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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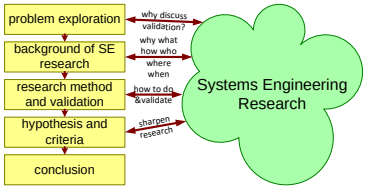
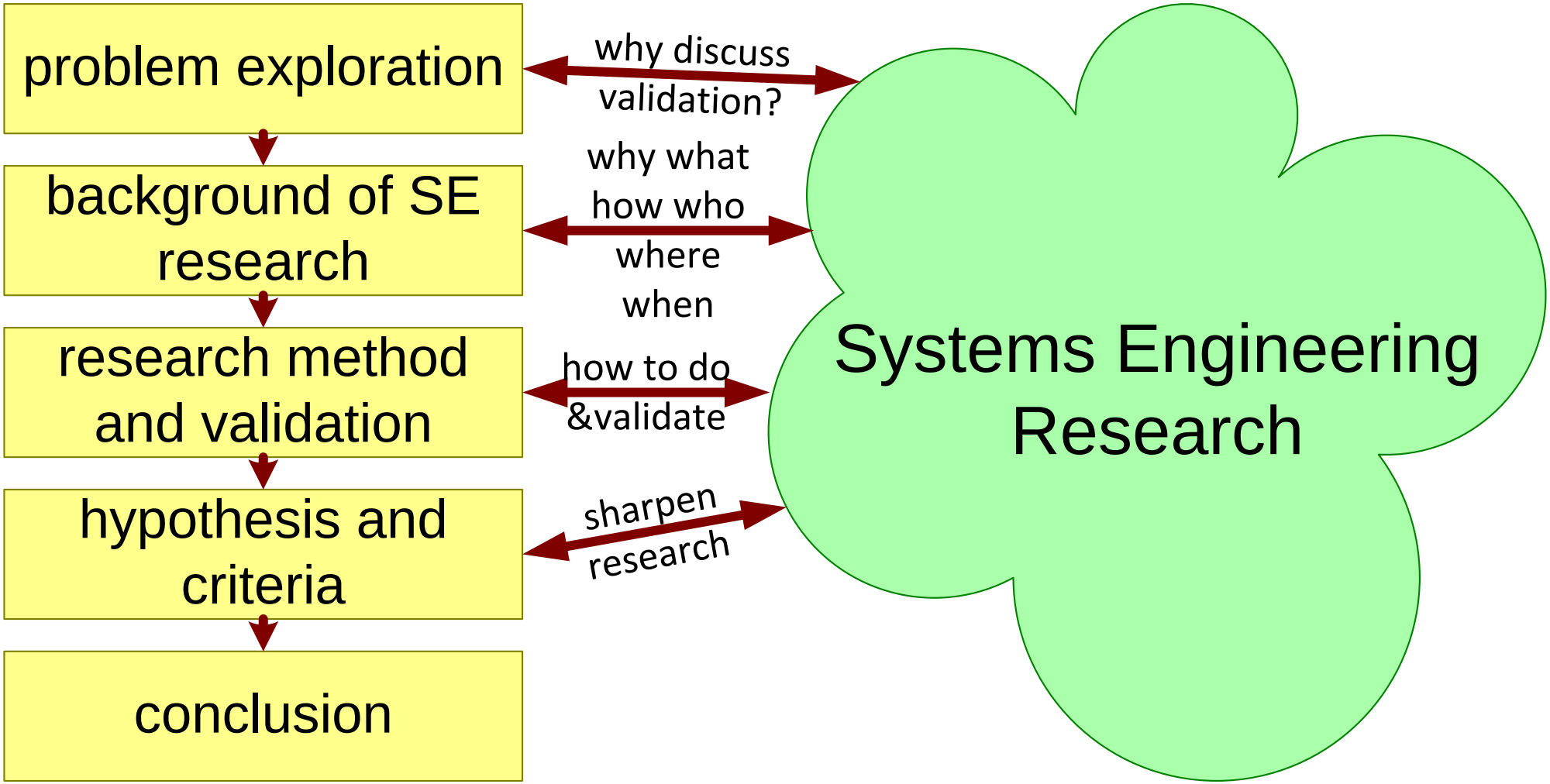
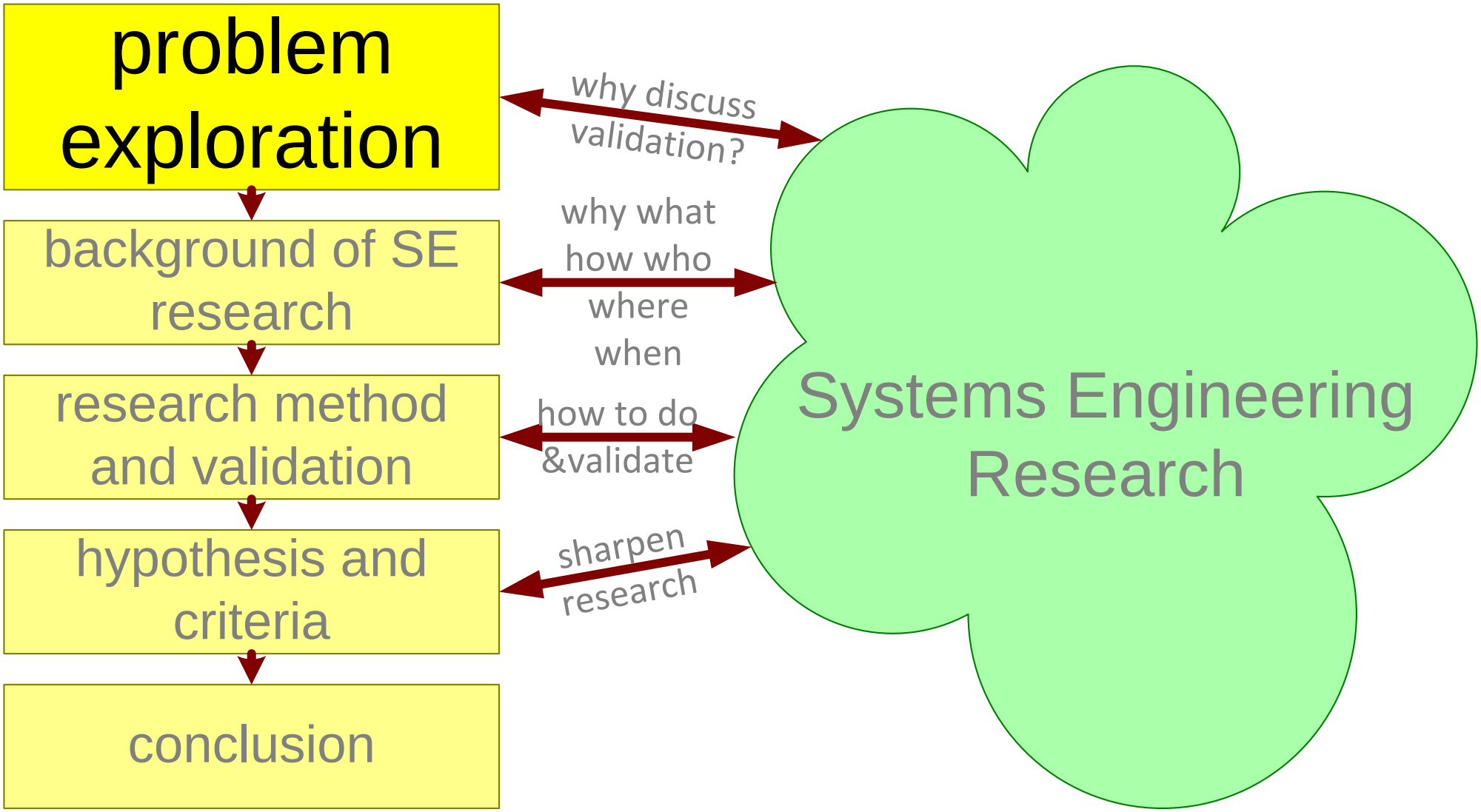
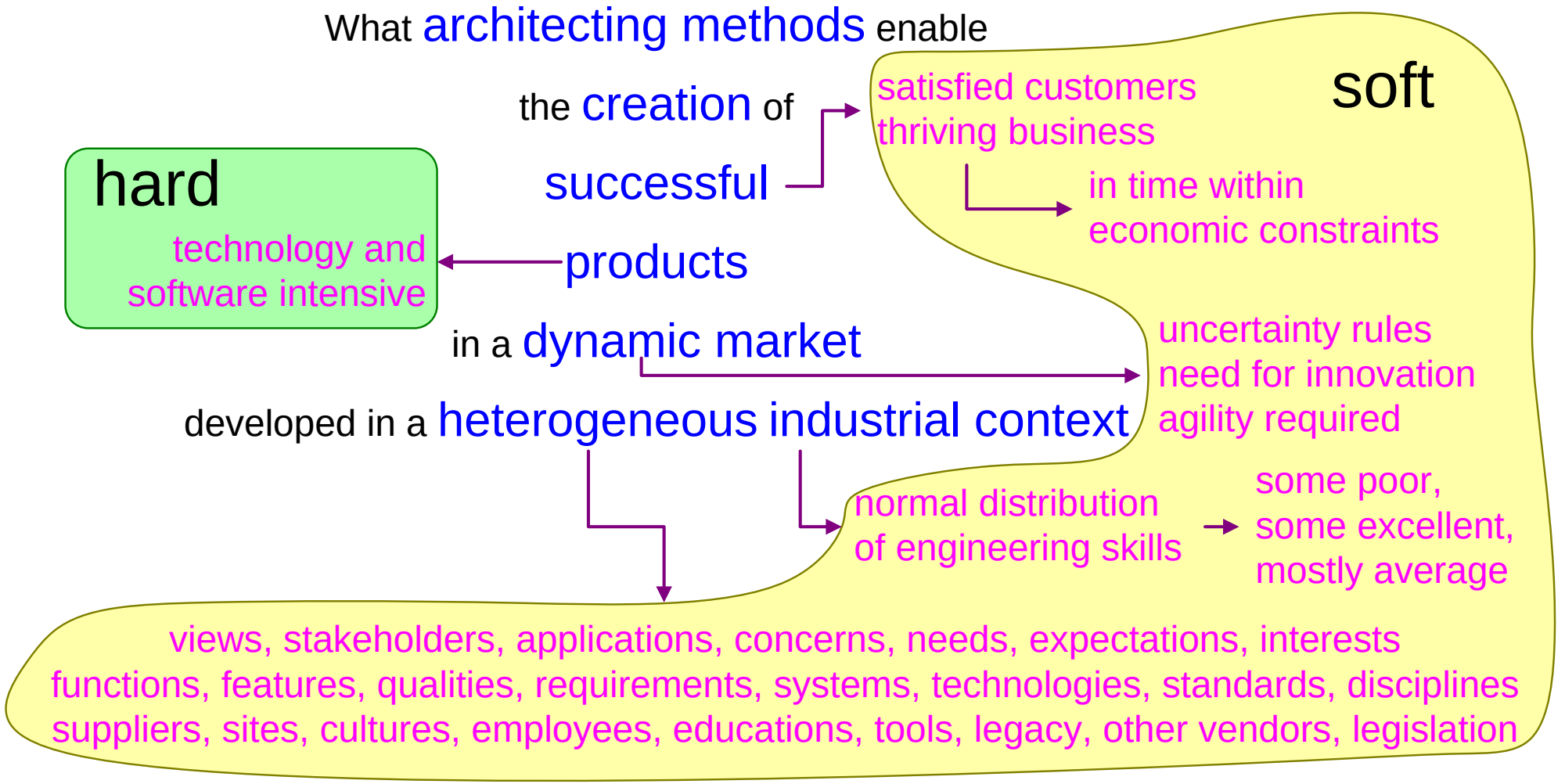


