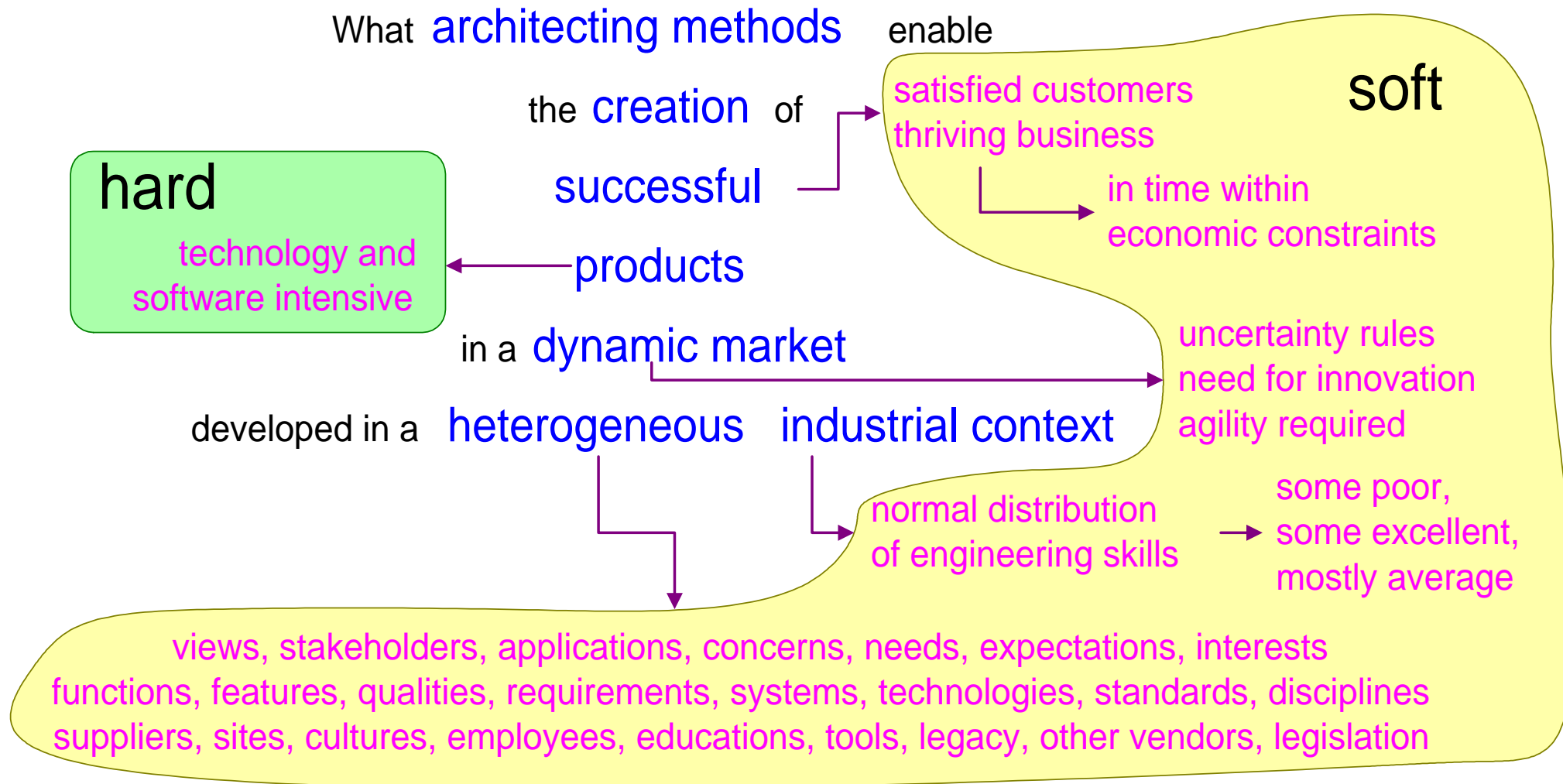


# Figure Of Contents™

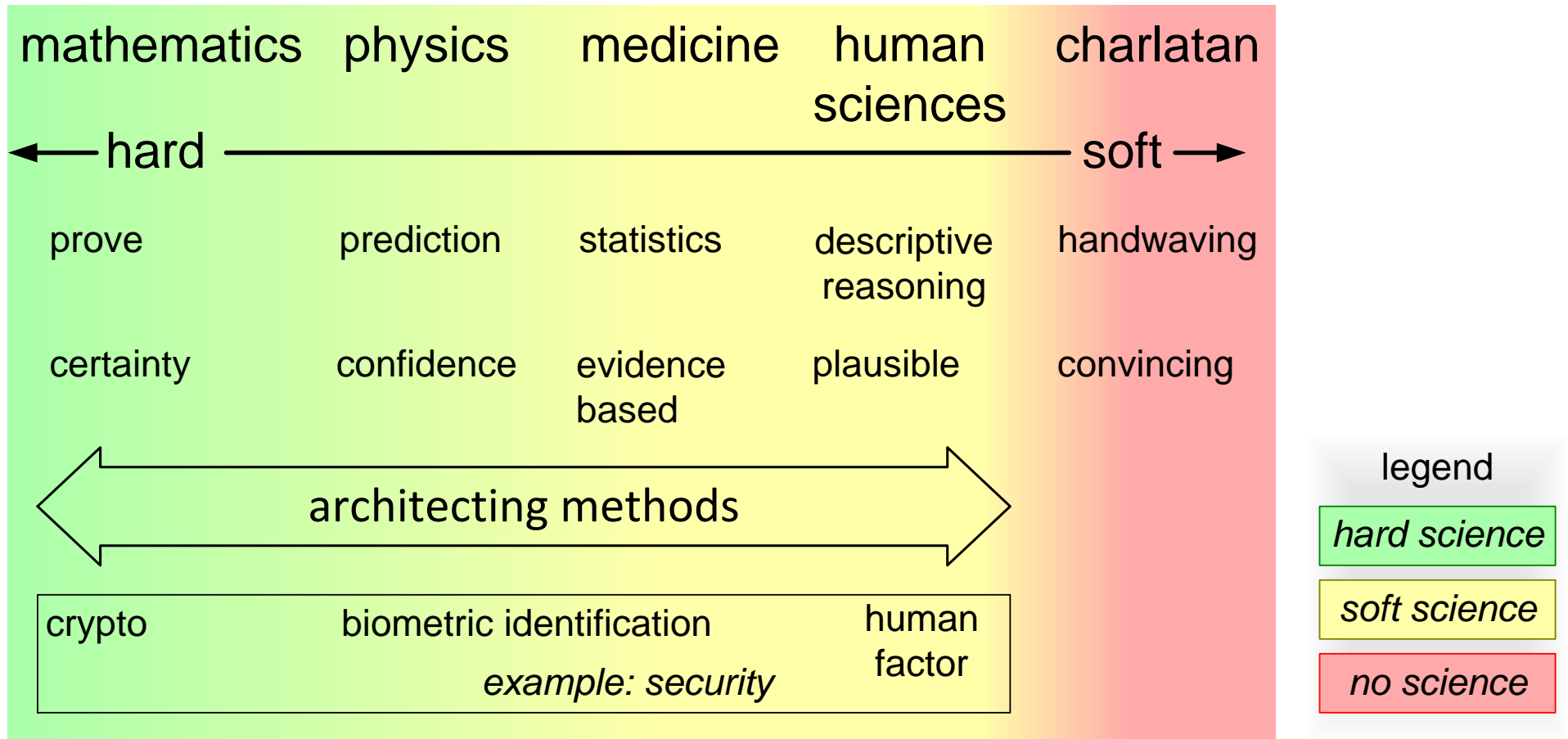




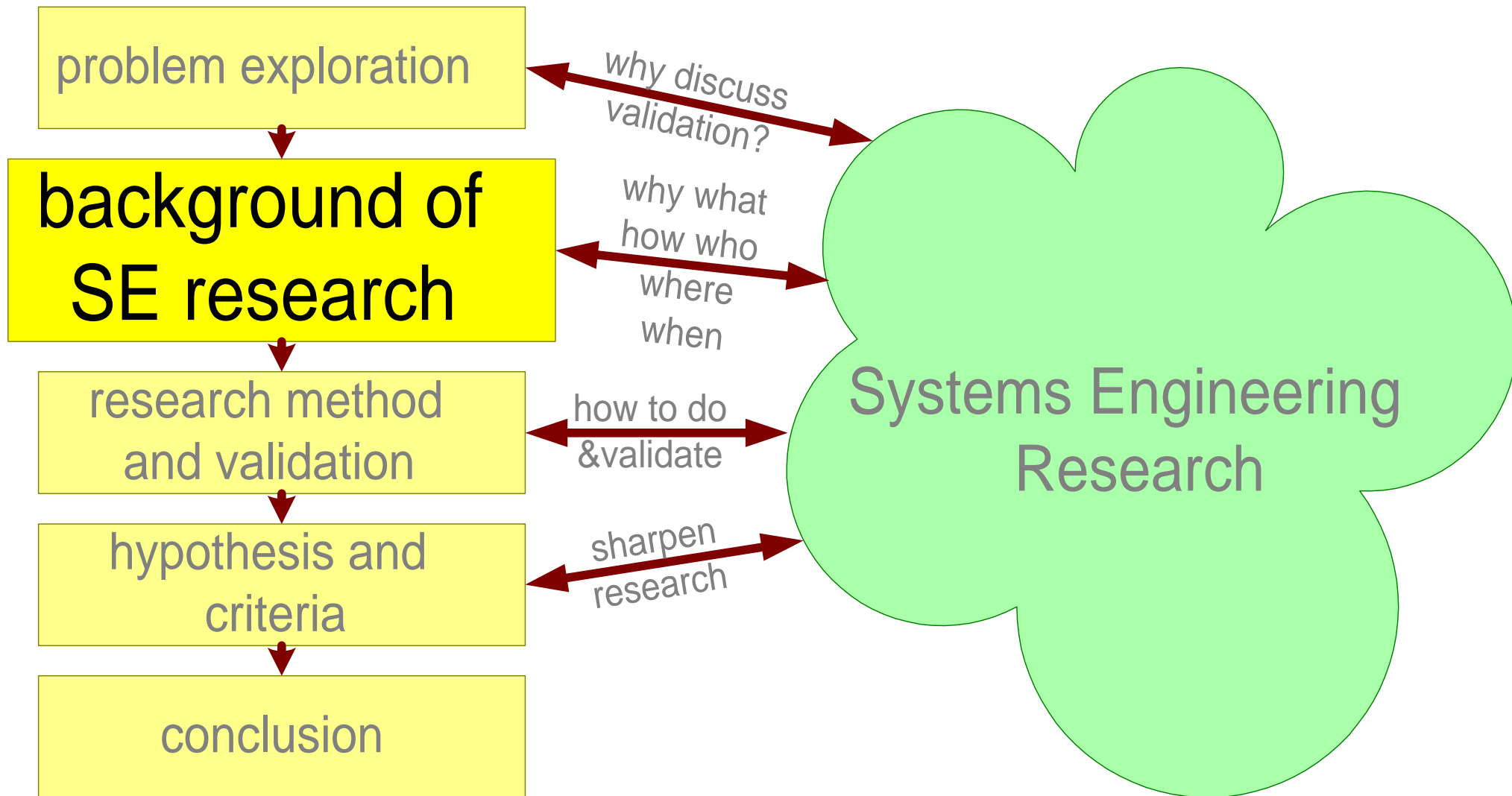
# Reflection from my PhD thesis



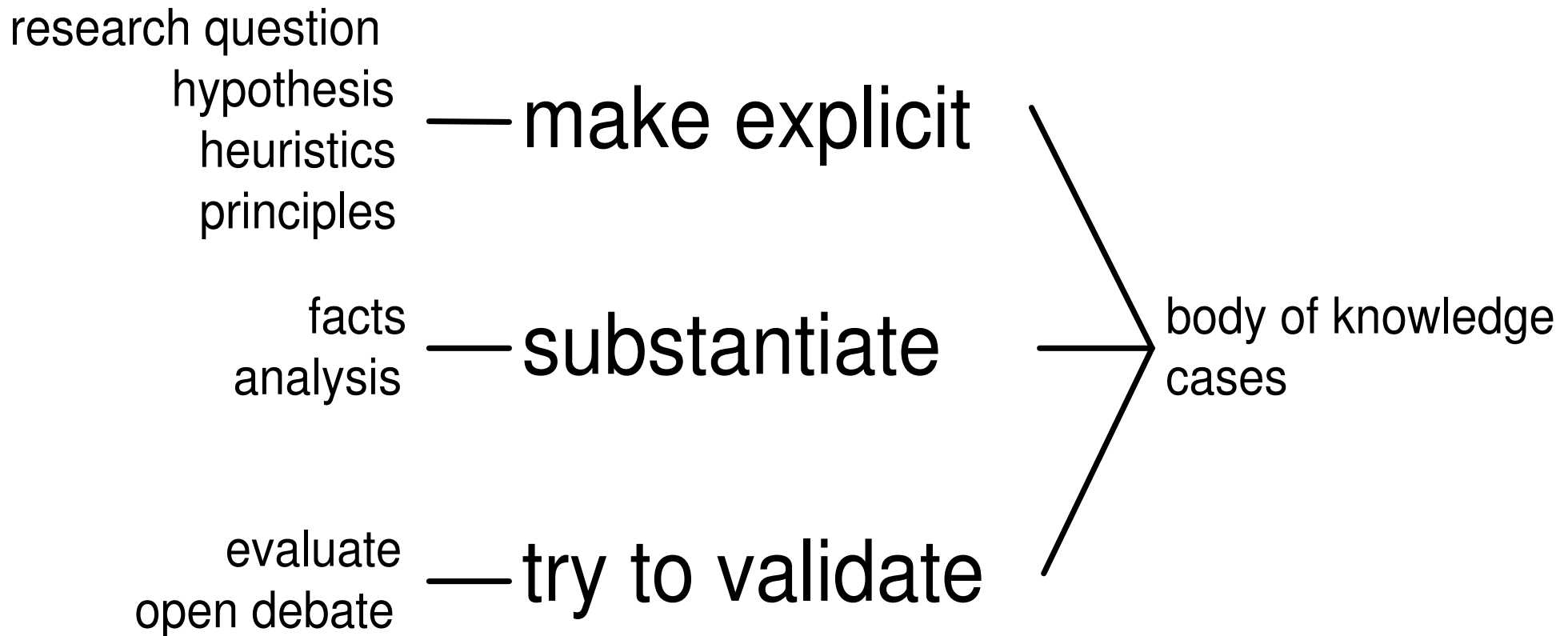
