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

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Abstract

Research of Multi-Disciplinary subjects is complicated by its nature. Systems Engineering is the application area of the research results. Systems Engineering is applied in industrial or commercial domains. The drivers and culture in these domains differ quite a lot from the drivers of the (academic) research community. We will discuss and illustrate a research approach called *Industry-as-laboratory*. We will discuss how to get from industrial problem to a research hypothesis, and how to validate the hypothesis.

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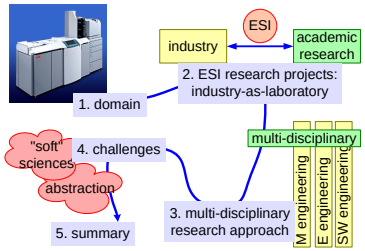

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The Domain: Printers and Copiers by Océ

31x5E

2050

2090

Typical Industrial Problem in Mechatronic Systems

Many multi-disciplinary problems in product development

Mechanical engineering precedes
Electronics engineering precedes
Software engineering

Most of the problems show up late in engineering and in the integration phase

For instance mechatronics assumes 1 ms response
Software promises 10 ms response

Lack of systematic approaches to detect / solve these problems in early phases

Lots of tuning, trial and error
Unpredictable project timing and costs

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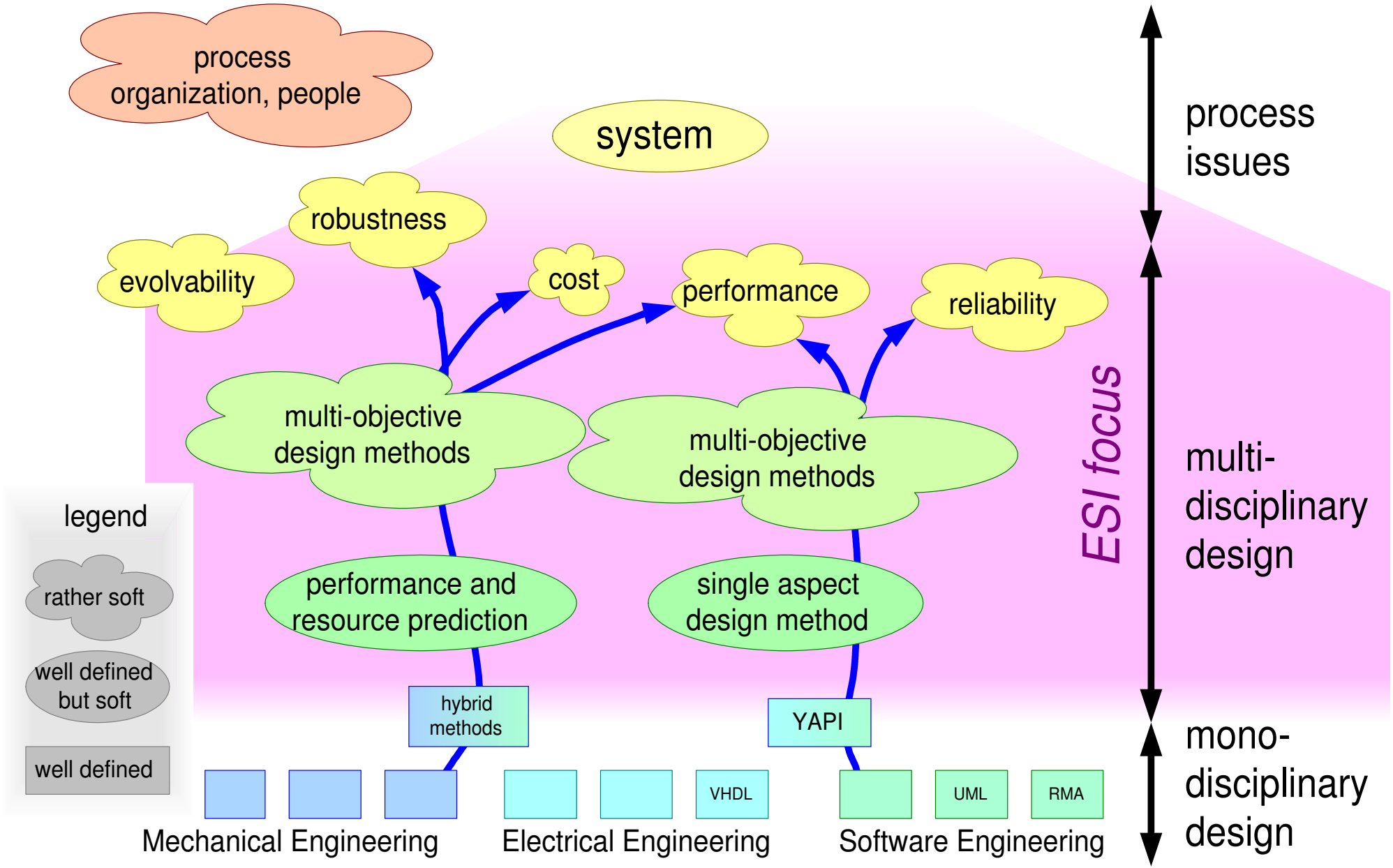
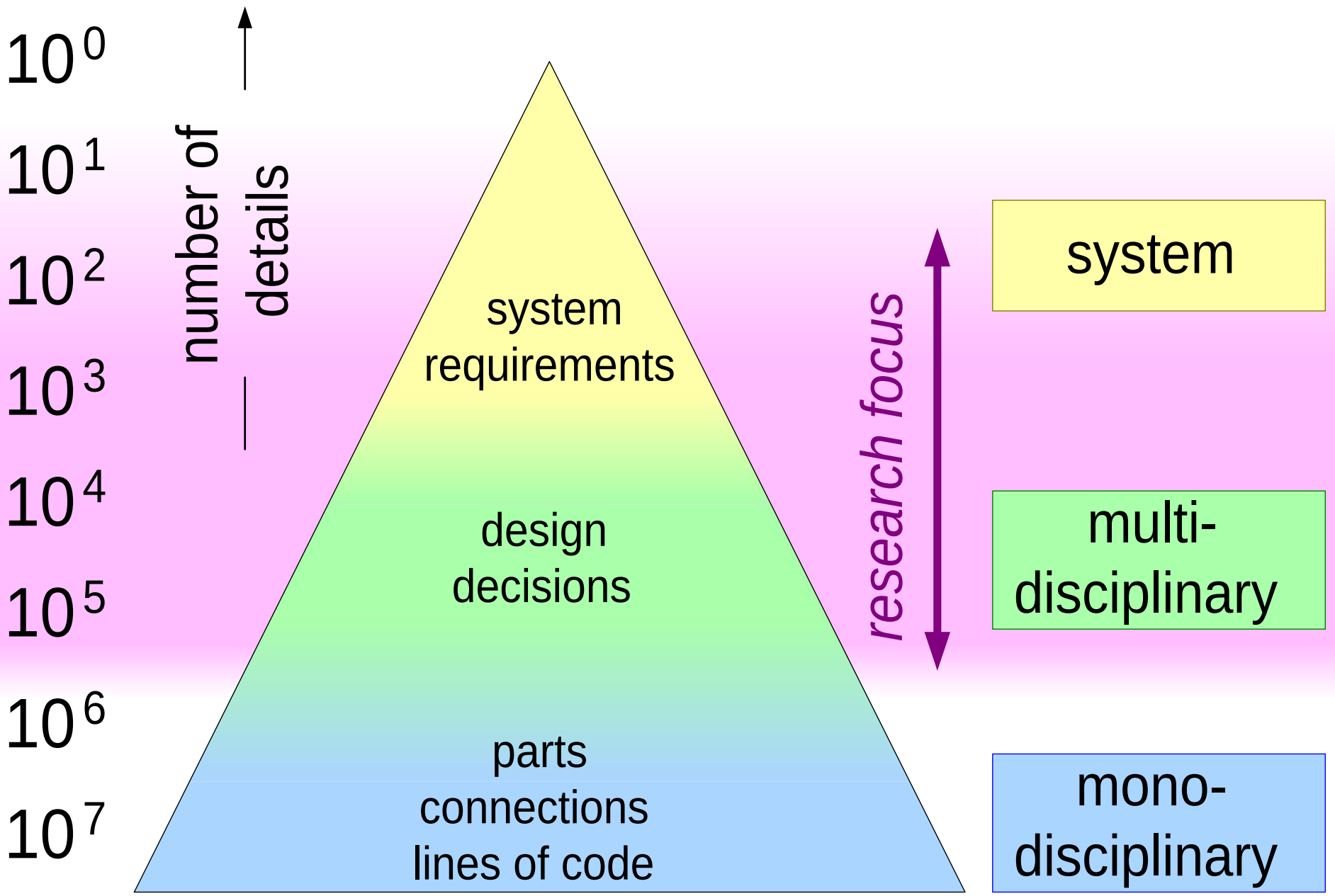
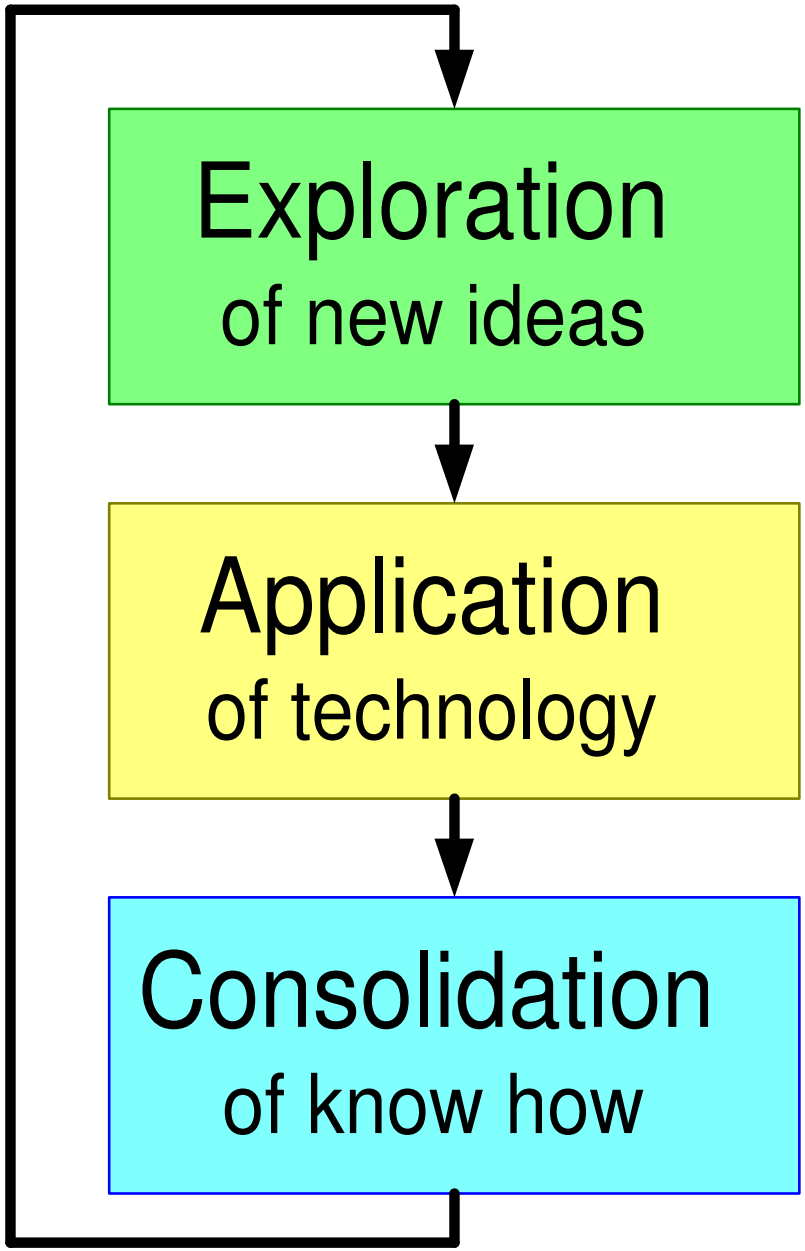
From Mono-Disciplinary to System