Figure Of Contents™

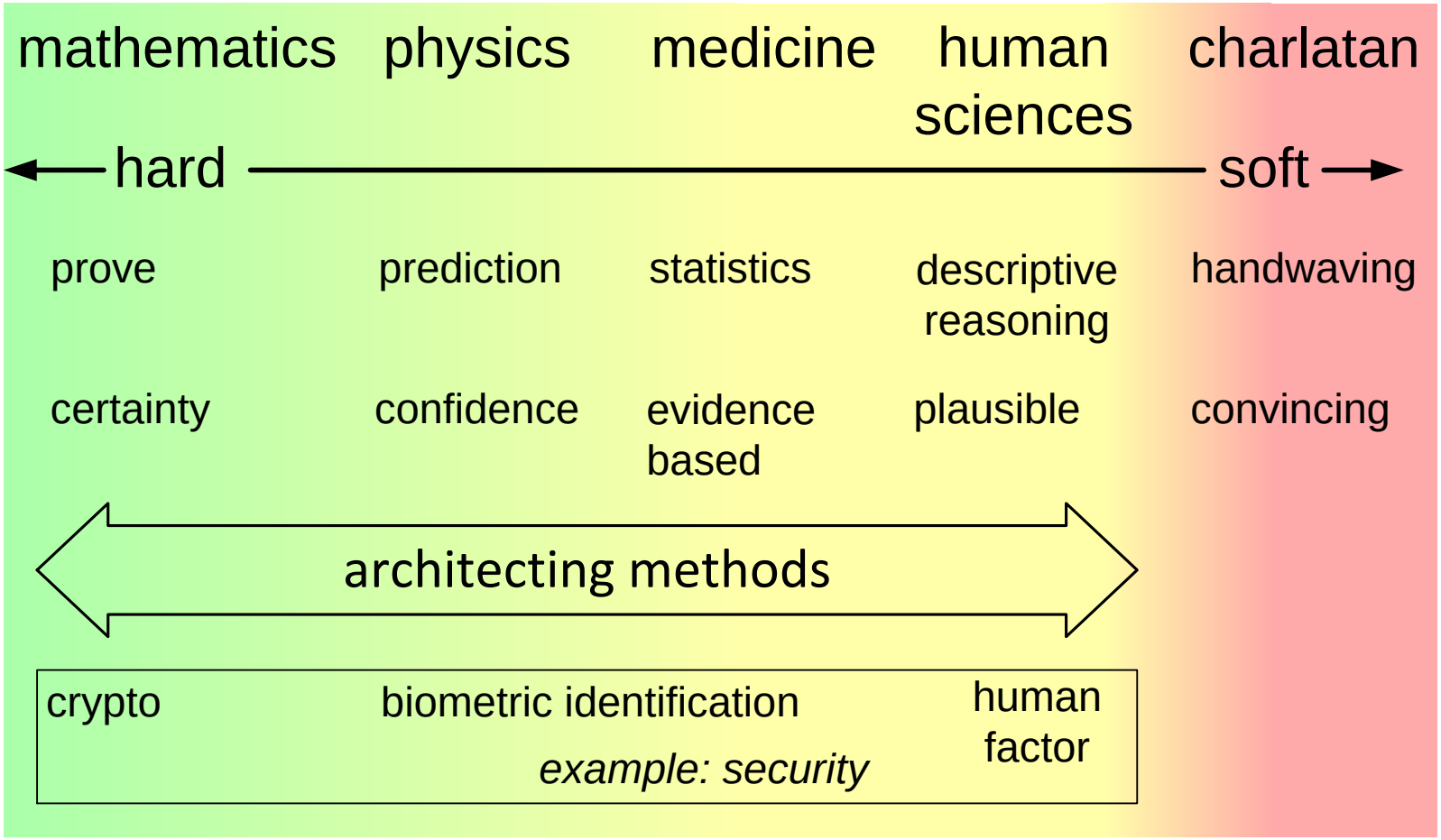


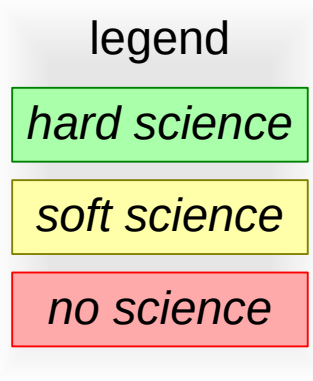

problem exploration
background of SE research
research method and validation
hypothesis and criteria
conclusion
why discuss validation?
why what how who where when
how to do &validate
sharpen research
Systems Engineering Research