# Spectrum of sciences



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

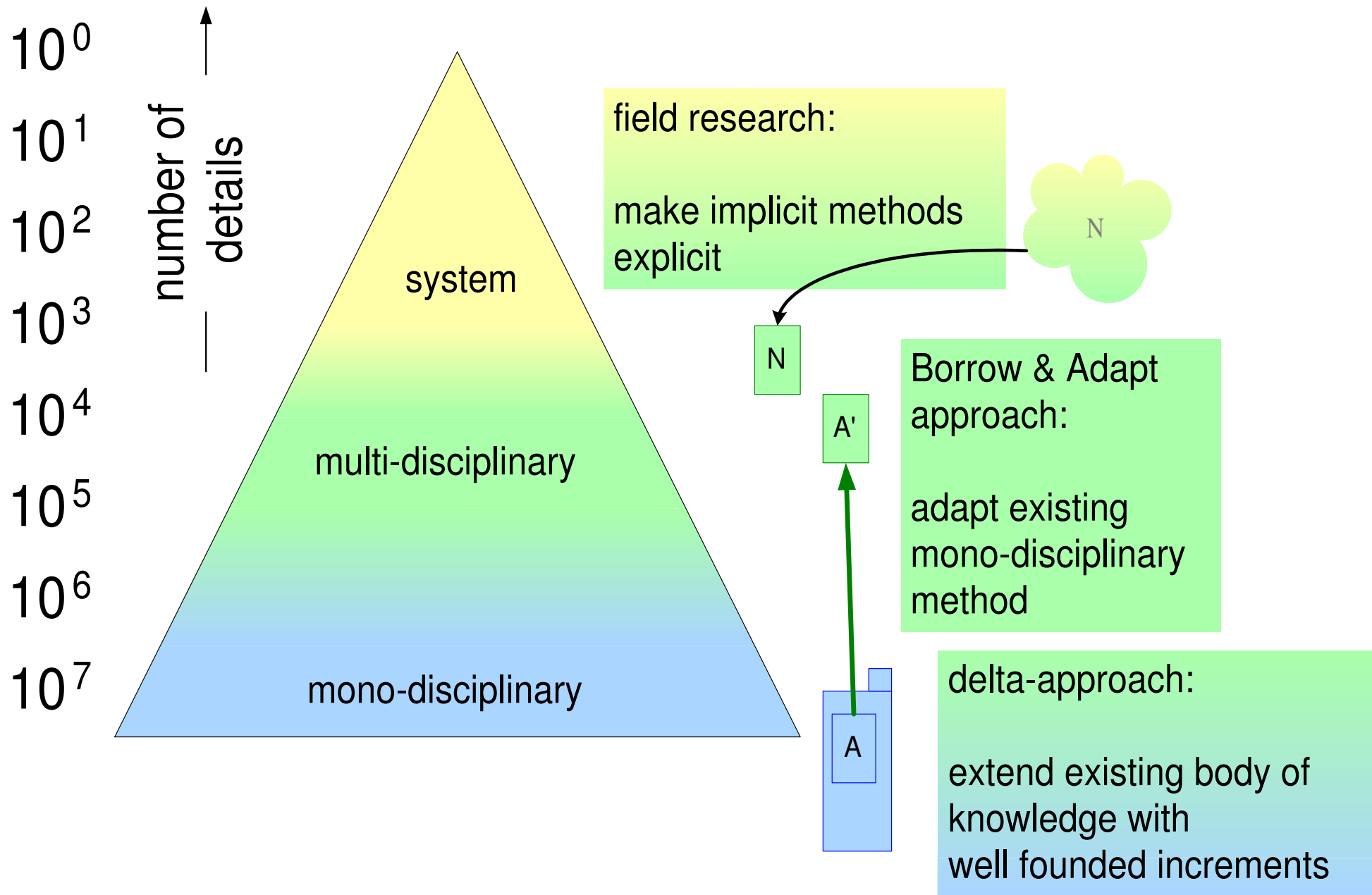


## *soft is not in conflict with scientific attitude*

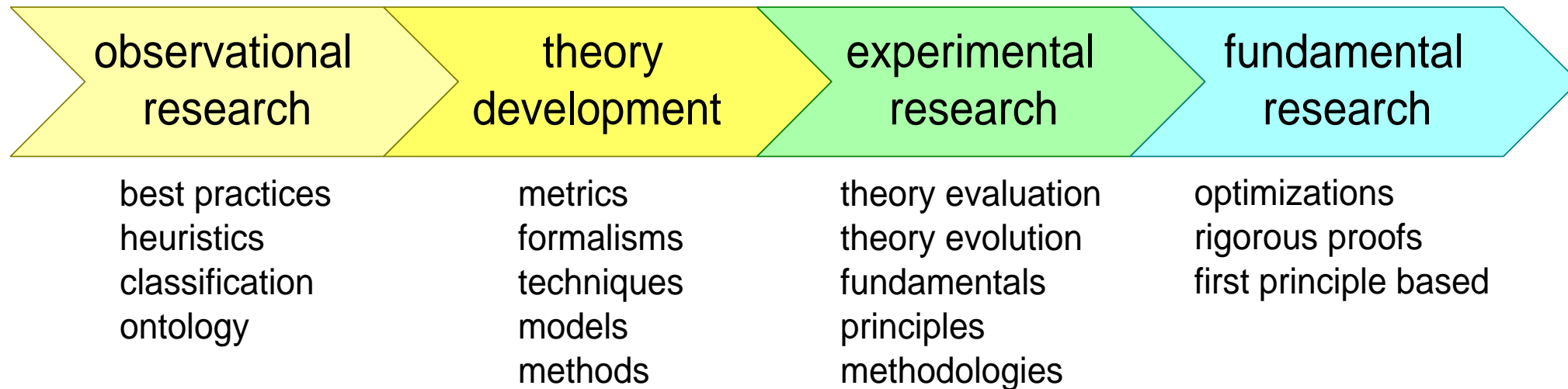




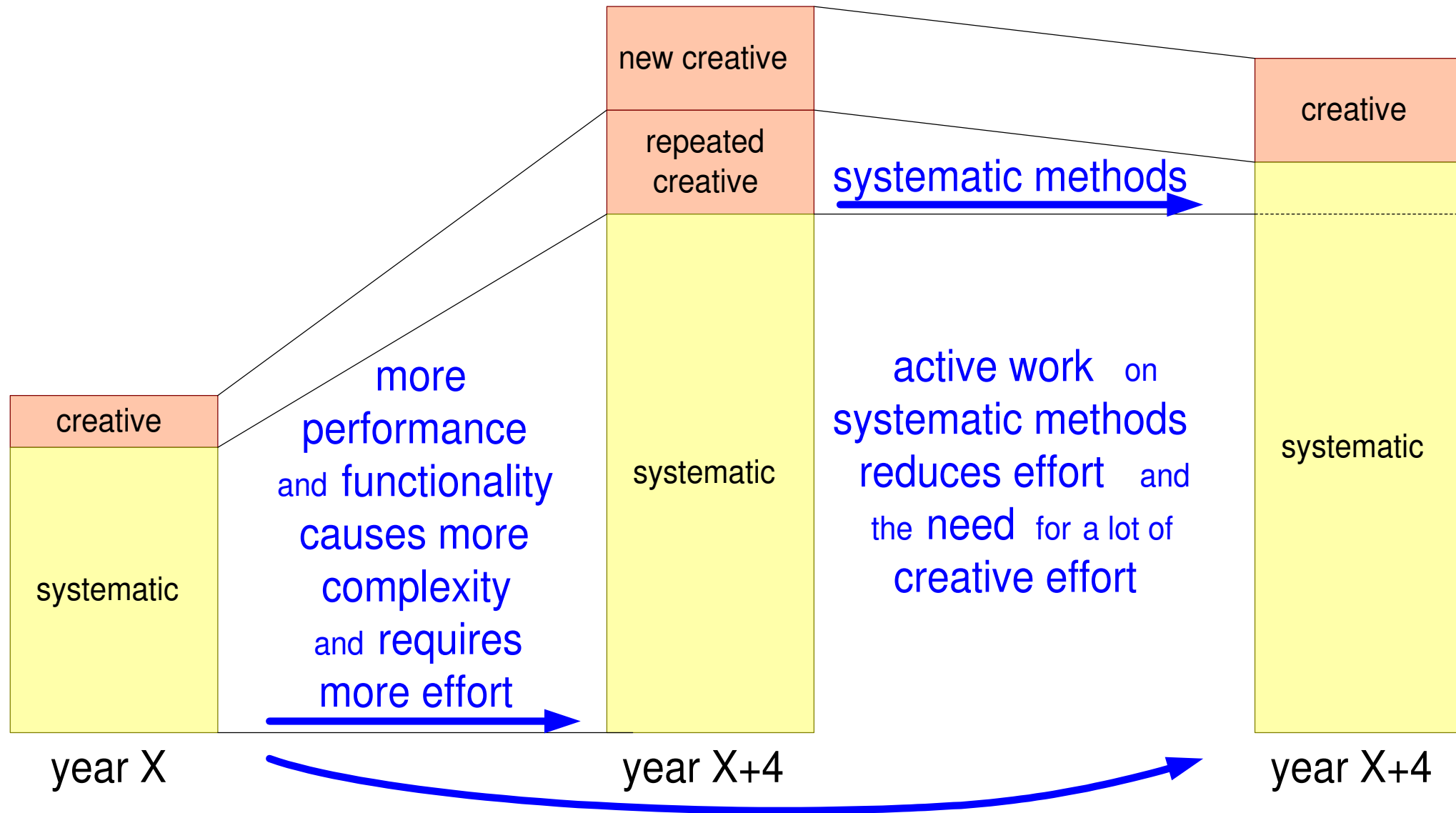