Exponential Pyramid, from requirement to bolts and nuts



Technology Management Cycle

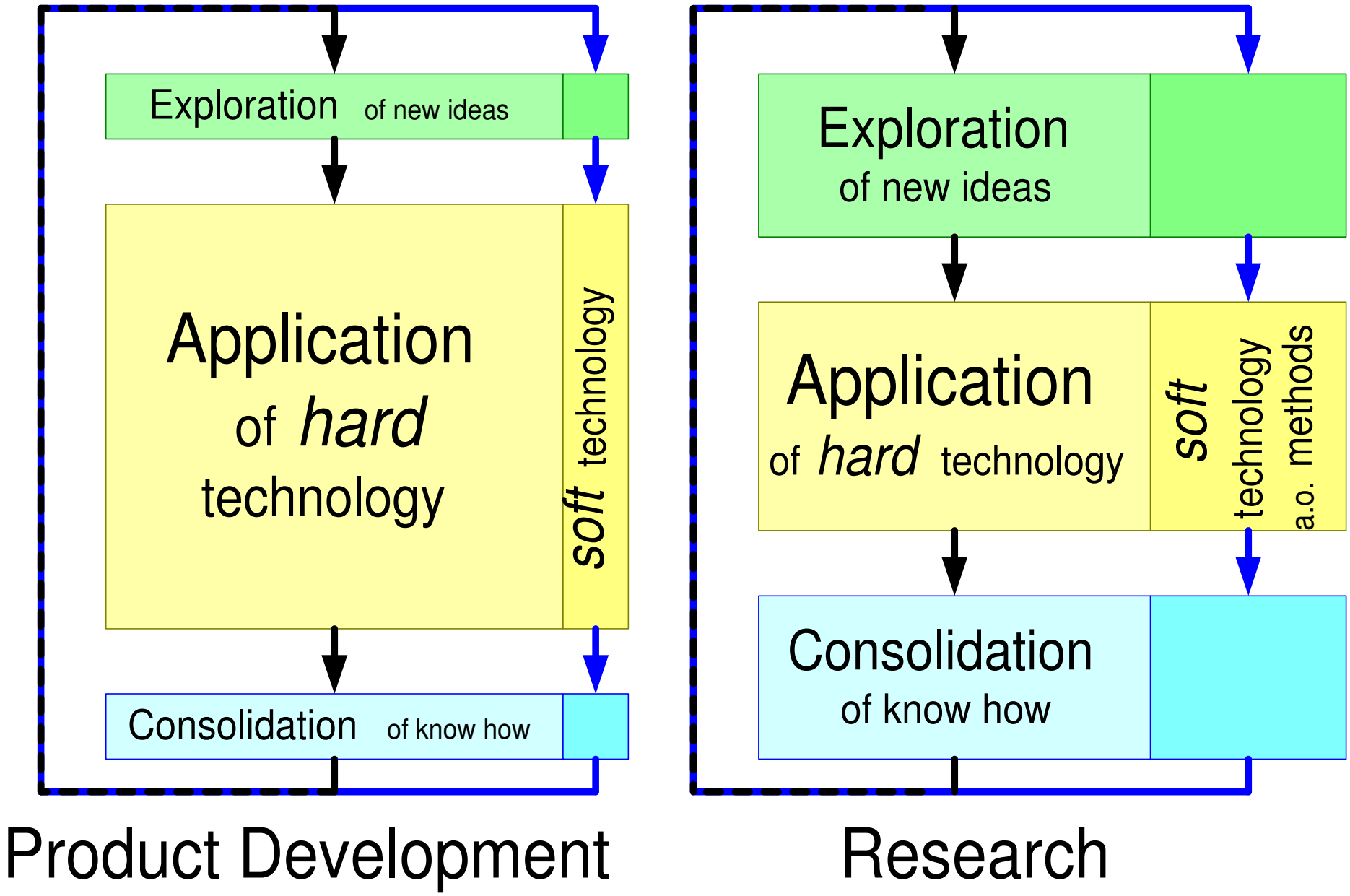


Literature search
Creative option generation
Try out