Reflection from my PhD thesis



Spectrum of sciences





Problem Statement

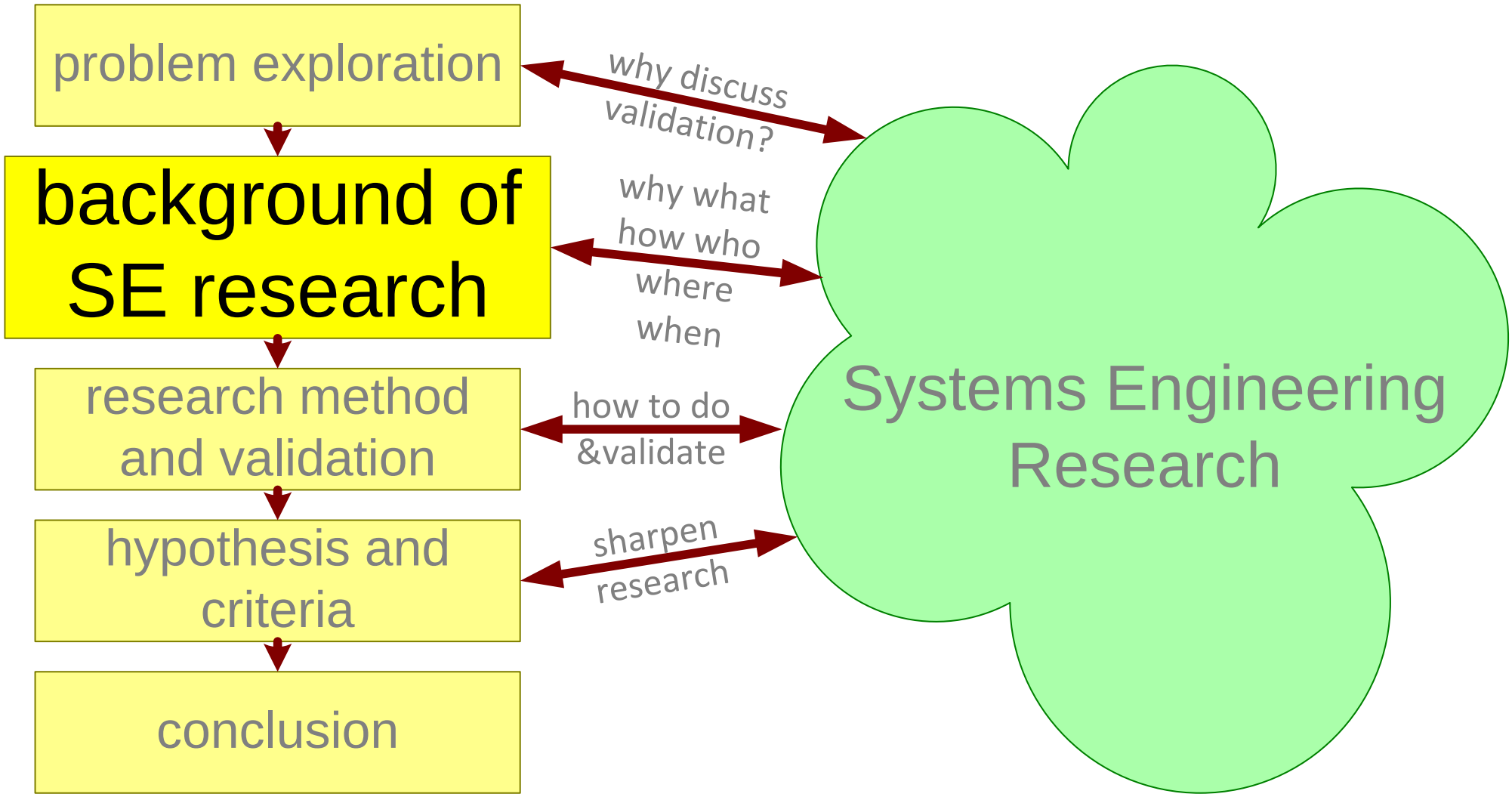
How do we validate

Systems Engineering

research

given that most context factors are

soft and uncontrolled?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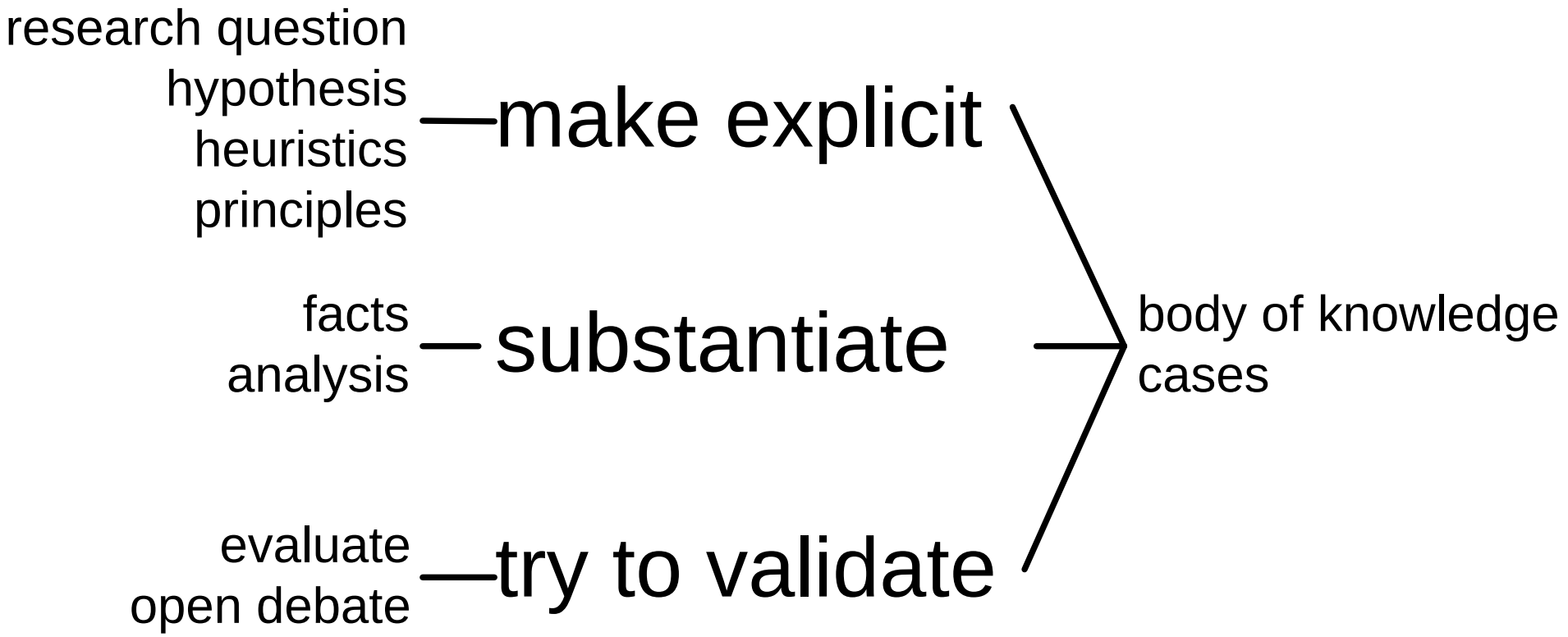
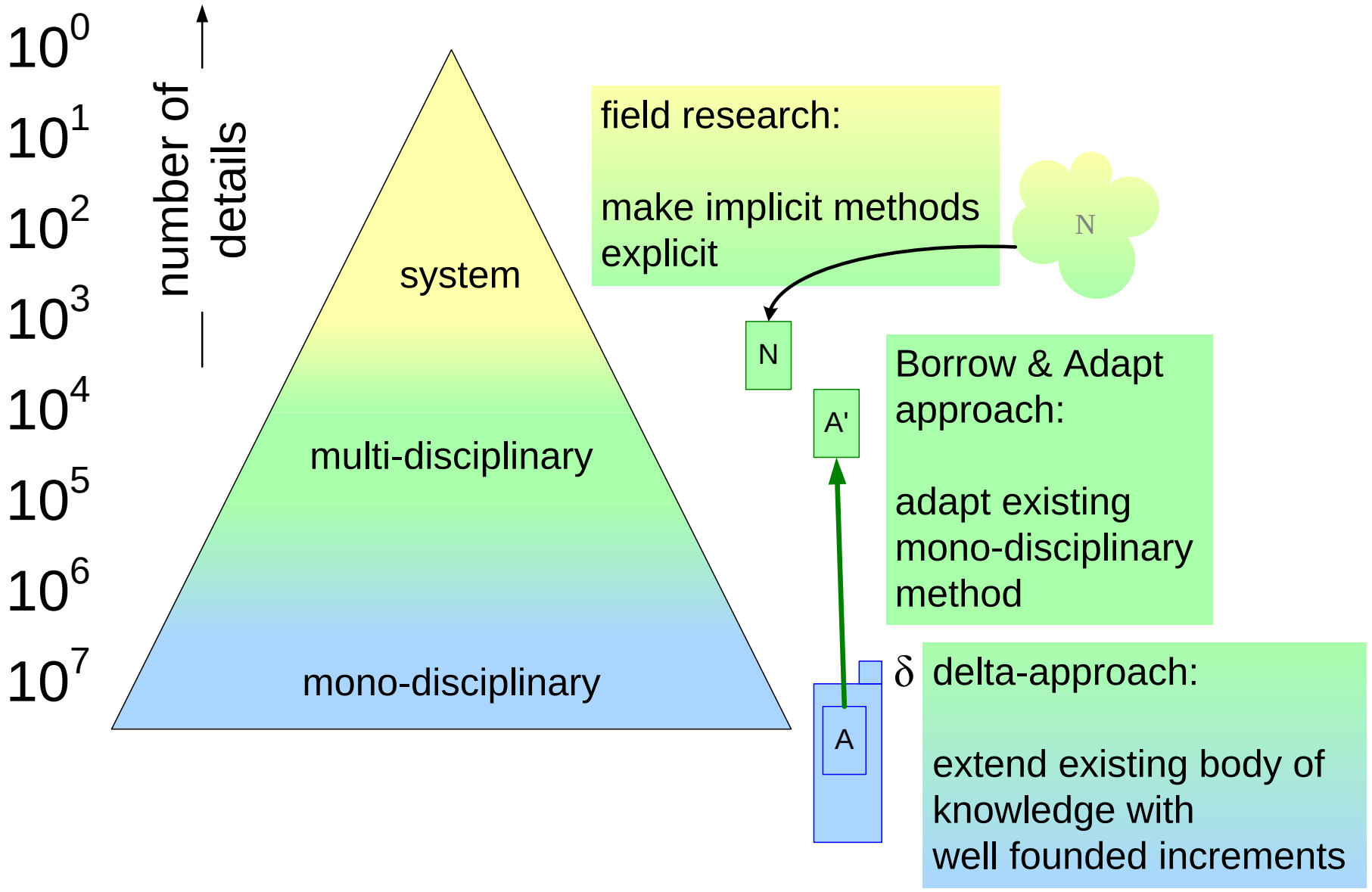
Soft problems can be approached with a scientific attitude

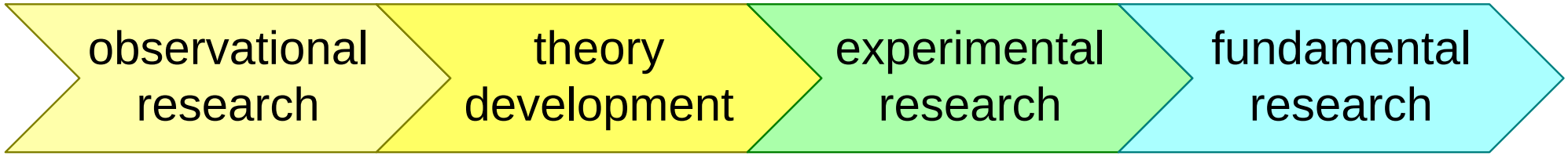
soft is not in conflict with scientific attitude



Different Types of Research

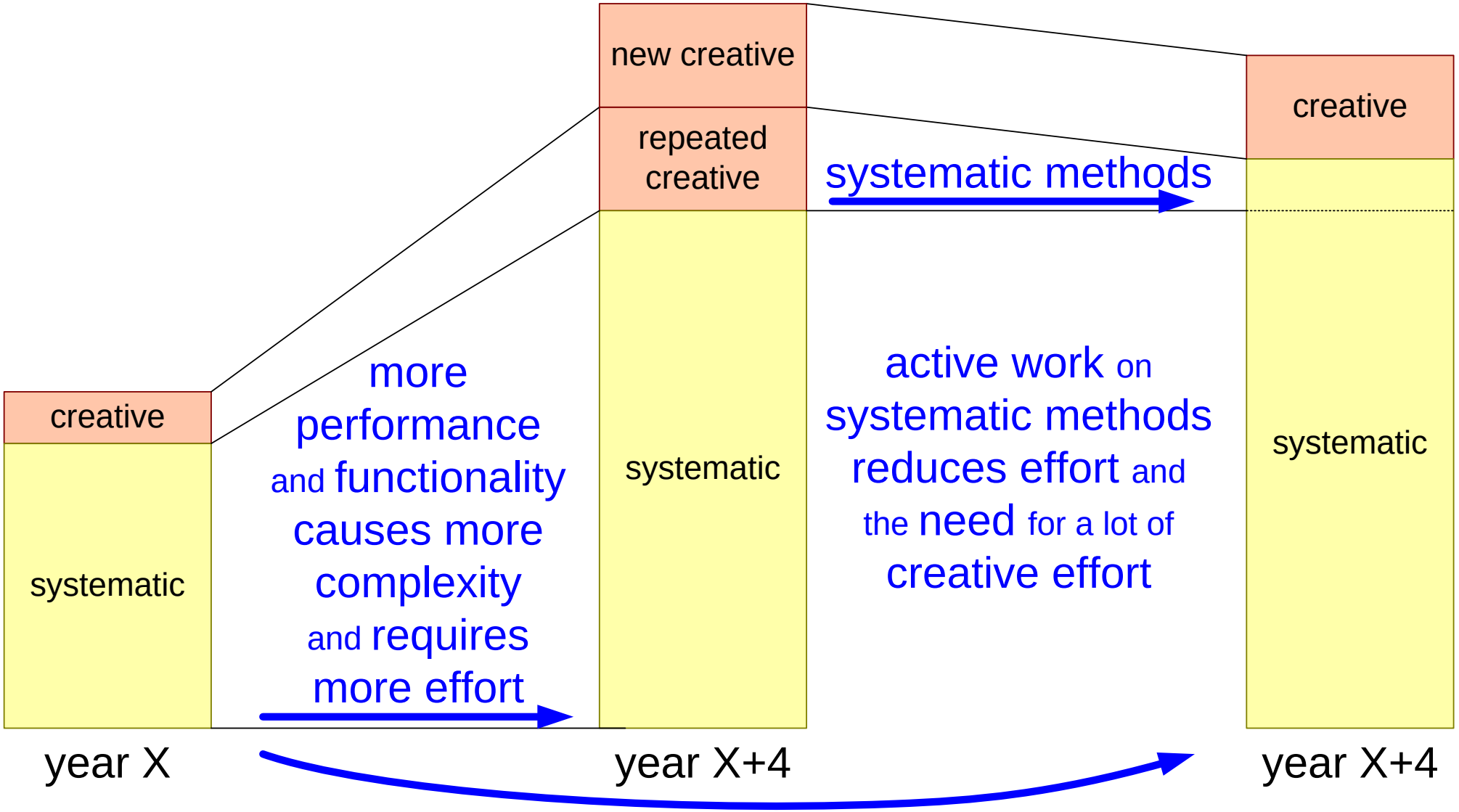


And another Dimension of Research Types

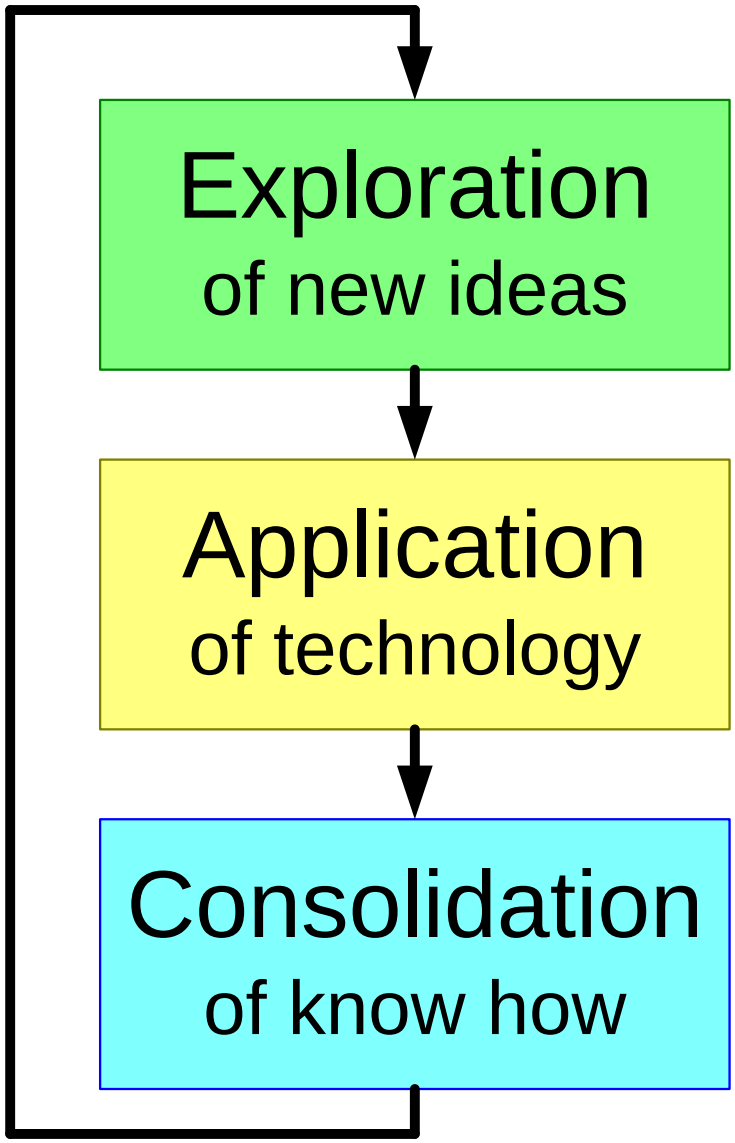


observational research	theory development	experimental research	fundamental research
best practices	metrics	theory evaluation	optimizations
heuristics	formalisms	theory evolution	rigorous proofs
classification	techniques	fundamentals	first principle based
ontology	models	principles	
	methods	methodologies	