# Different Types of Research



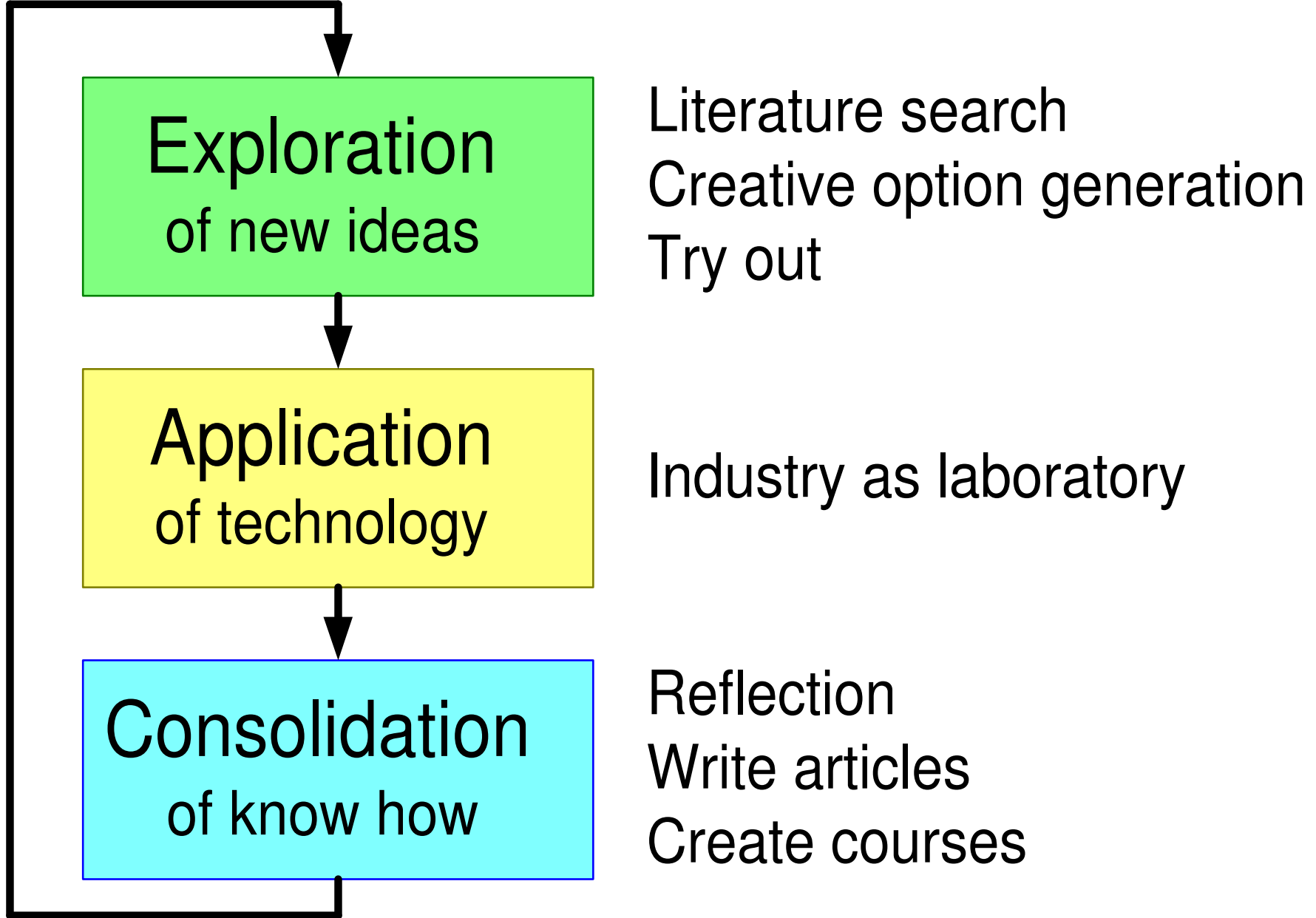
# And another Dimension of Research Types



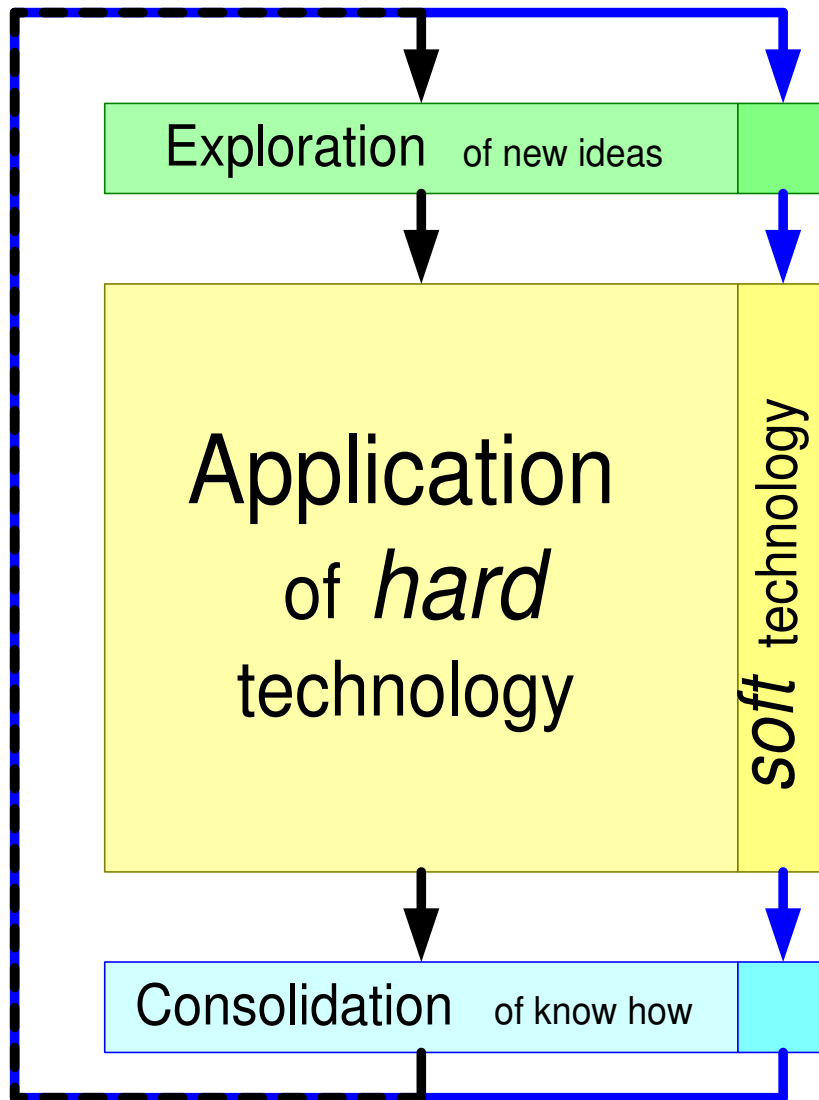
# Systematic Know-how to cope with Growing Complexity