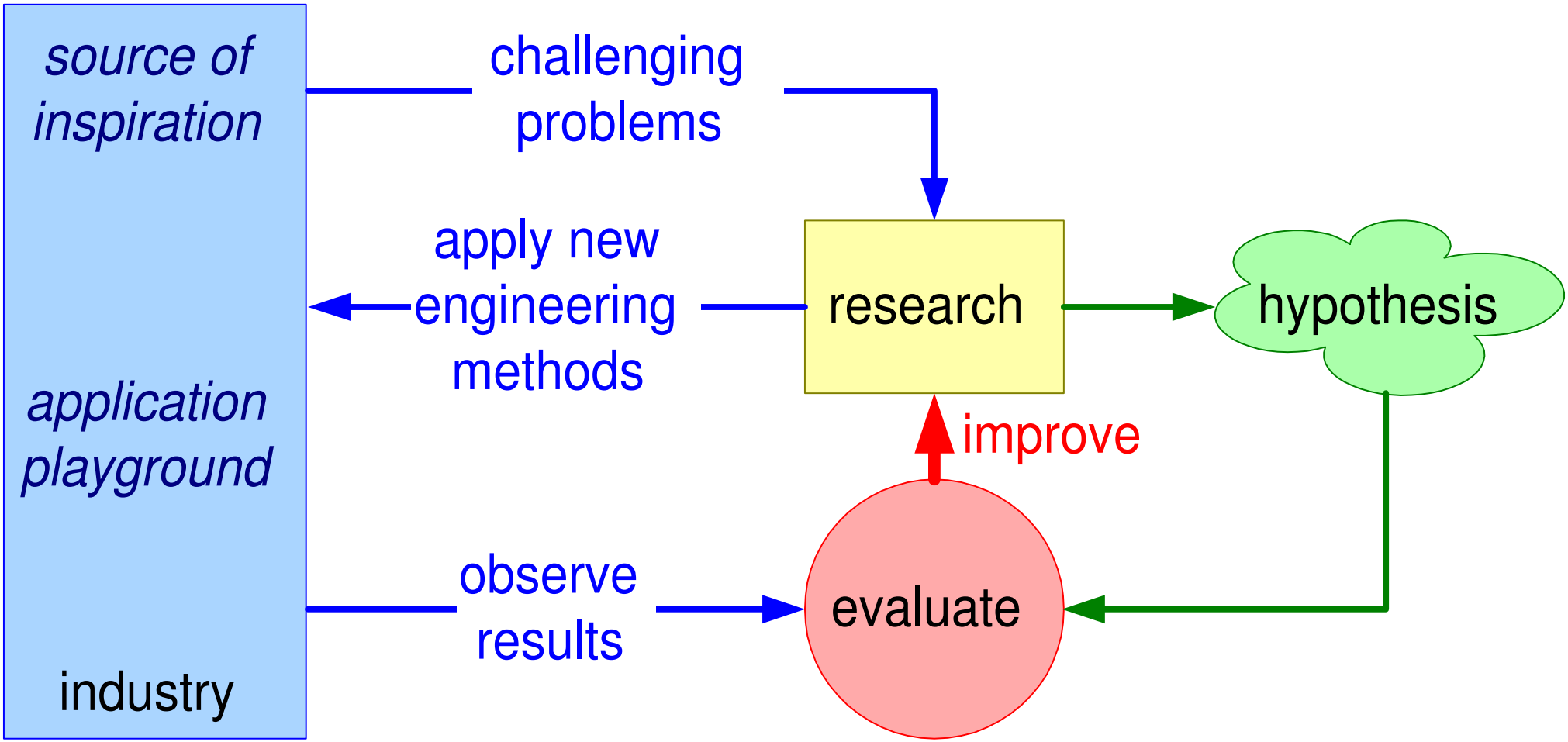
Industry as laboratory

Reflection
Write articles
Create courses

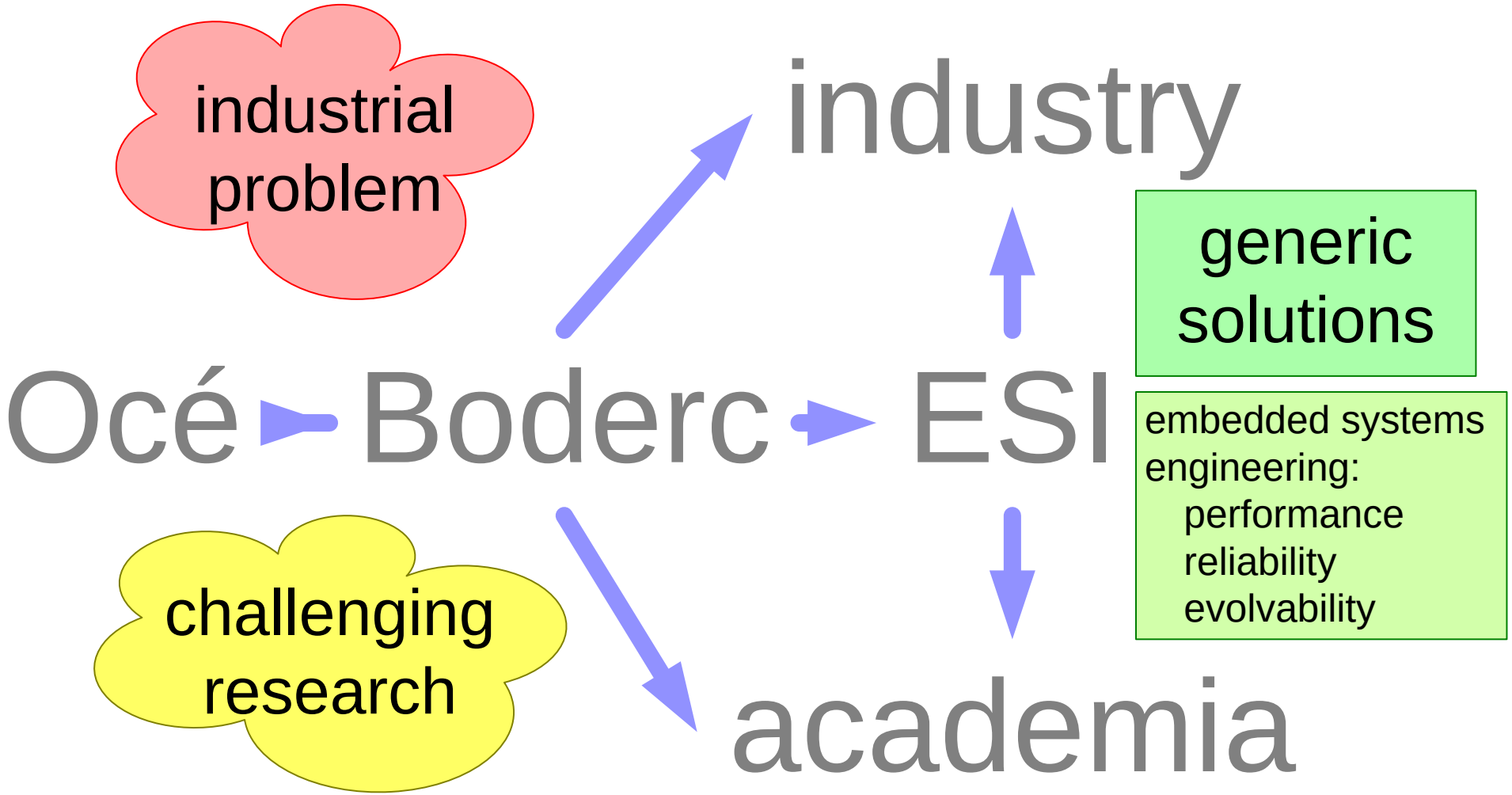
Method research requires application of methods