Systematic Know-how to cope with Growing Complexity



Technology Management Cycle

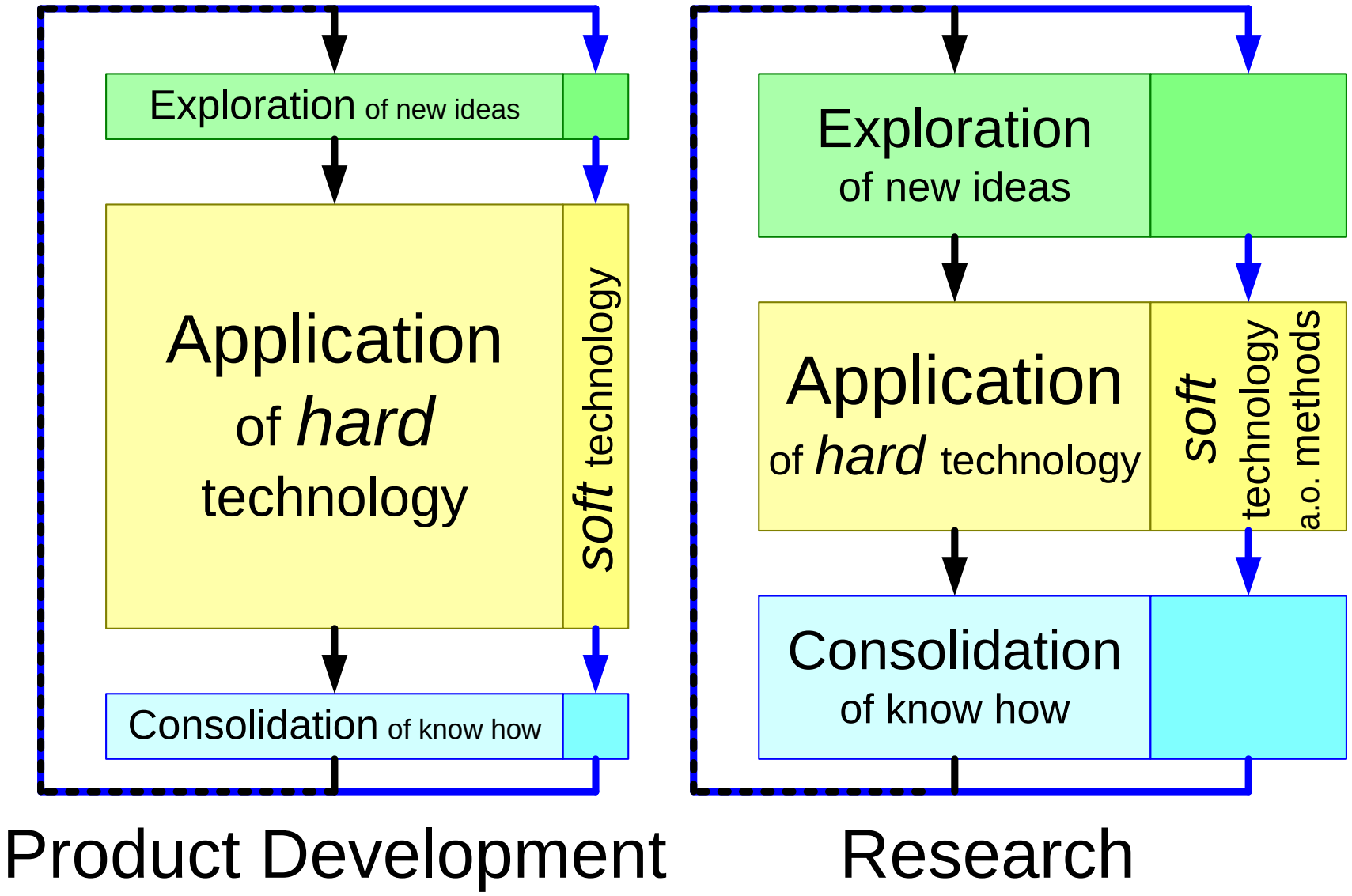


Literature search
Creative option generation
Try out

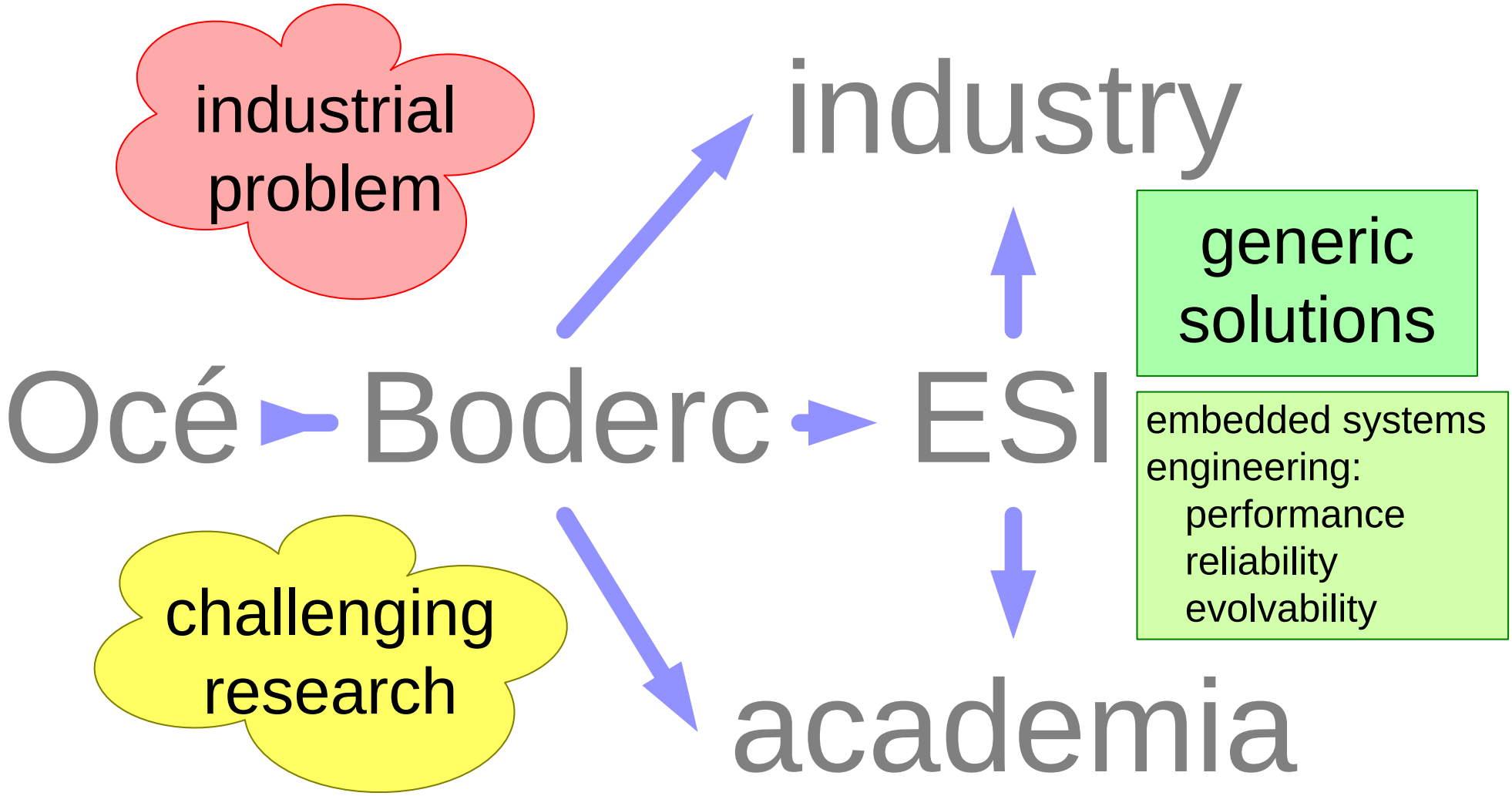
Industry as laboratory

Reflection
Write articles
Create courses

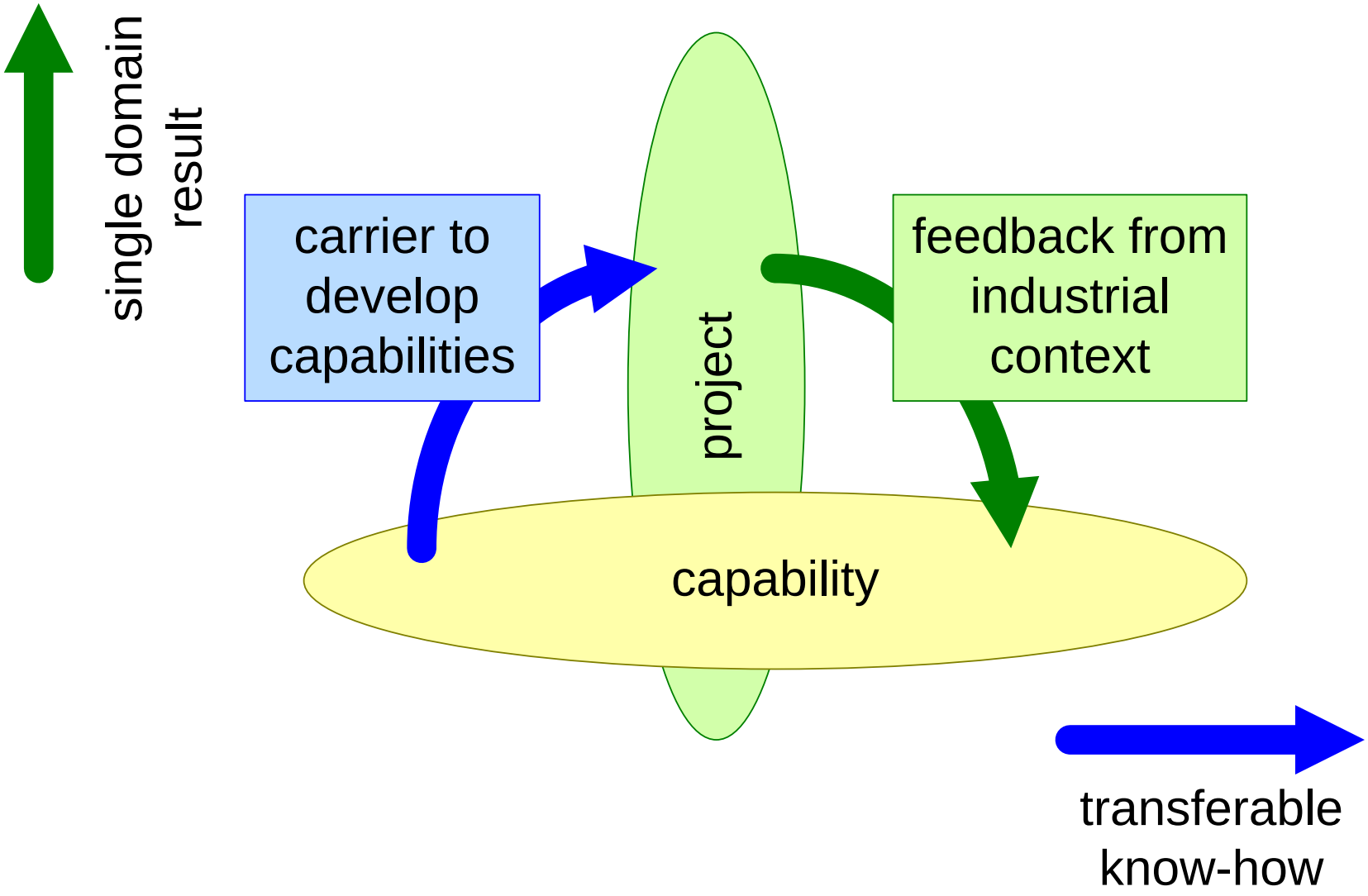
SE research requires application



Example Boderc Stakeholders