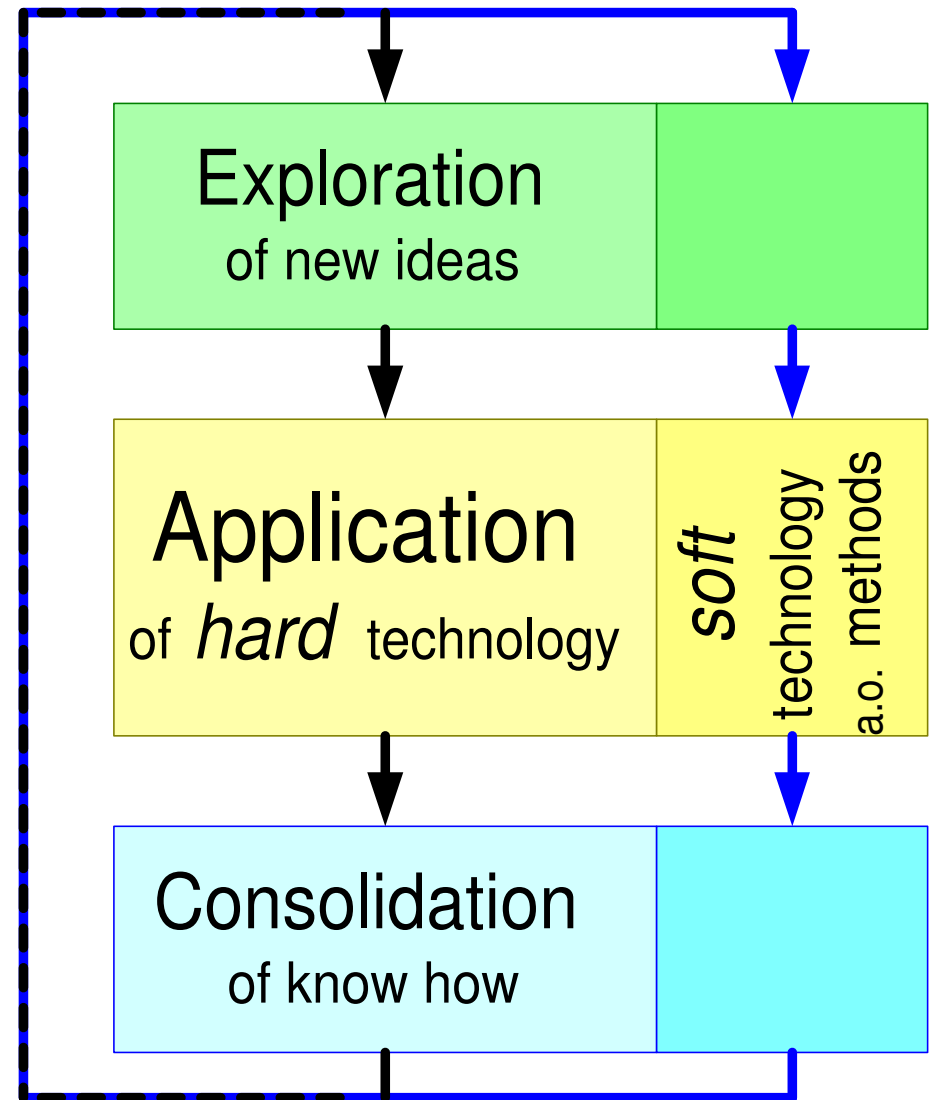
# Technology Management Cycle



# SE research requires application

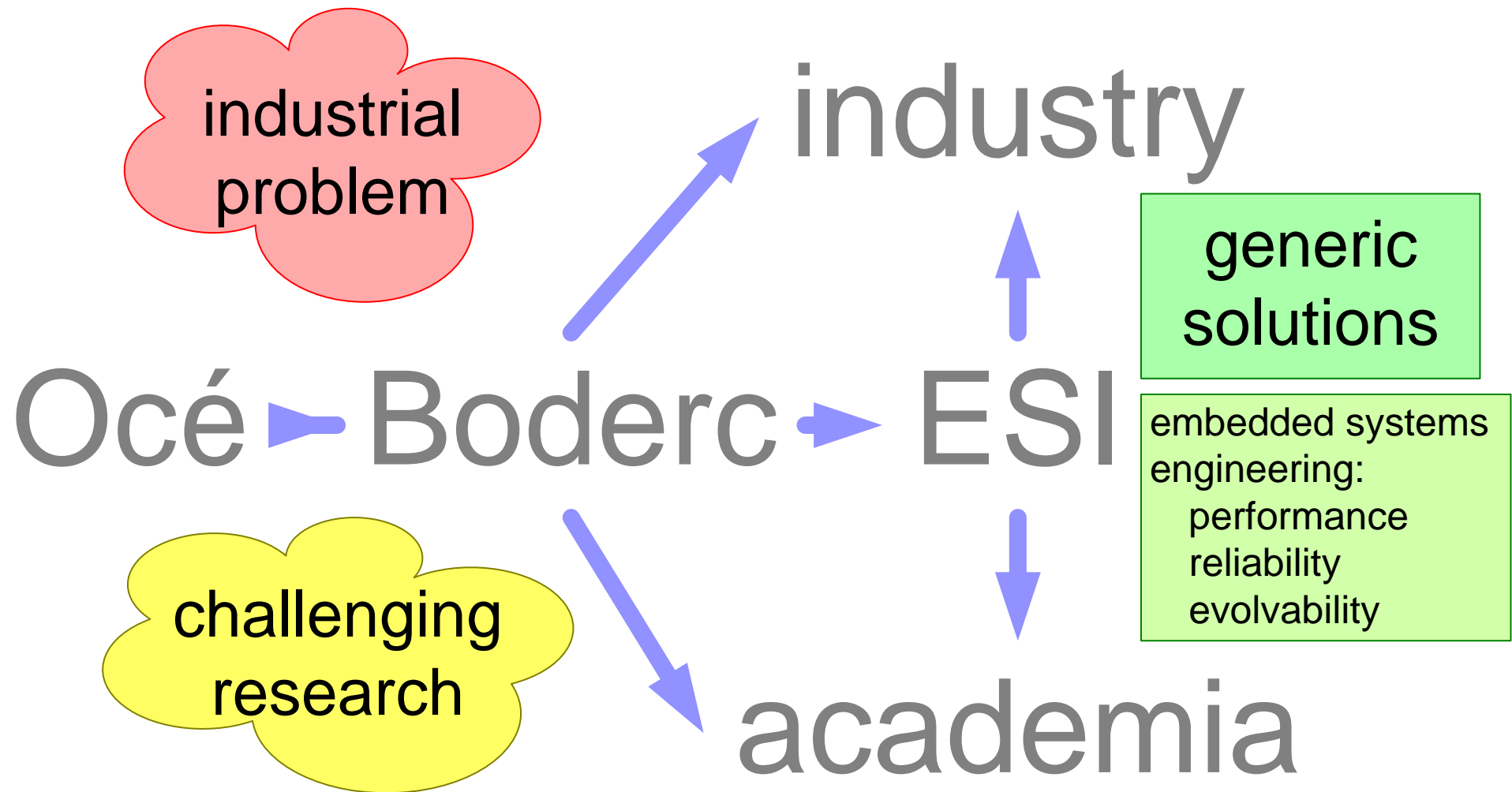


Product Development

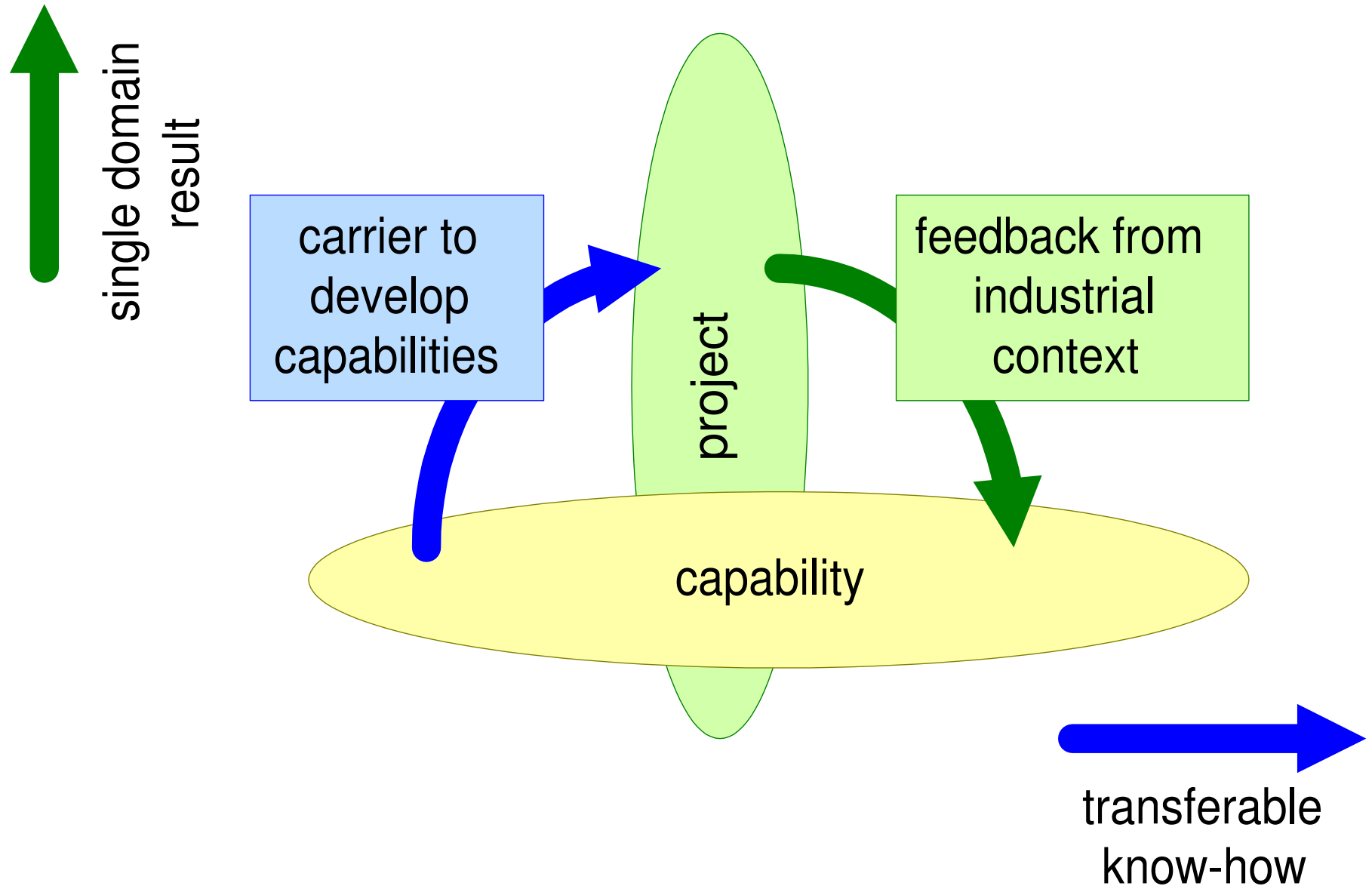


Research

# 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