Project as Carrier for Capability Development



Methodology

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

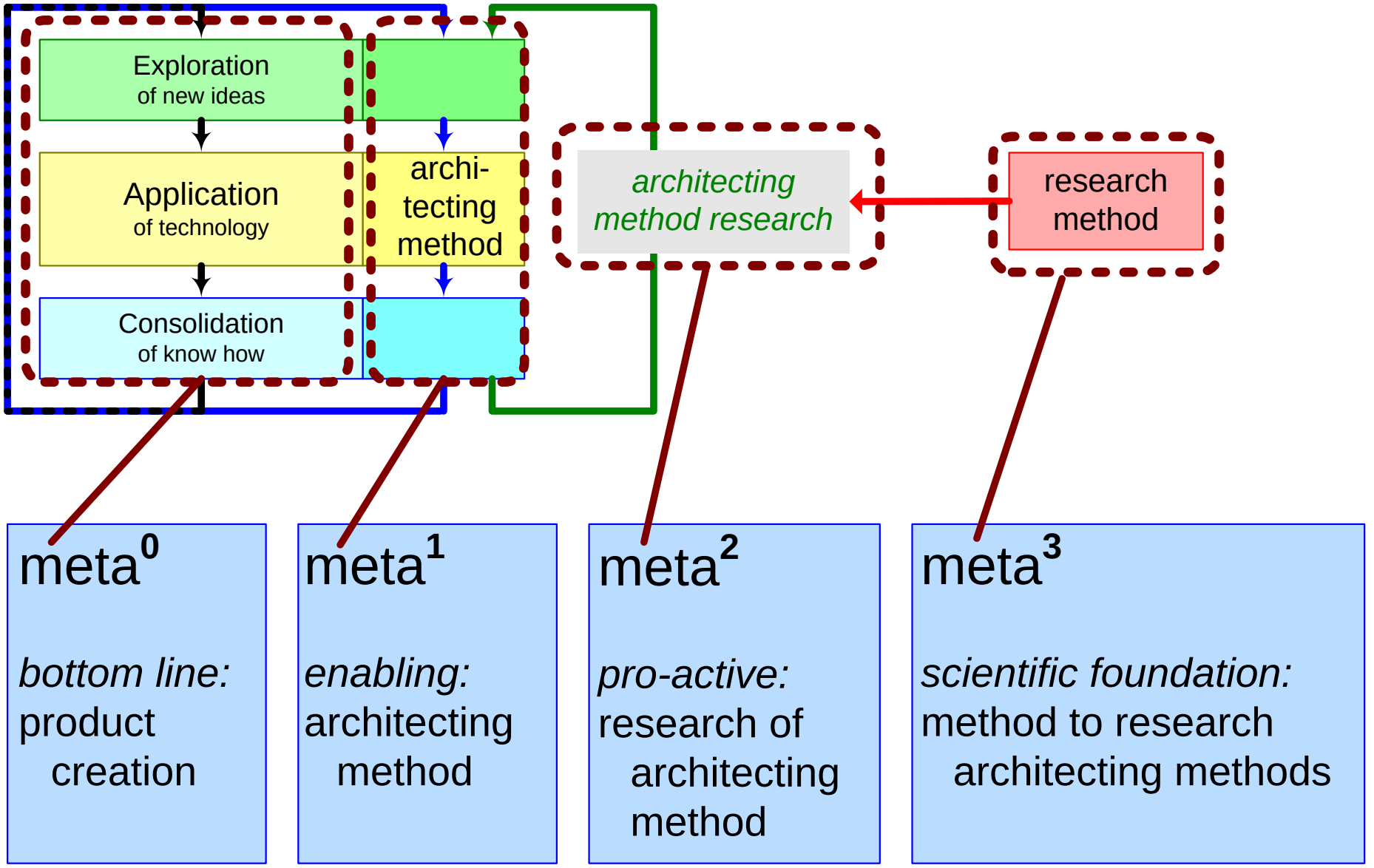
Models instantations of formalisms to understand, explore, optimize or verify specification or design

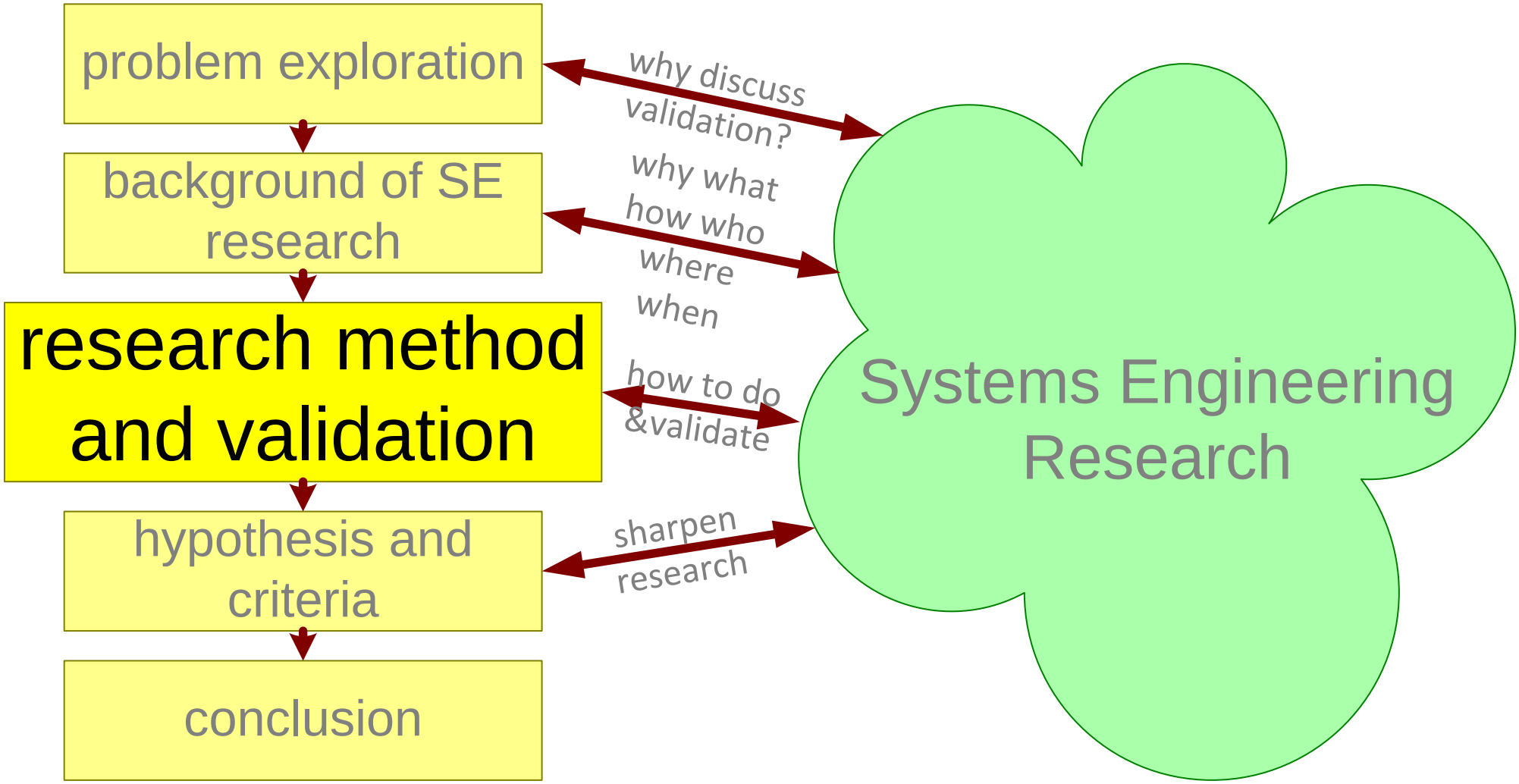
Techniques to get the required information from models: e.g. performance