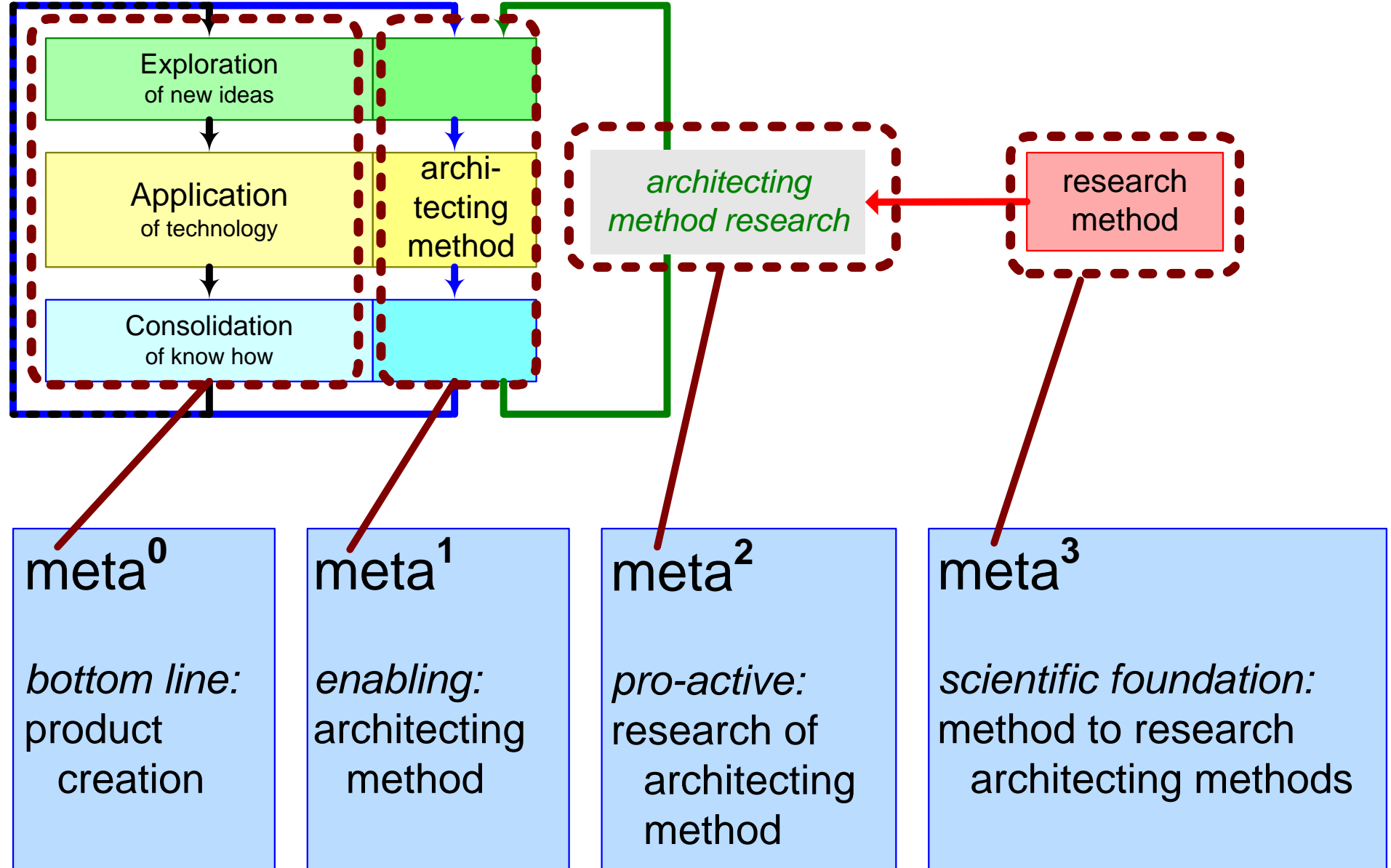
**Techniques** to get the required information from models:  
e.g. performance

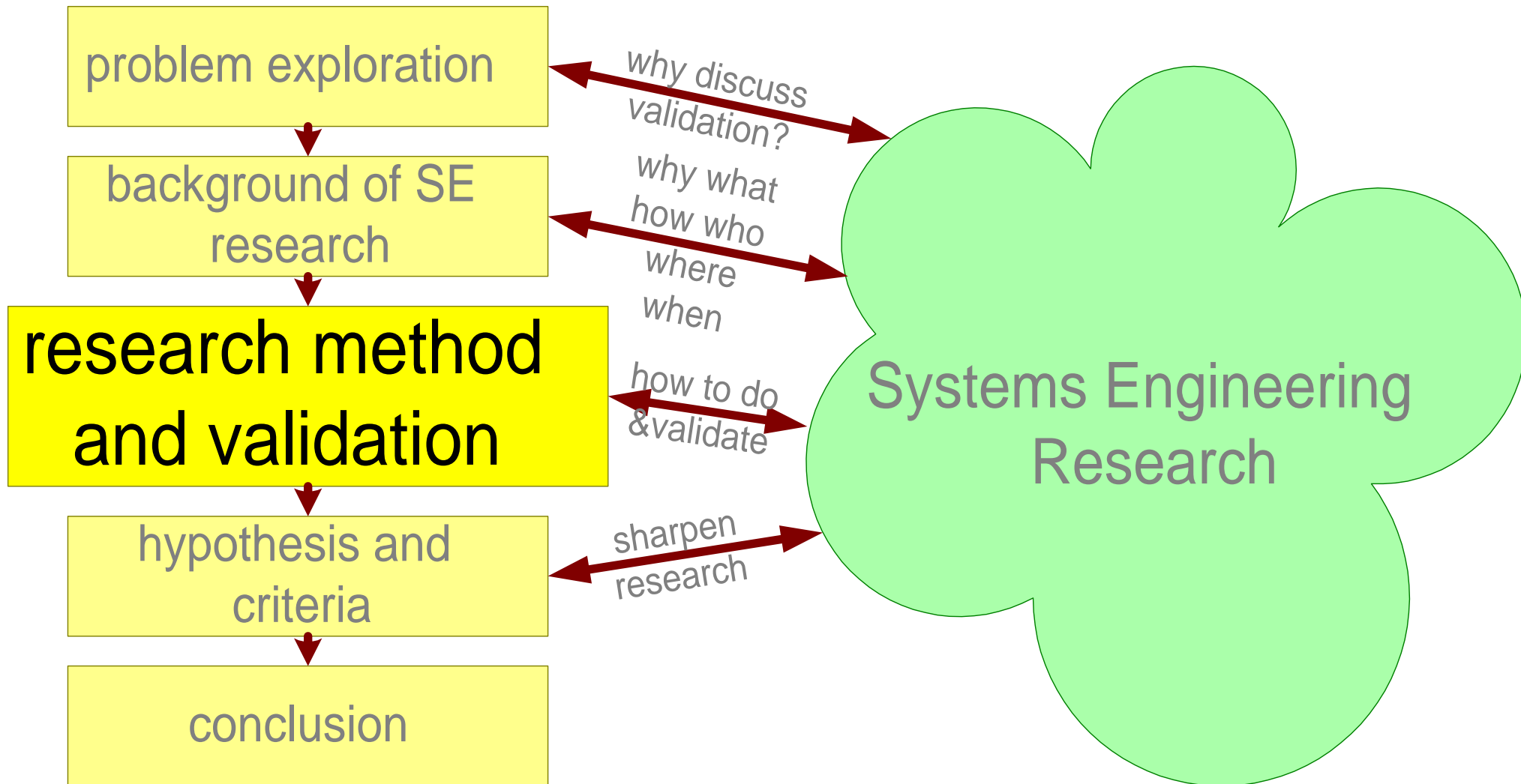
**Methods** to provide guidelines how to use formalisms, create models, use techniques and apply tools