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

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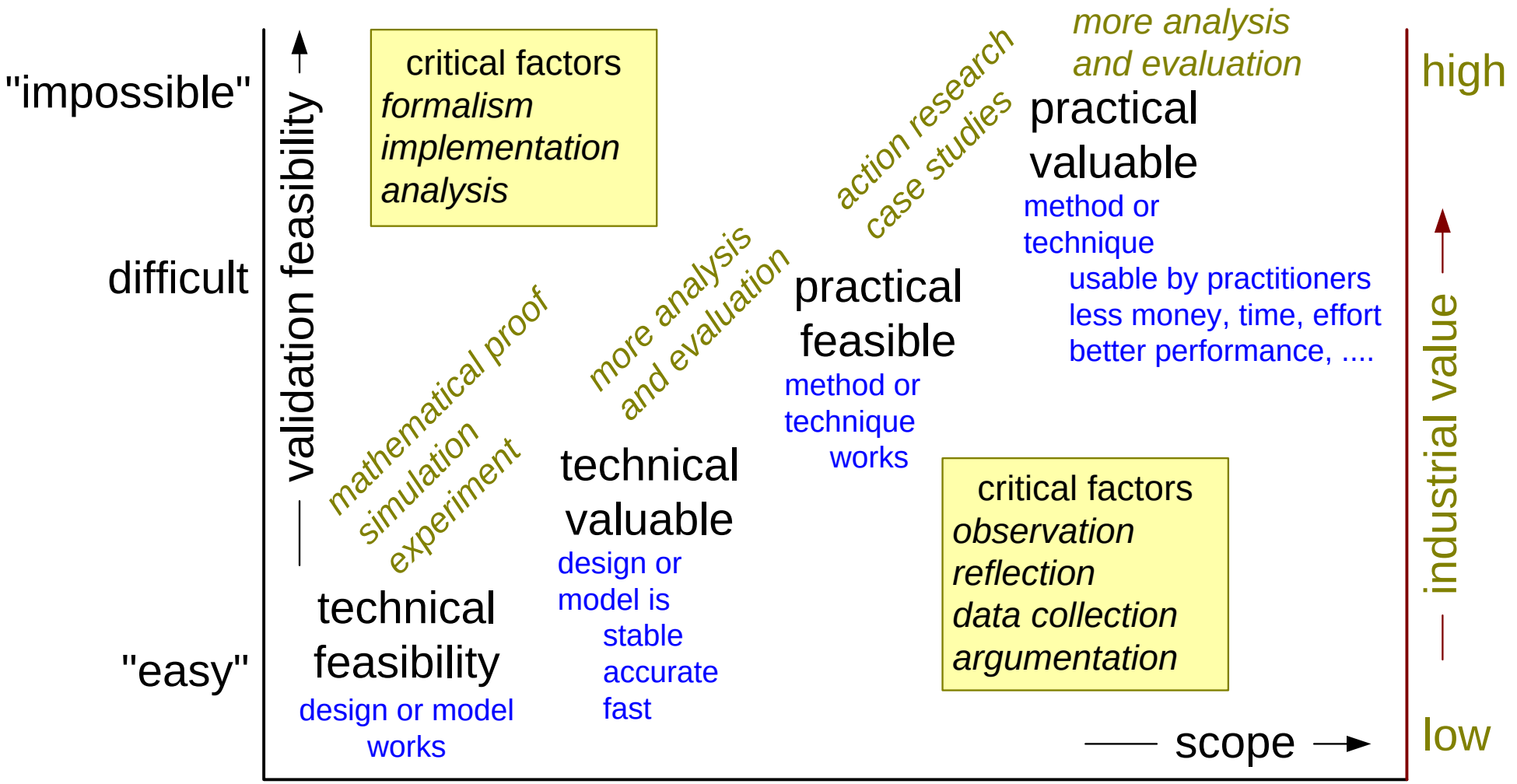
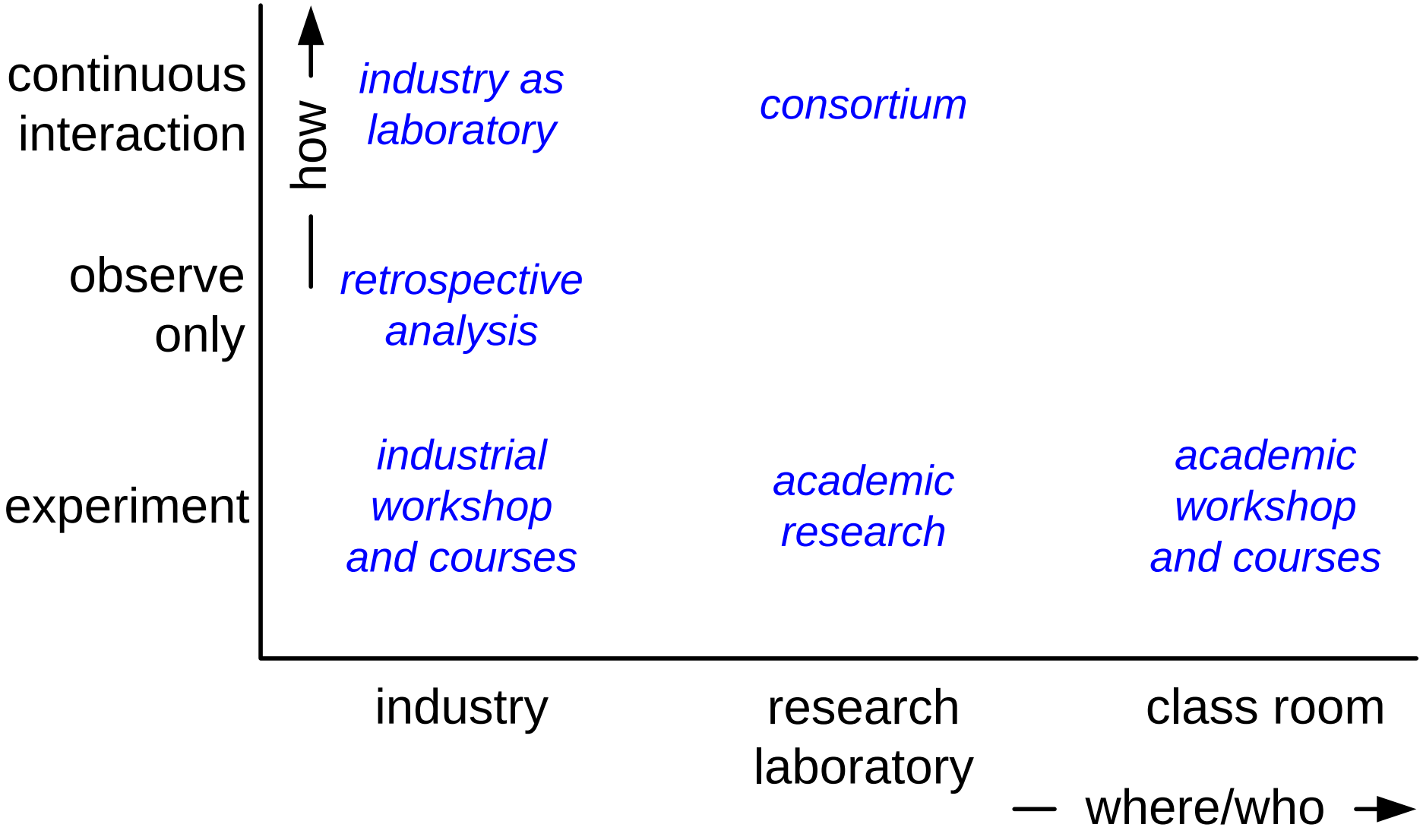
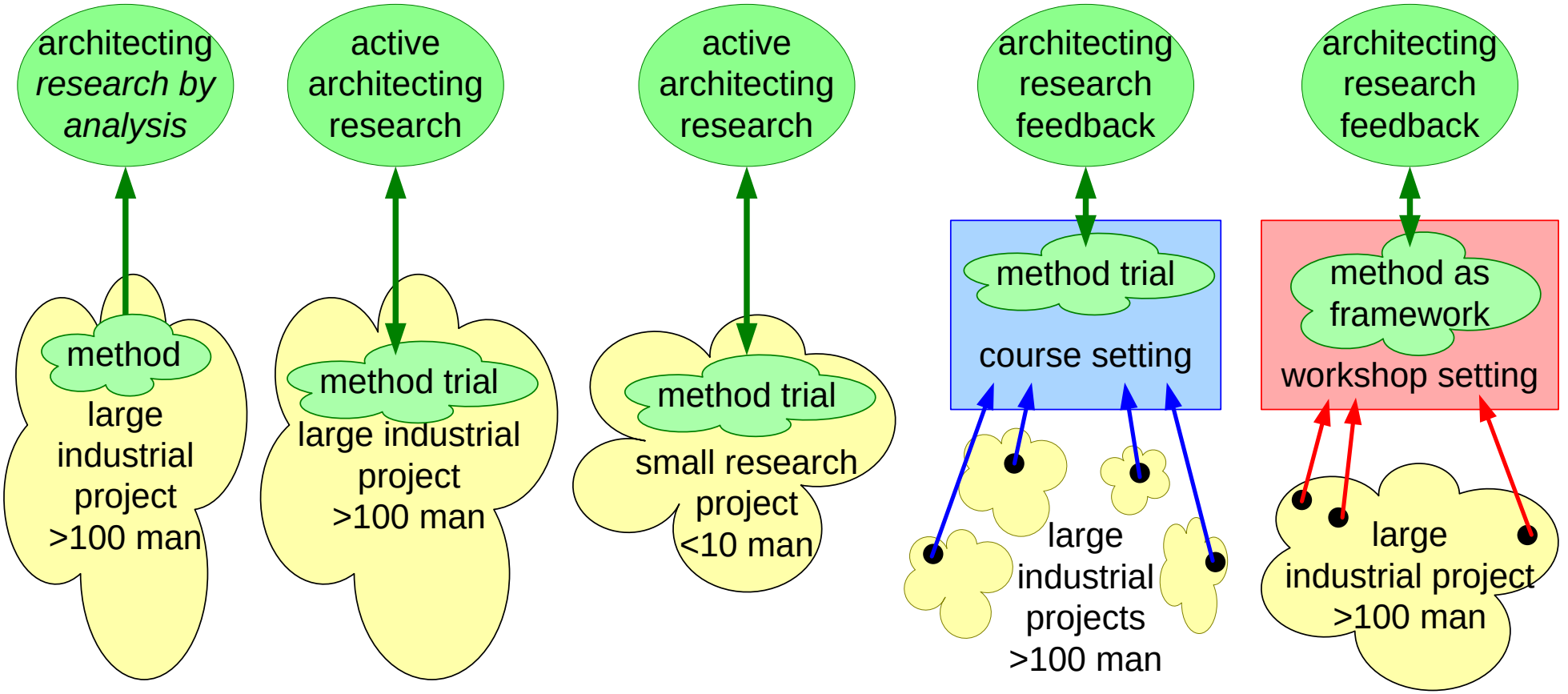
Scope versus Feasibility and Value



Different Research Methods

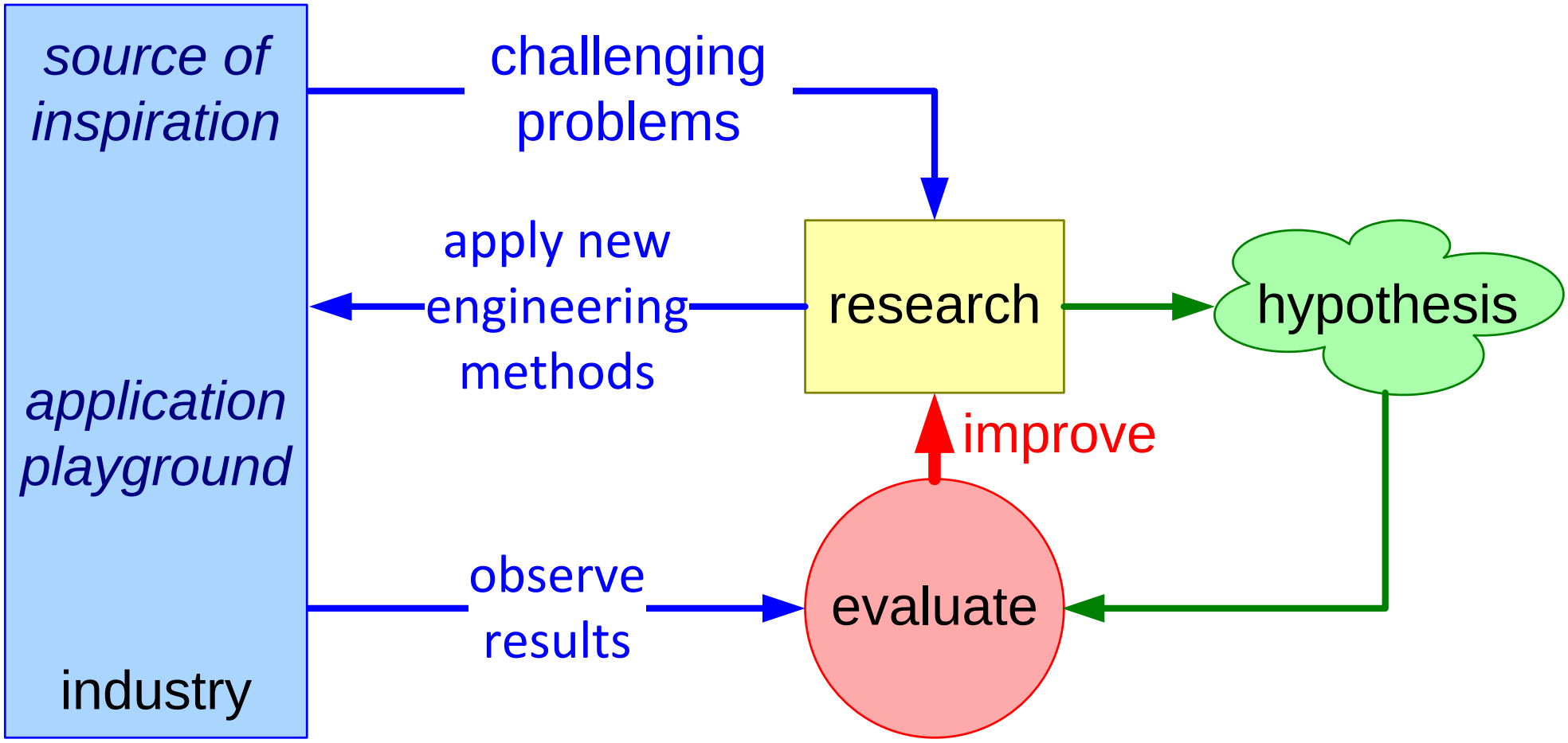


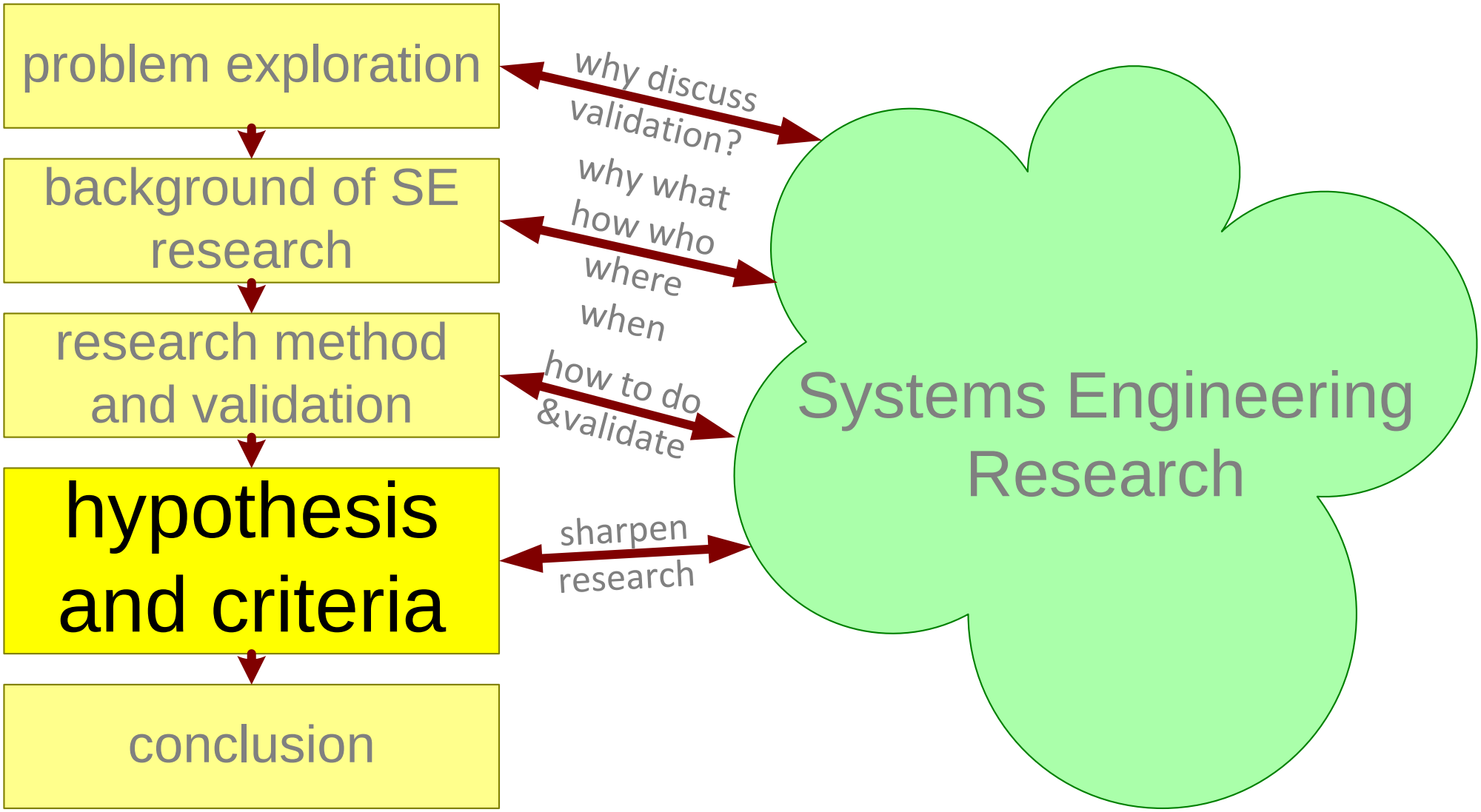
Different Research Methods (2)



retrospective analysis | industry as laboratory | trial in research environment | feedback from courses | feedback from workshop

Industry as Laboratory

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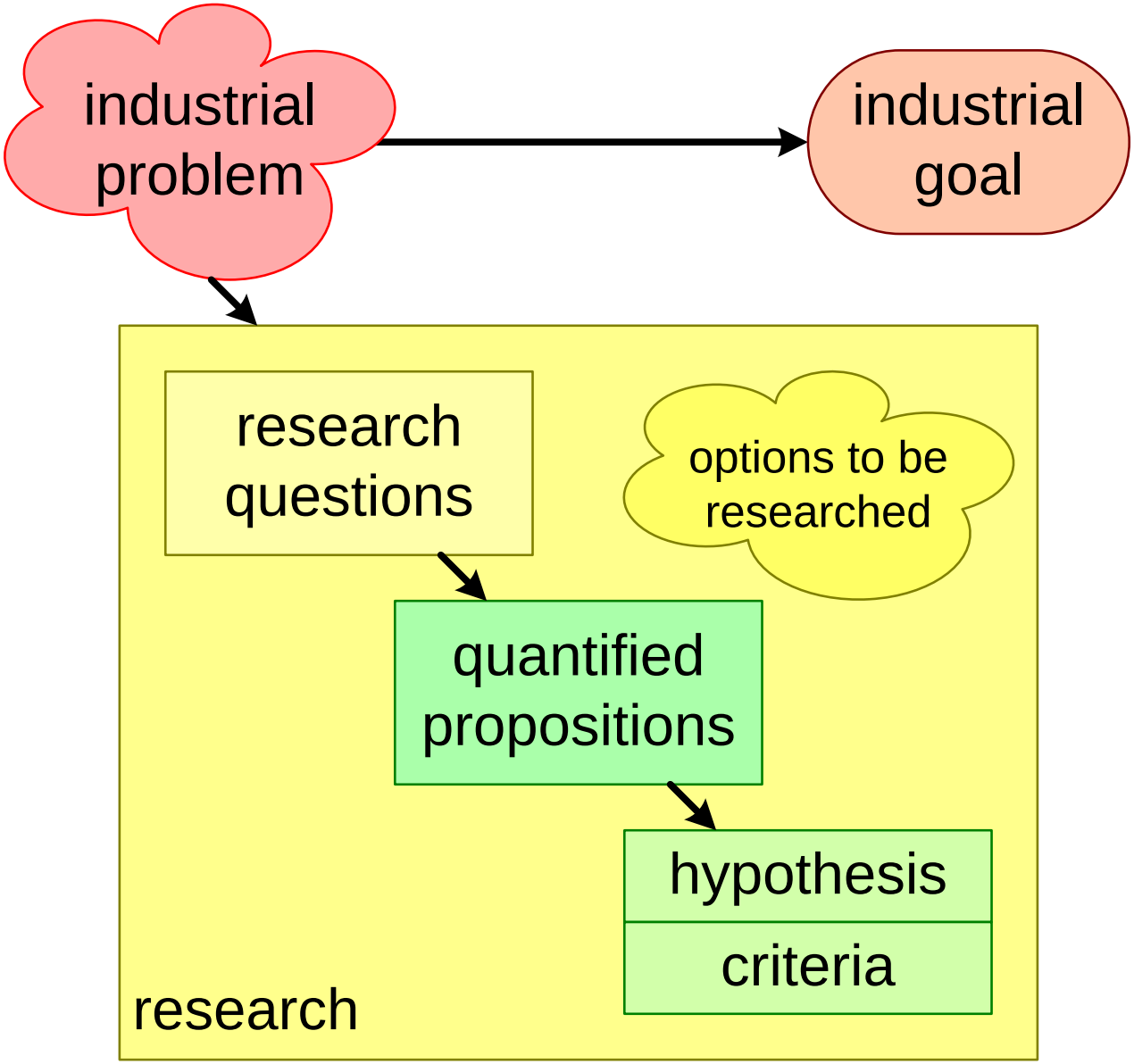
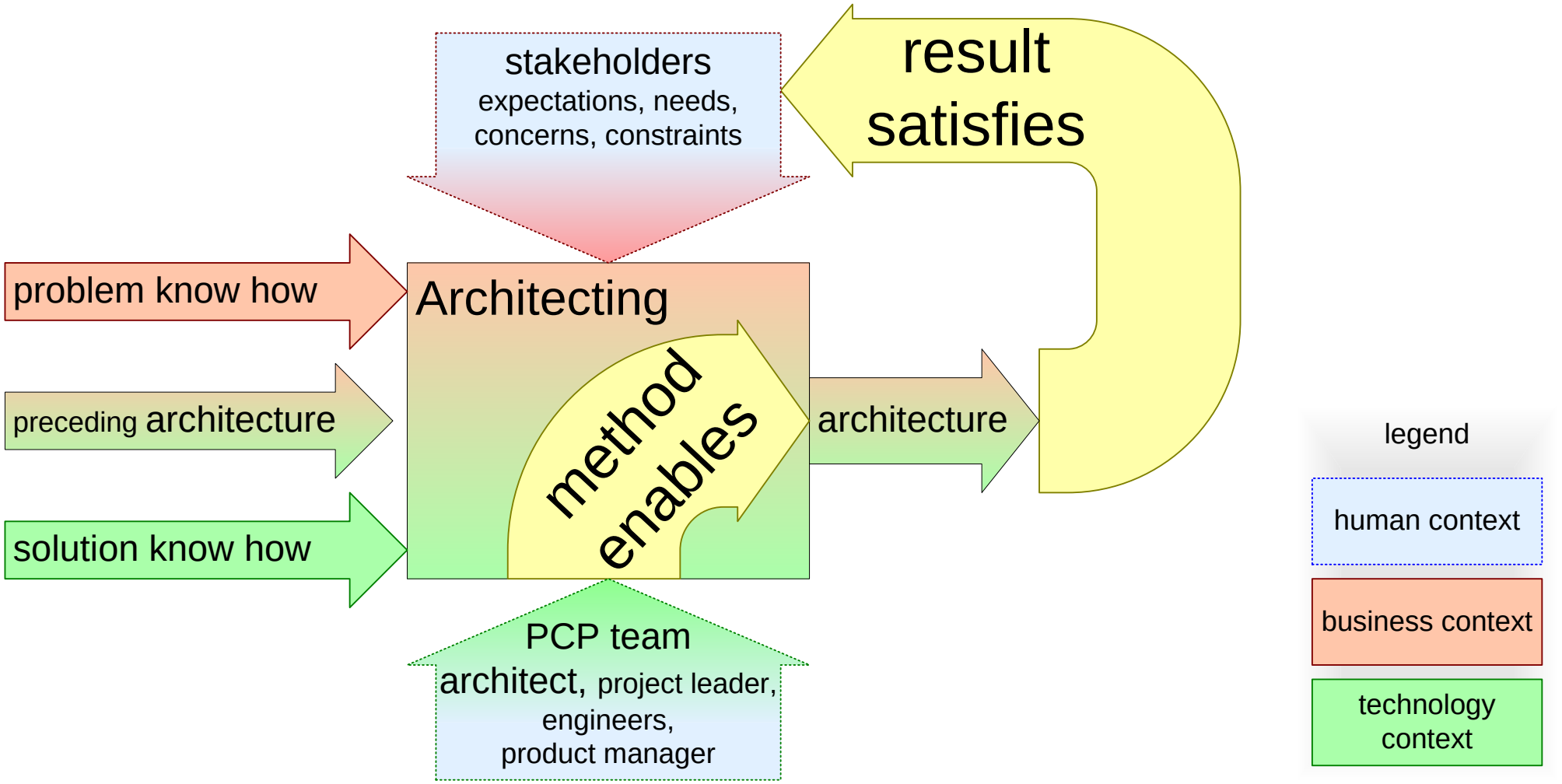
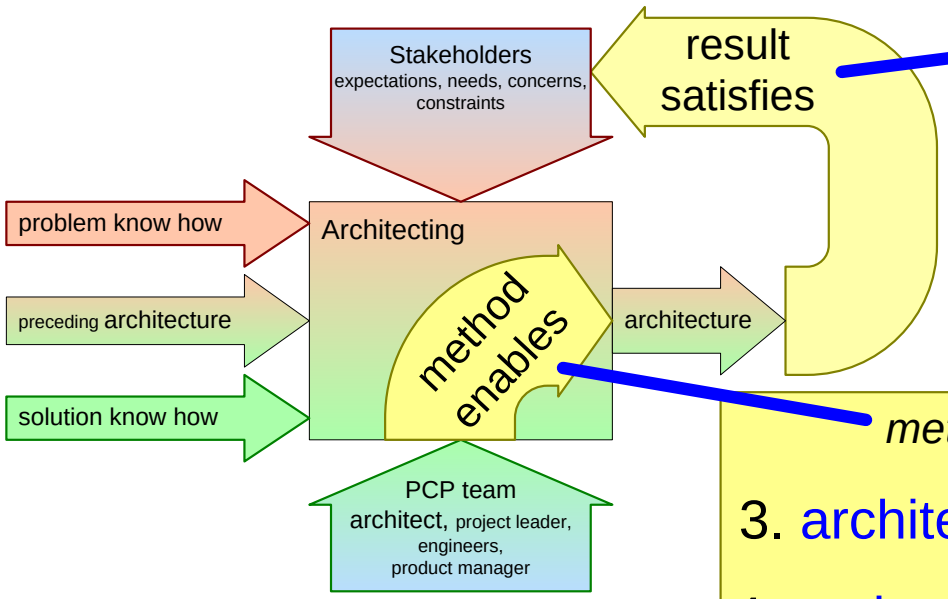
From Industrial Problem to Validated Research