**Tools** to support efficient application of formalisms, techniques and methods

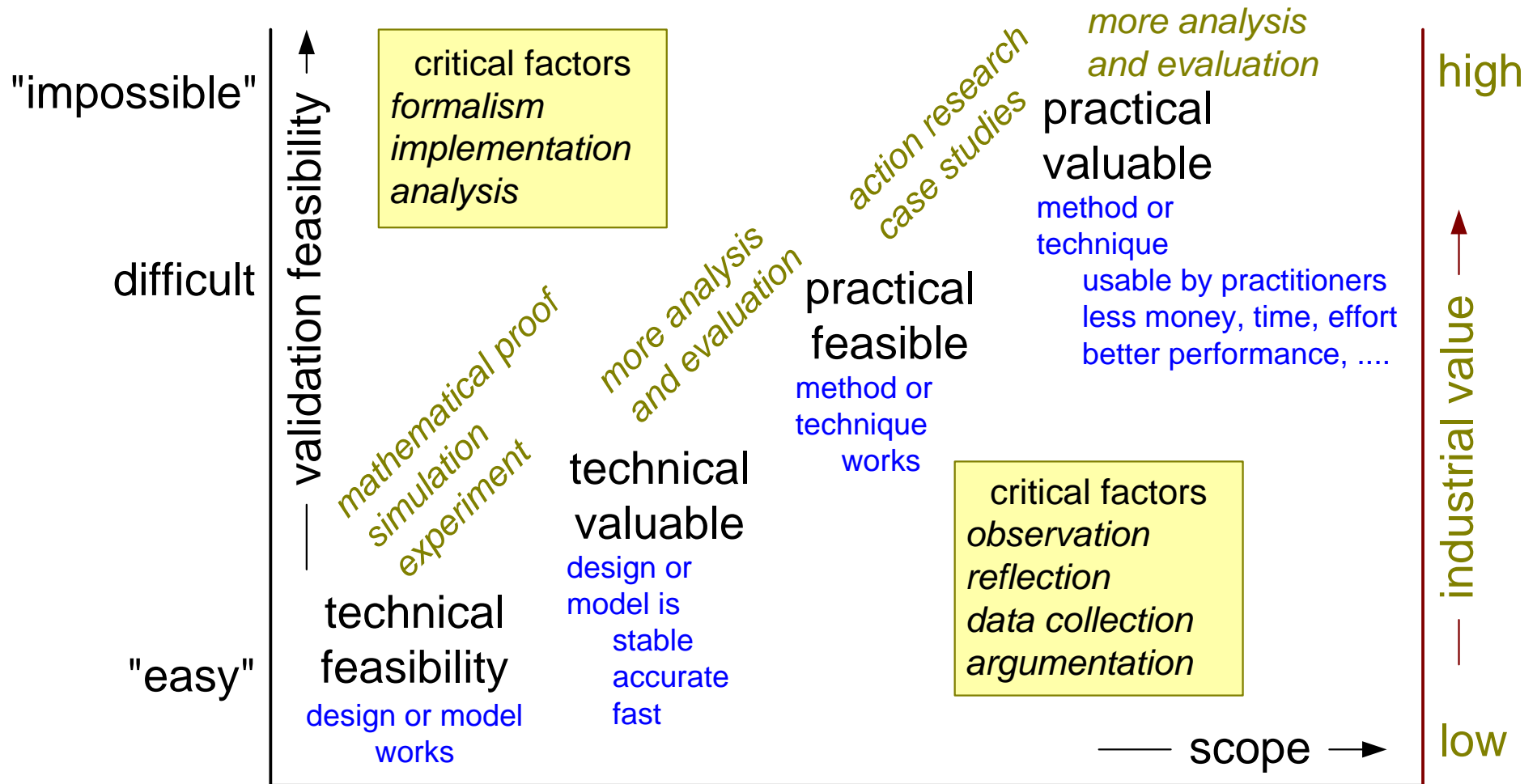


# Moving in the *meta* direction

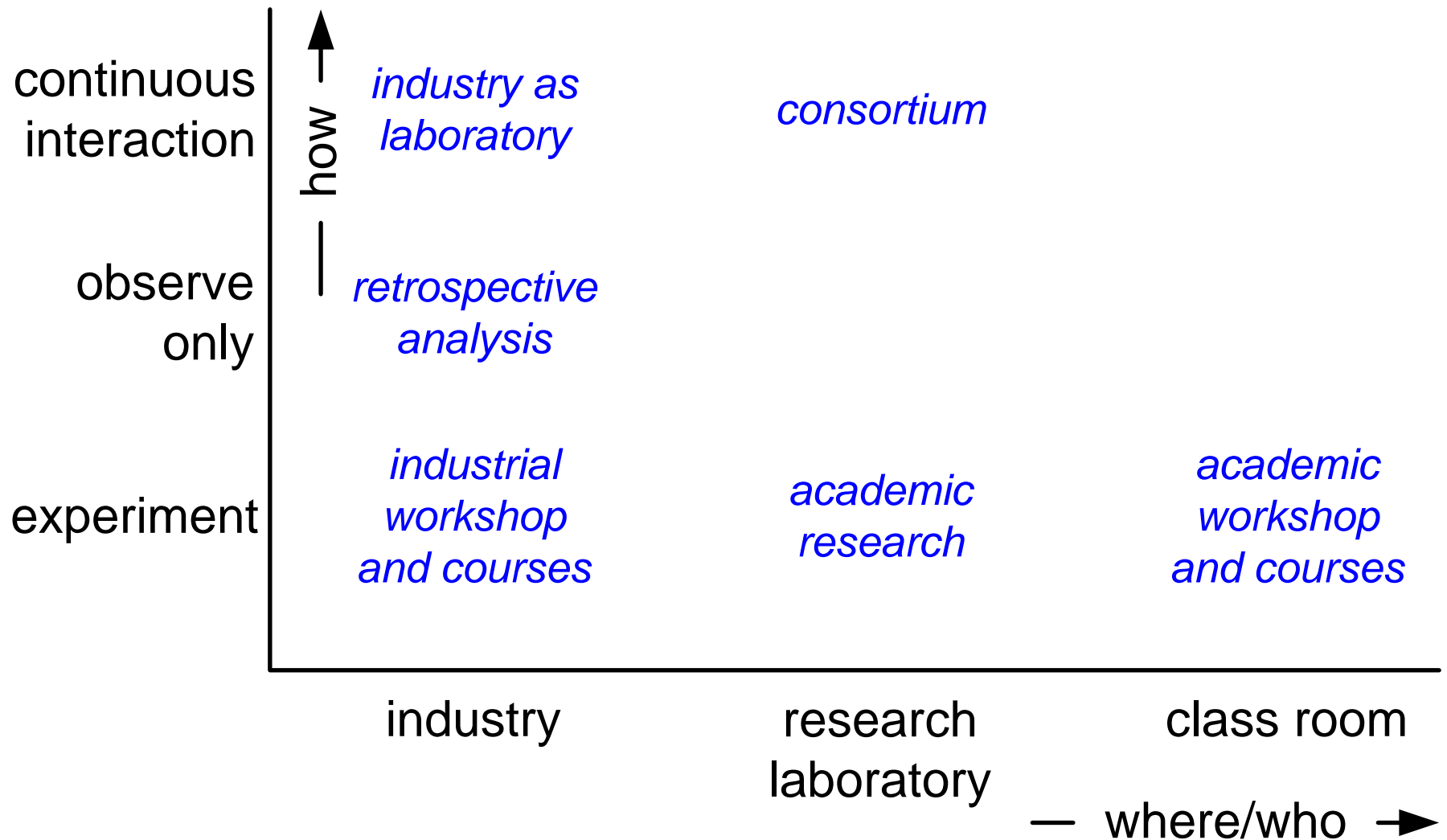




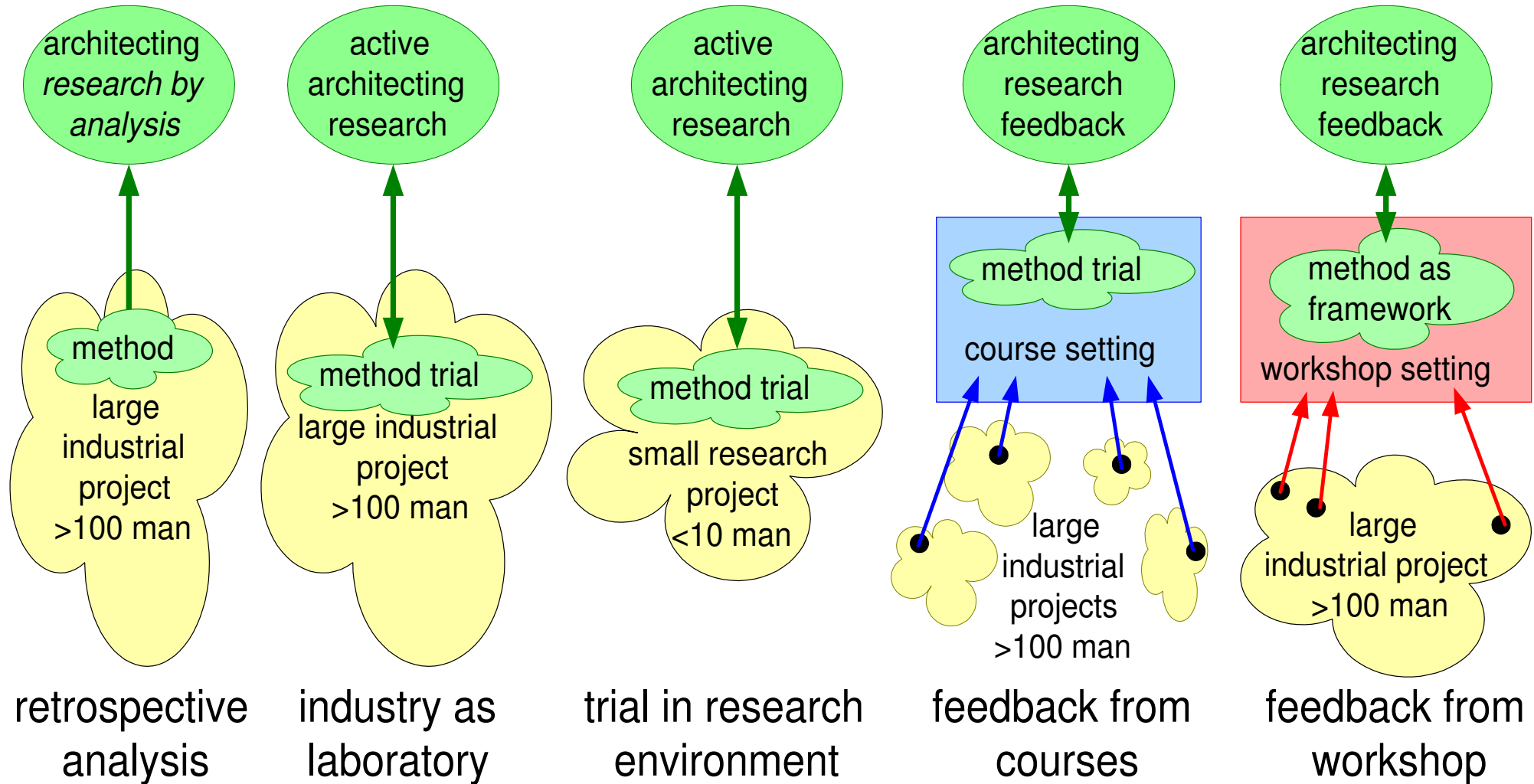
# Scope versus Feasibility and Value



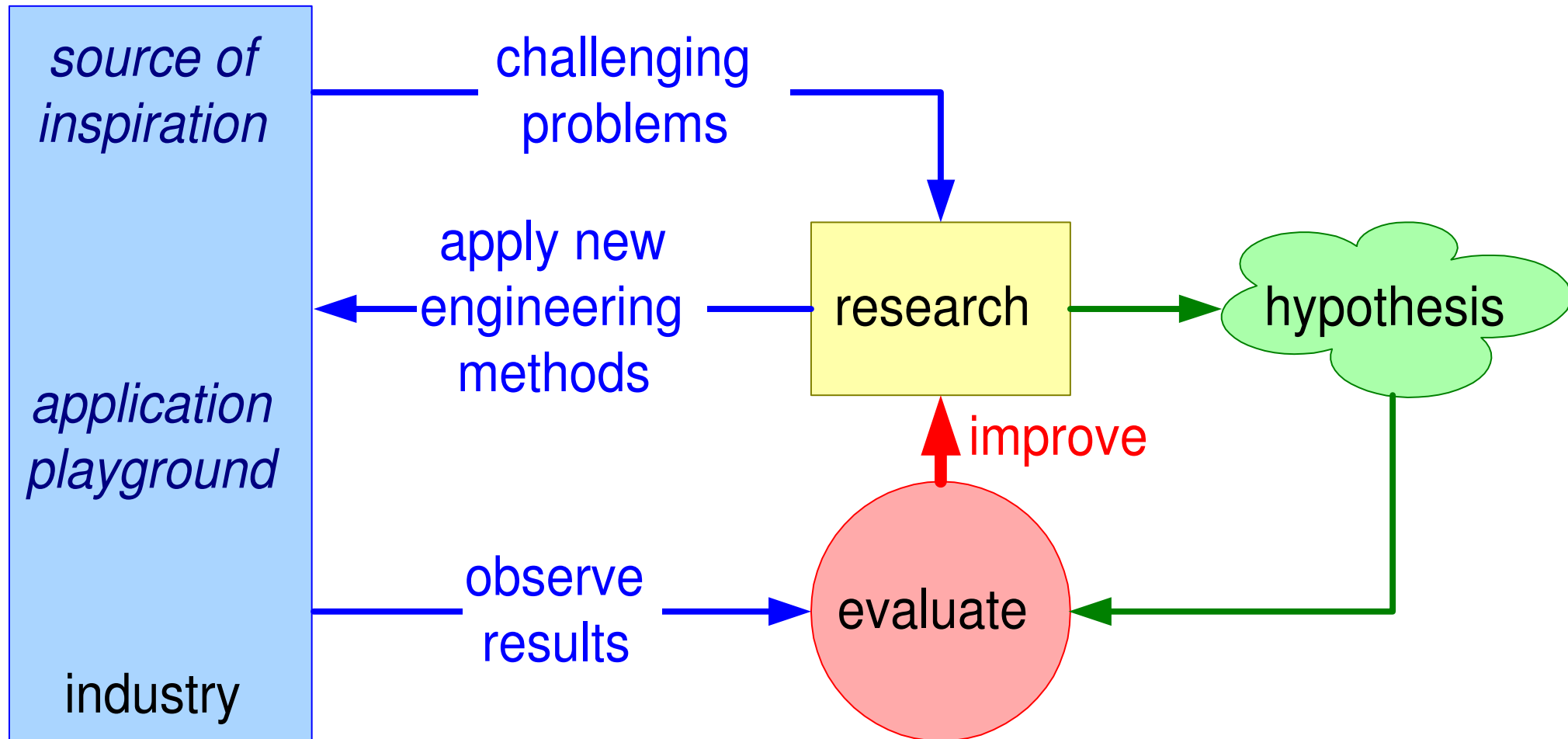
# Different Research Methods

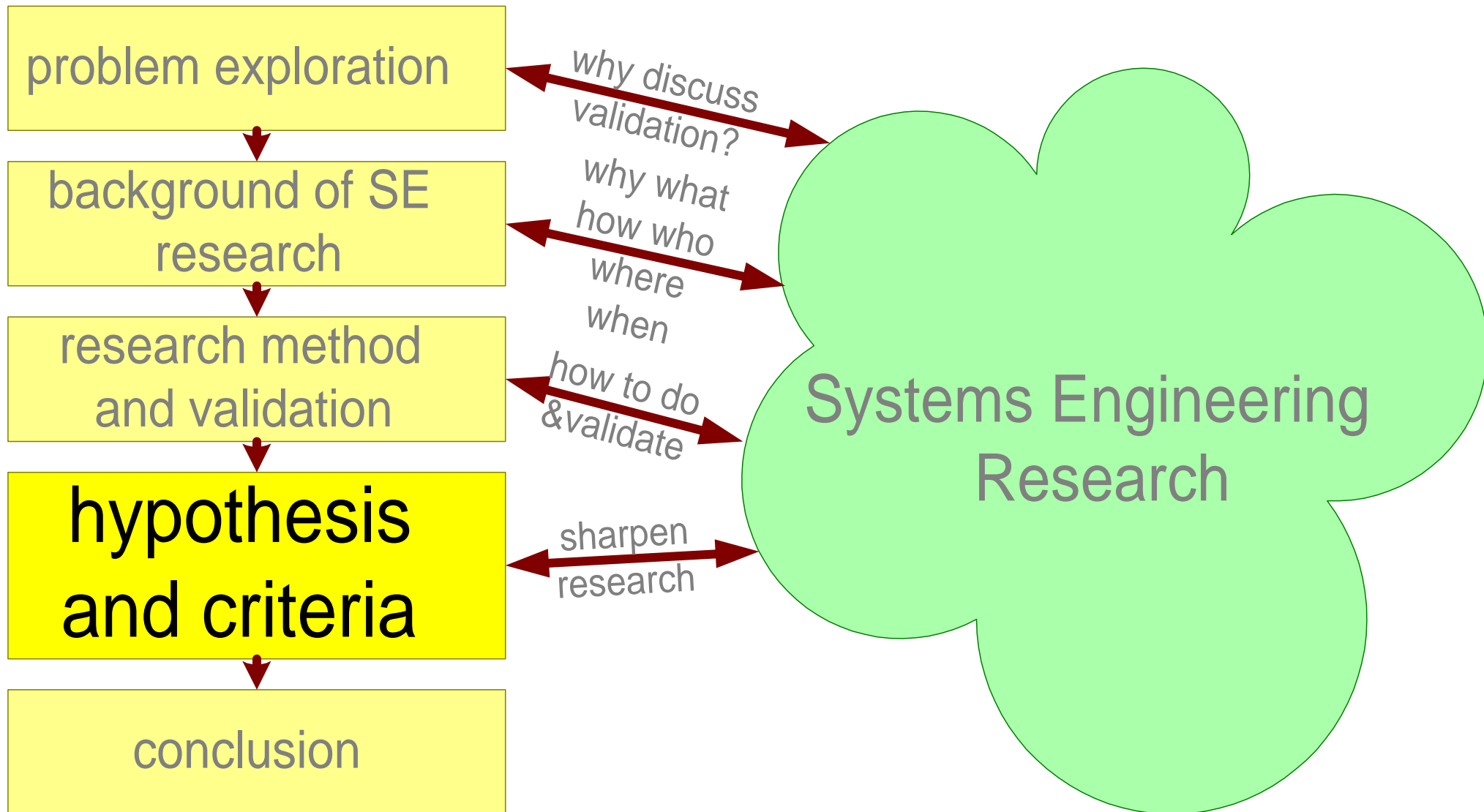


# Different Research Methods (2)

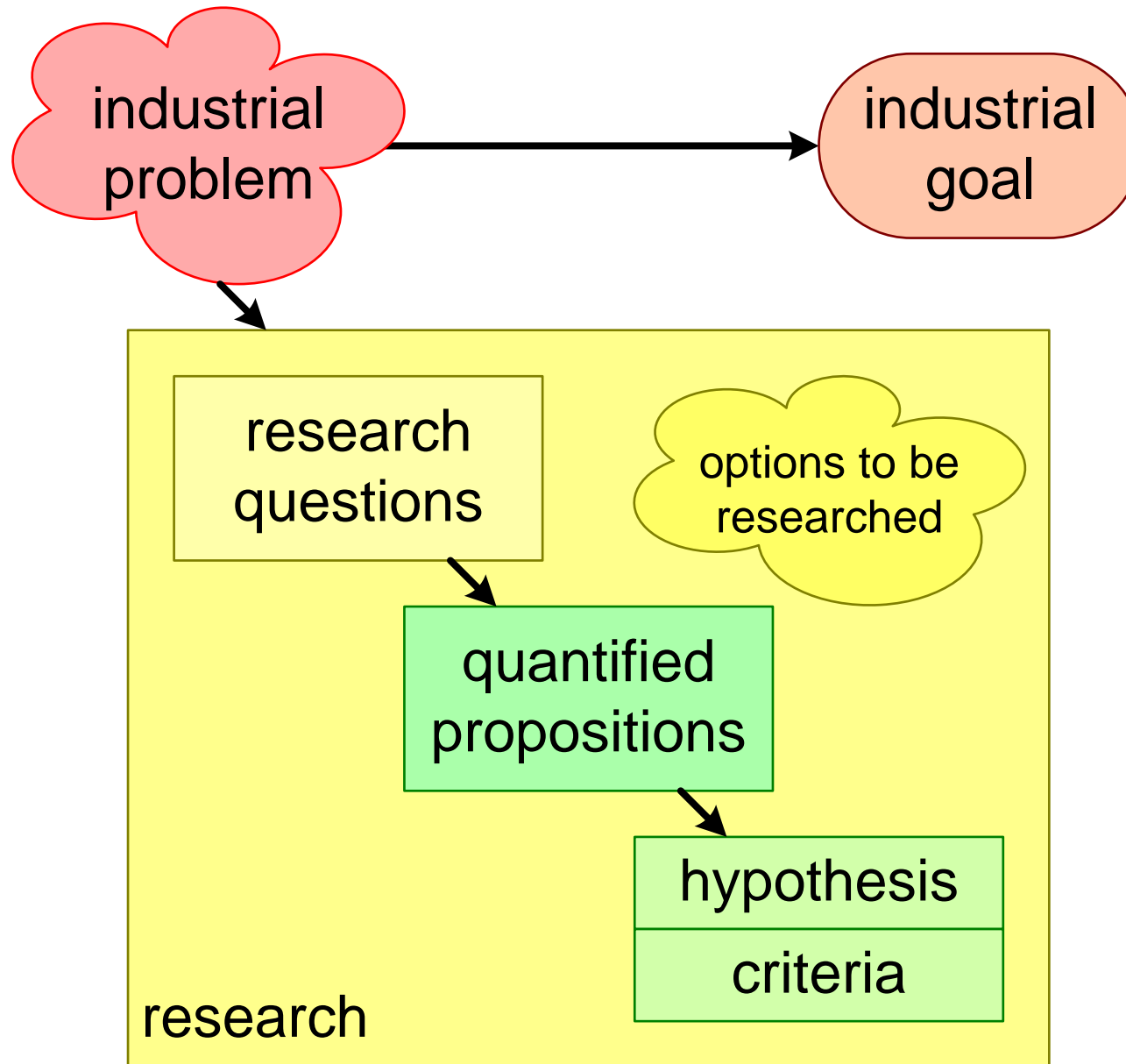


# Industry as Laboratory



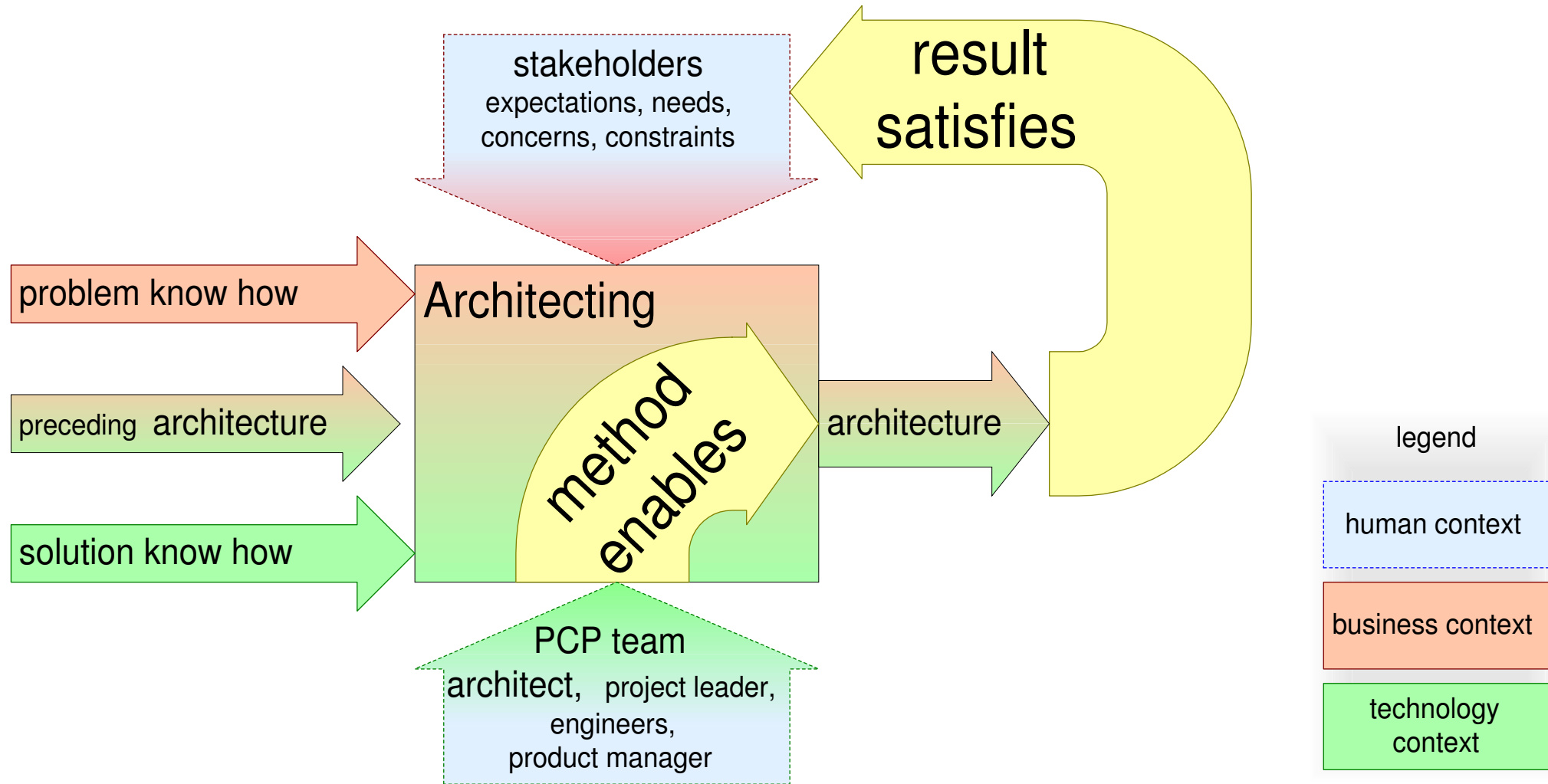


# From Industrial Problem to Validated Research

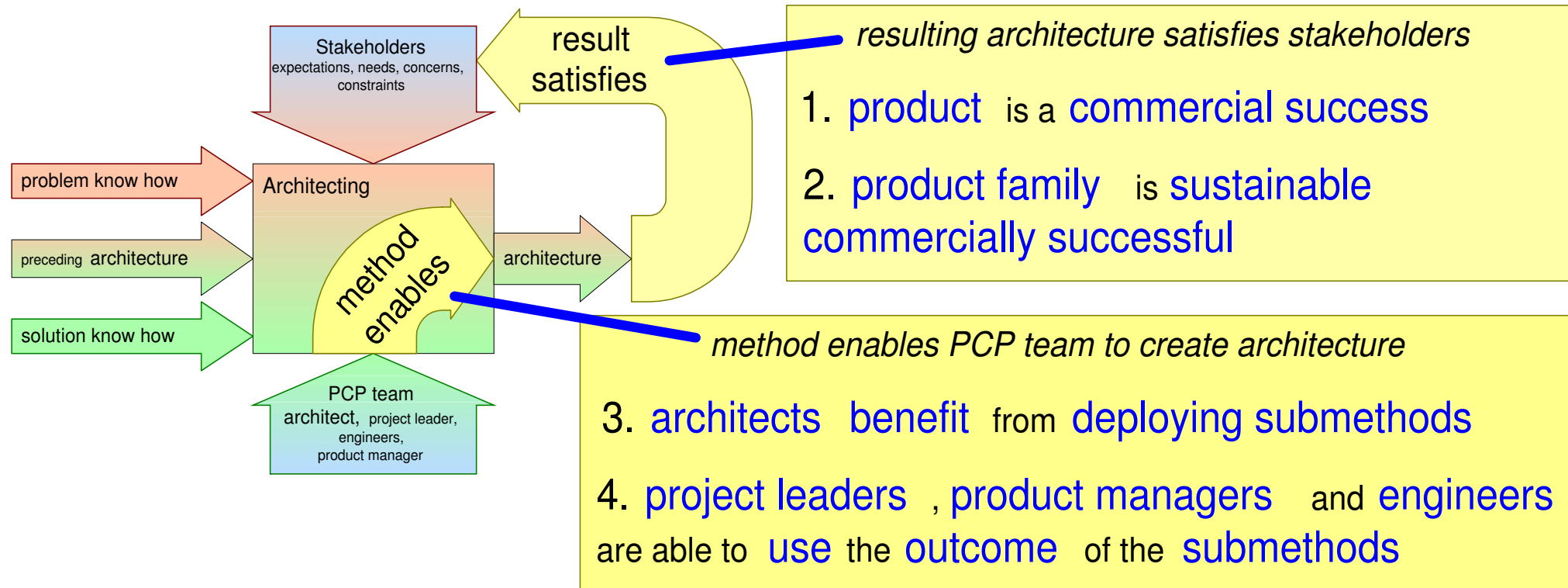


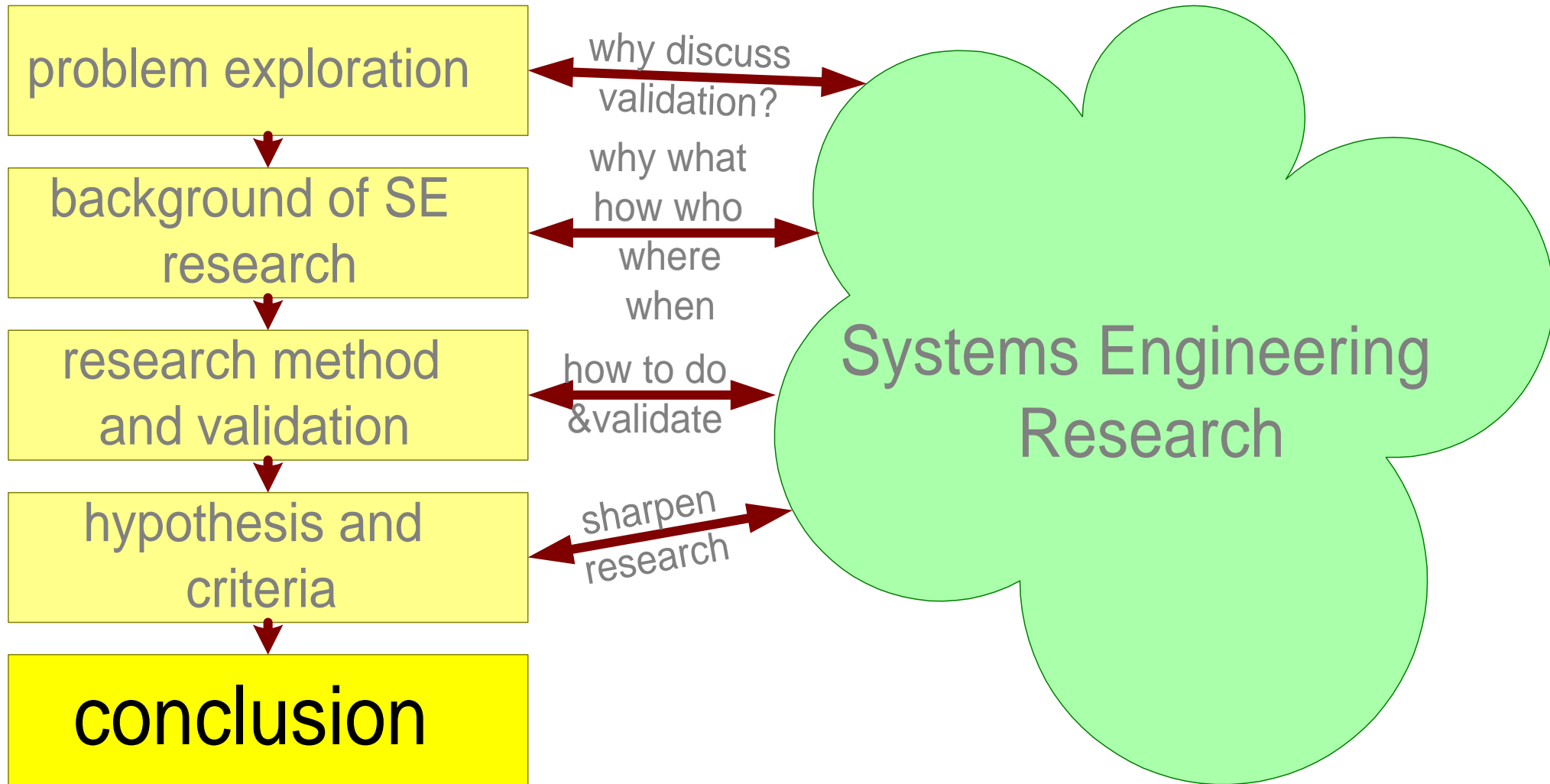


# Successful architecting and architecting method



# From hypothesis to criteria





# The Final Result

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

theory

casus (problem, goal, context)

experiment

analysis