Successful architecting and architecting method



From hypothesis to criteria

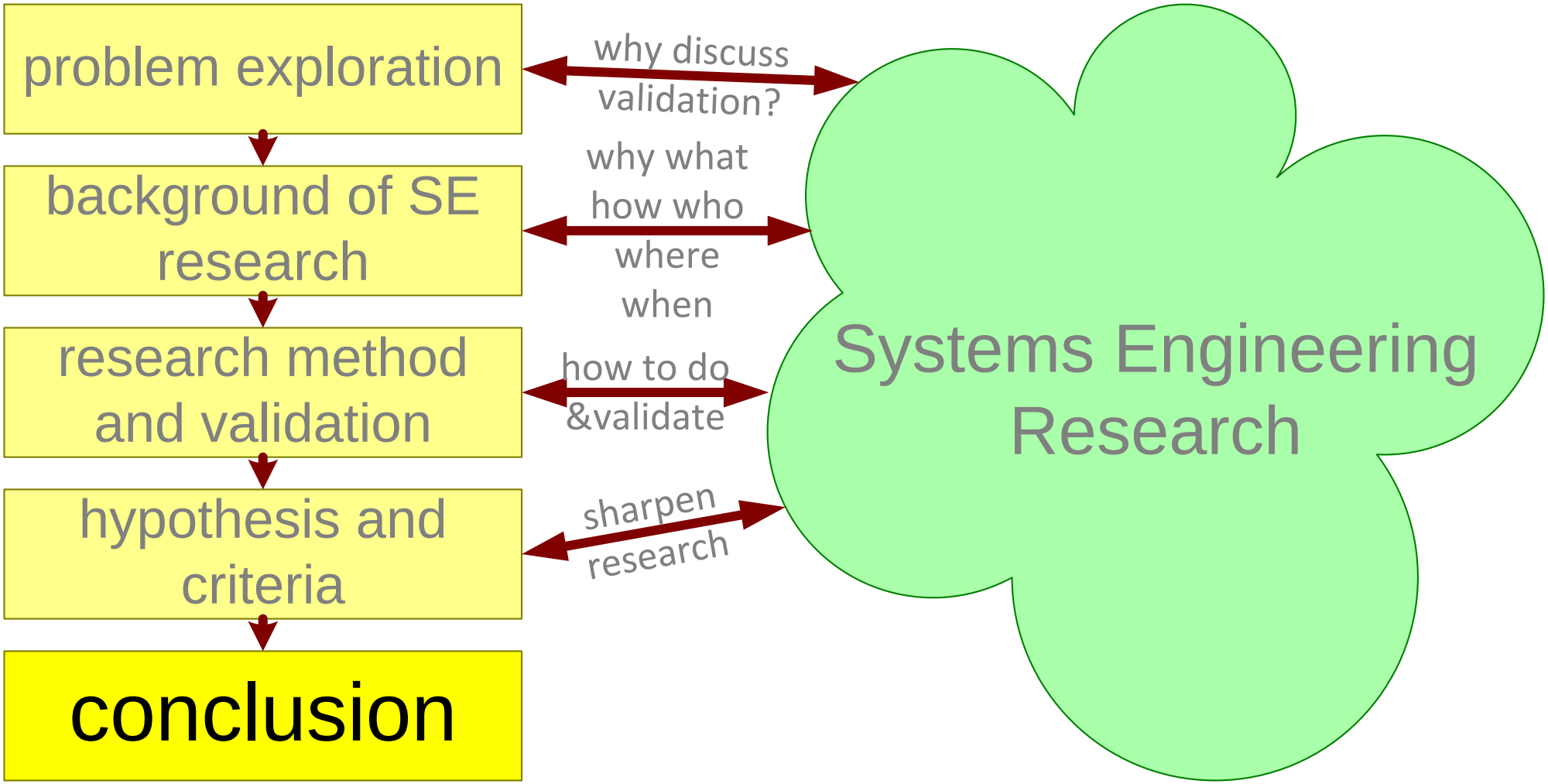


resulting architecture satisfies stakeholders

1. product is a commercial success
2. product family is sustainable commercially successful

method enables PCP team to create architecture

3. architects benefit from deploying submethods
4. project leaders, product managers and engineers are able to use the outcome of the submethods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The Final Result

research question, hypothesis, criteria, method

research positioning — *opening*

theory

casus (problem, goal, context)

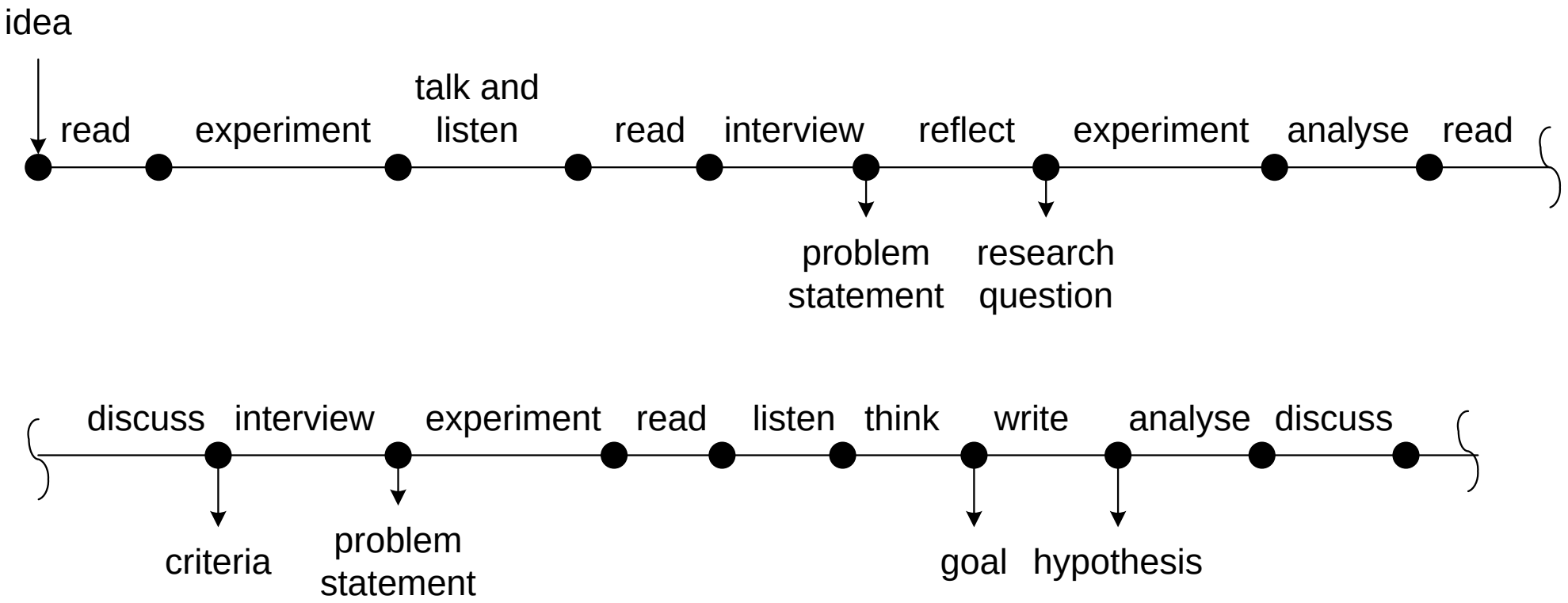
experiment

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

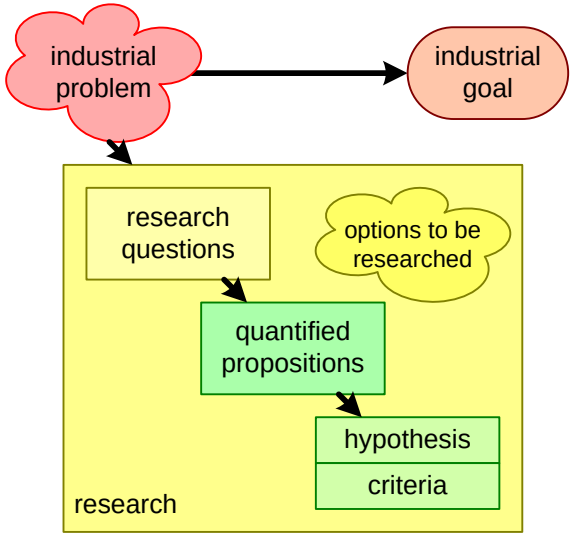
does your claim address the original needs?

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/CriterionsForArchitectingMethodsPaper.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`