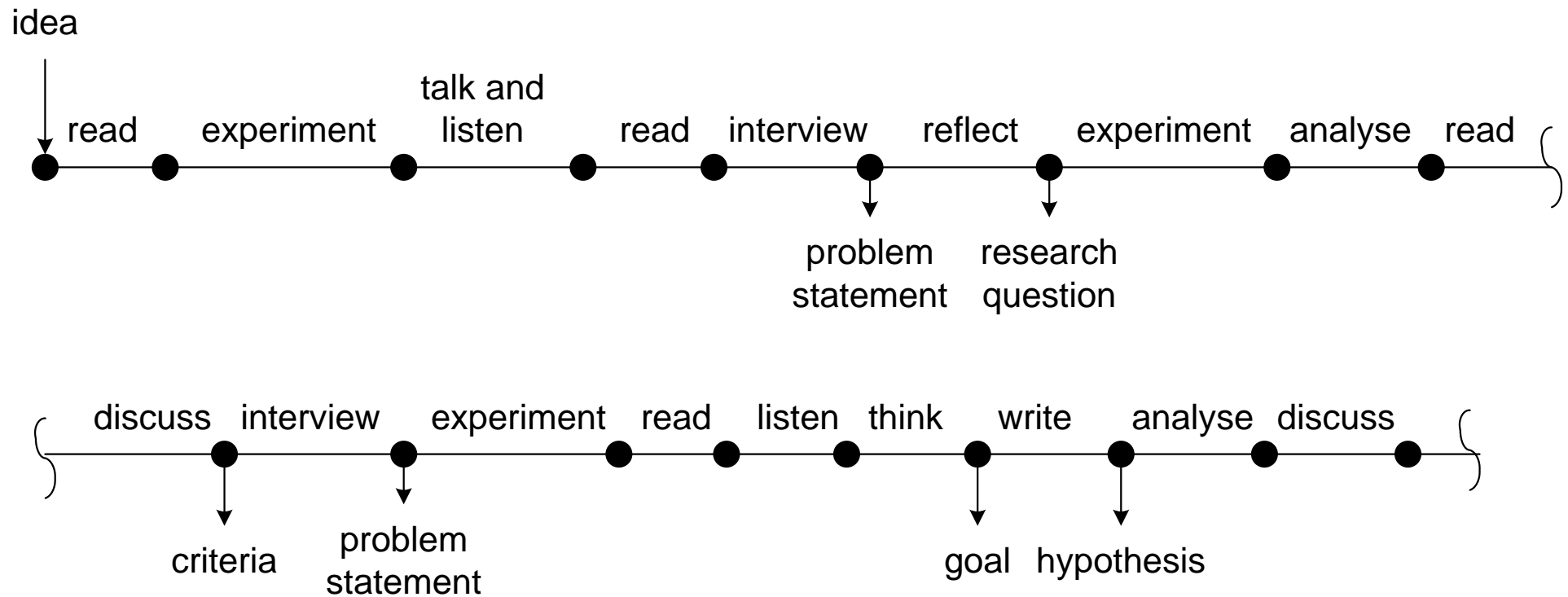
*core*

evaluation, validation

conclusion, recommendations

*closing*

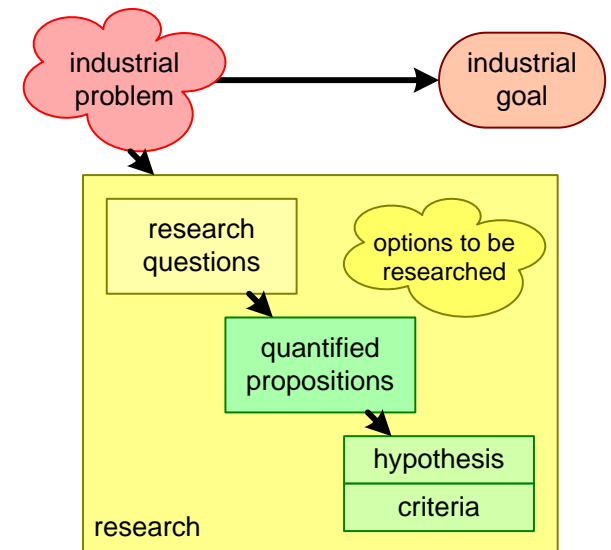
# and the Chaotic Route



*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:

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- “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

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- “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>