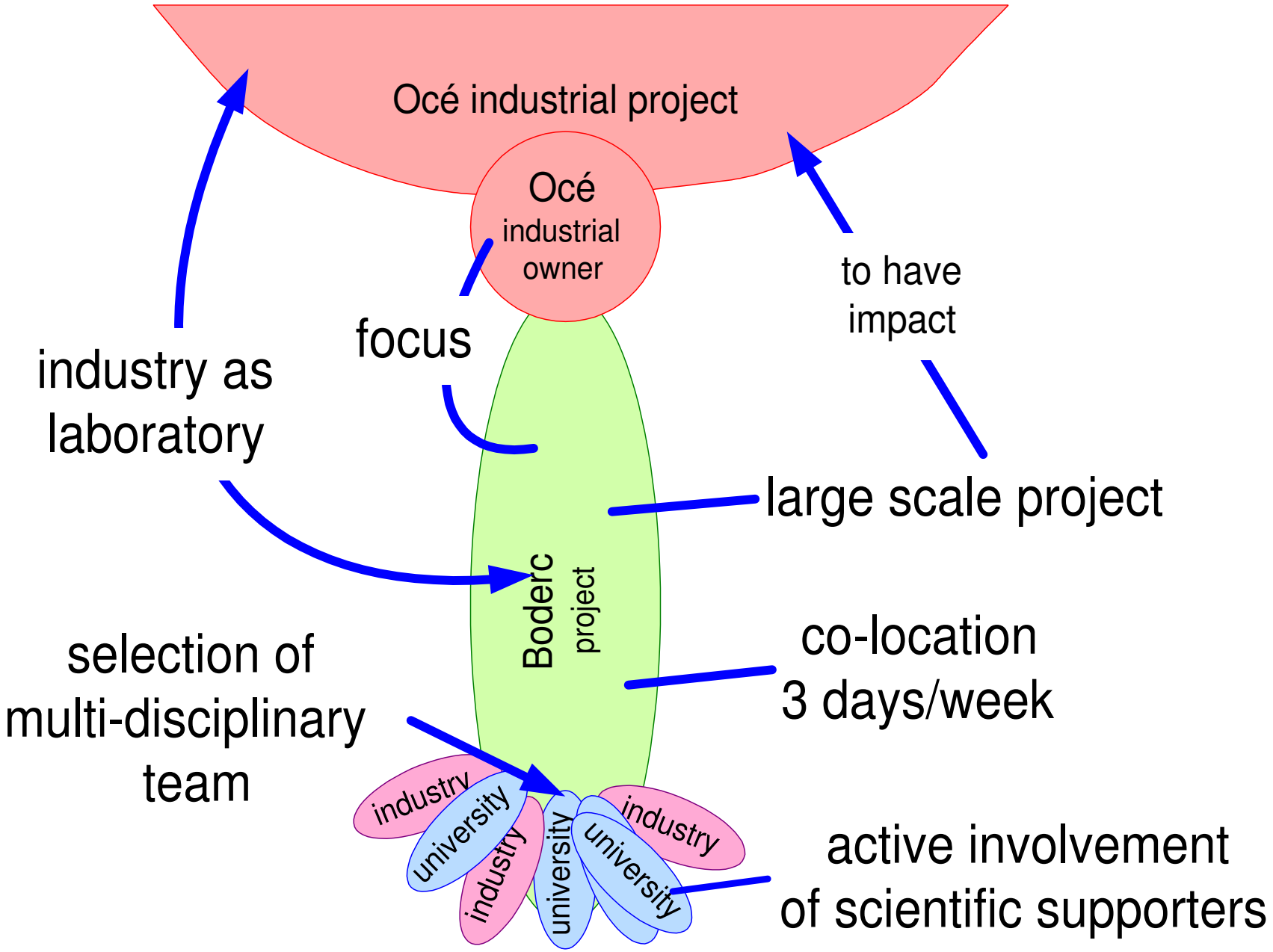
Industry as Laboratory



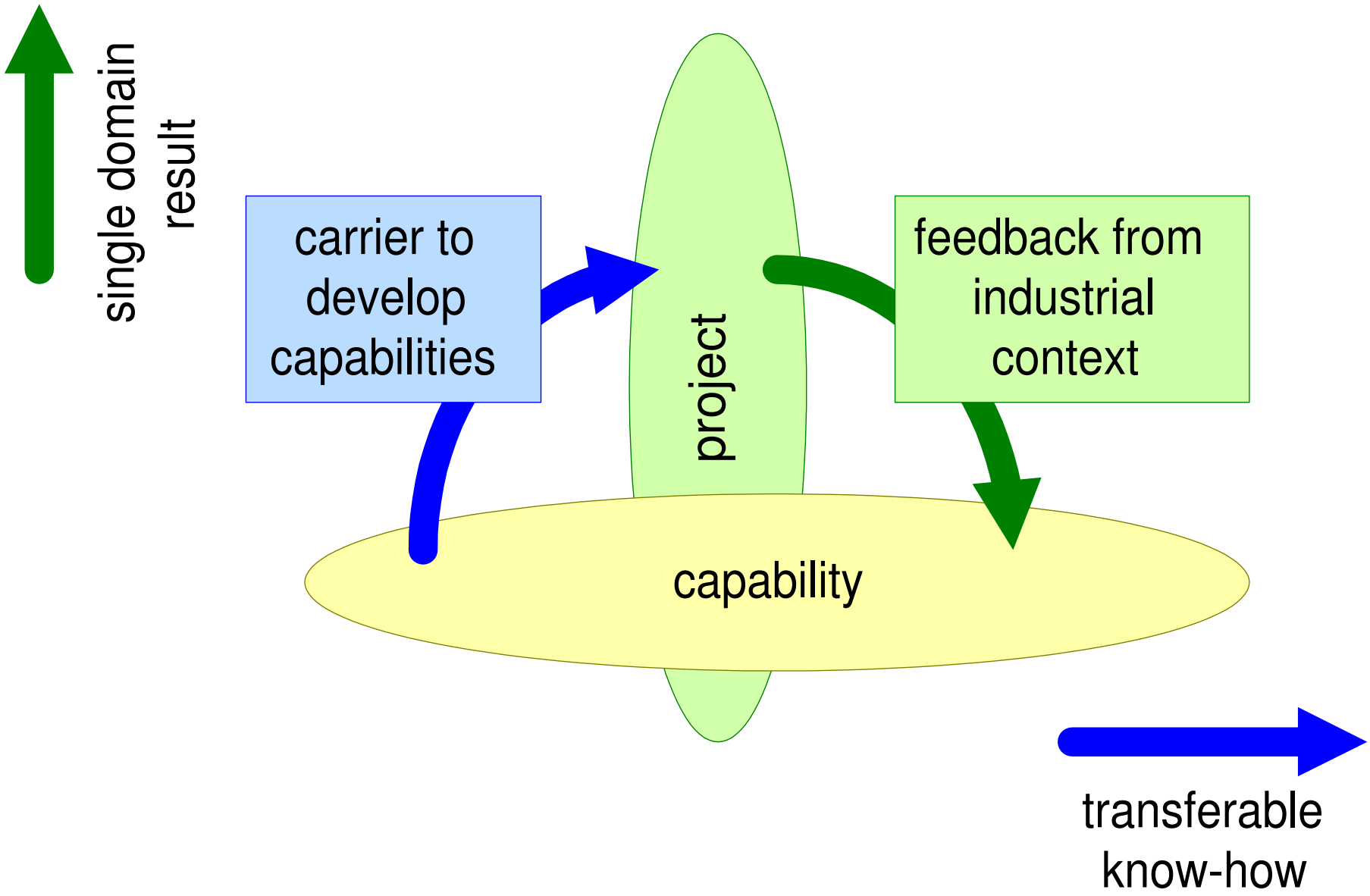
Stakeholders



Critical Success Factors for projects



Project as Carrier for Capability Development



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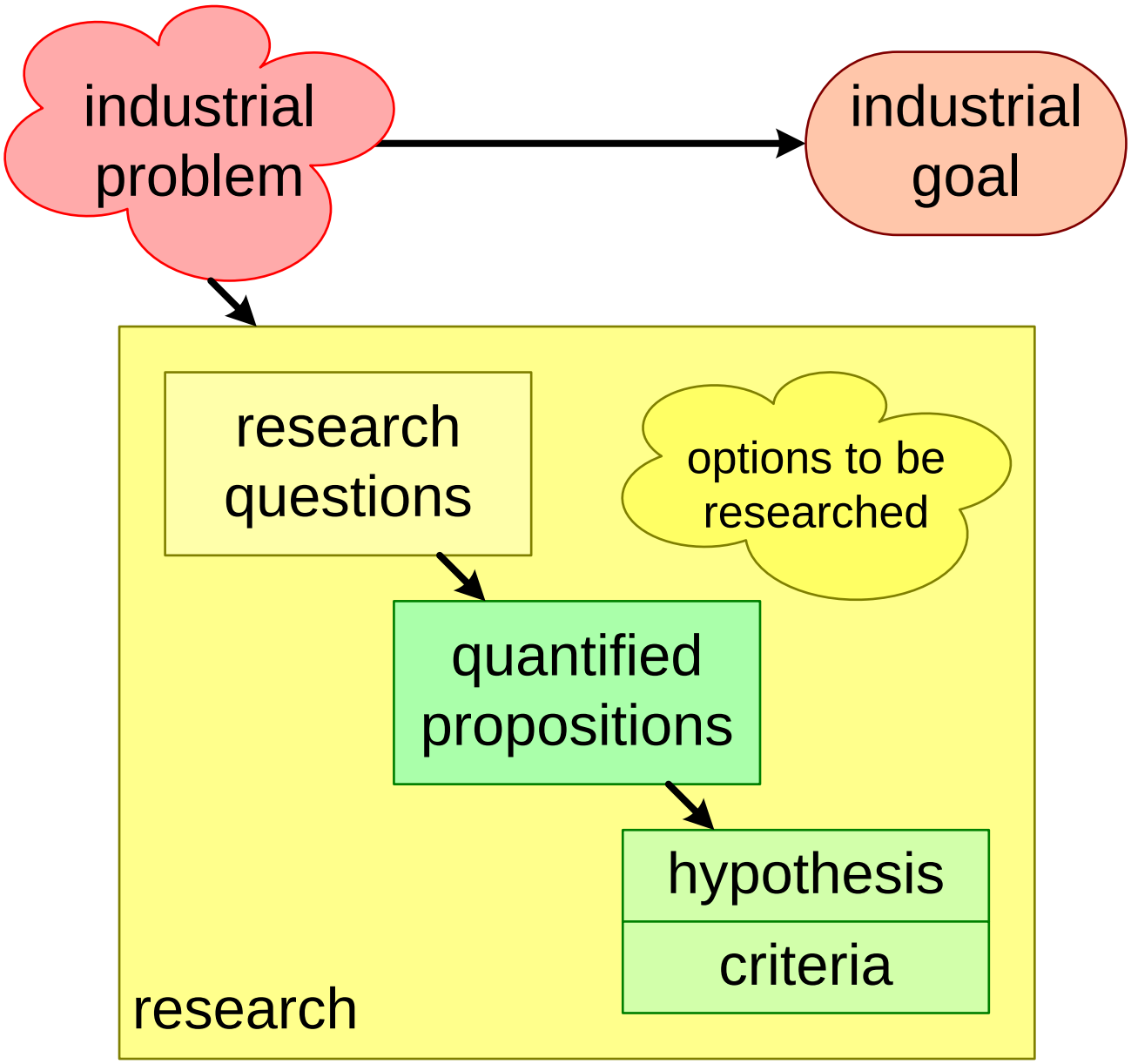
From Industrial Problem to Validated Research



Boderc Research Project Goal

Boderc goal =

A specific methodology — based on modeling

to predict — and analyze, discuss, document, and communicate

multi-disciplinary — system performance — throughput, quality

within industrial constraints and restricted design space

people, process, project duration, and cost

power computing response time

Boderc Research Questions

What Formalisms, Models, Techniques, Methods and Tools are needed?

What is an appropriate level of abstraction and effort to model?

What determines the useability of models?

Methodology

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

The Boderc Hypothesis

The product creation lead time

will be reduced significantly by

the use of multi-disciplinary models

during the early product development phases.

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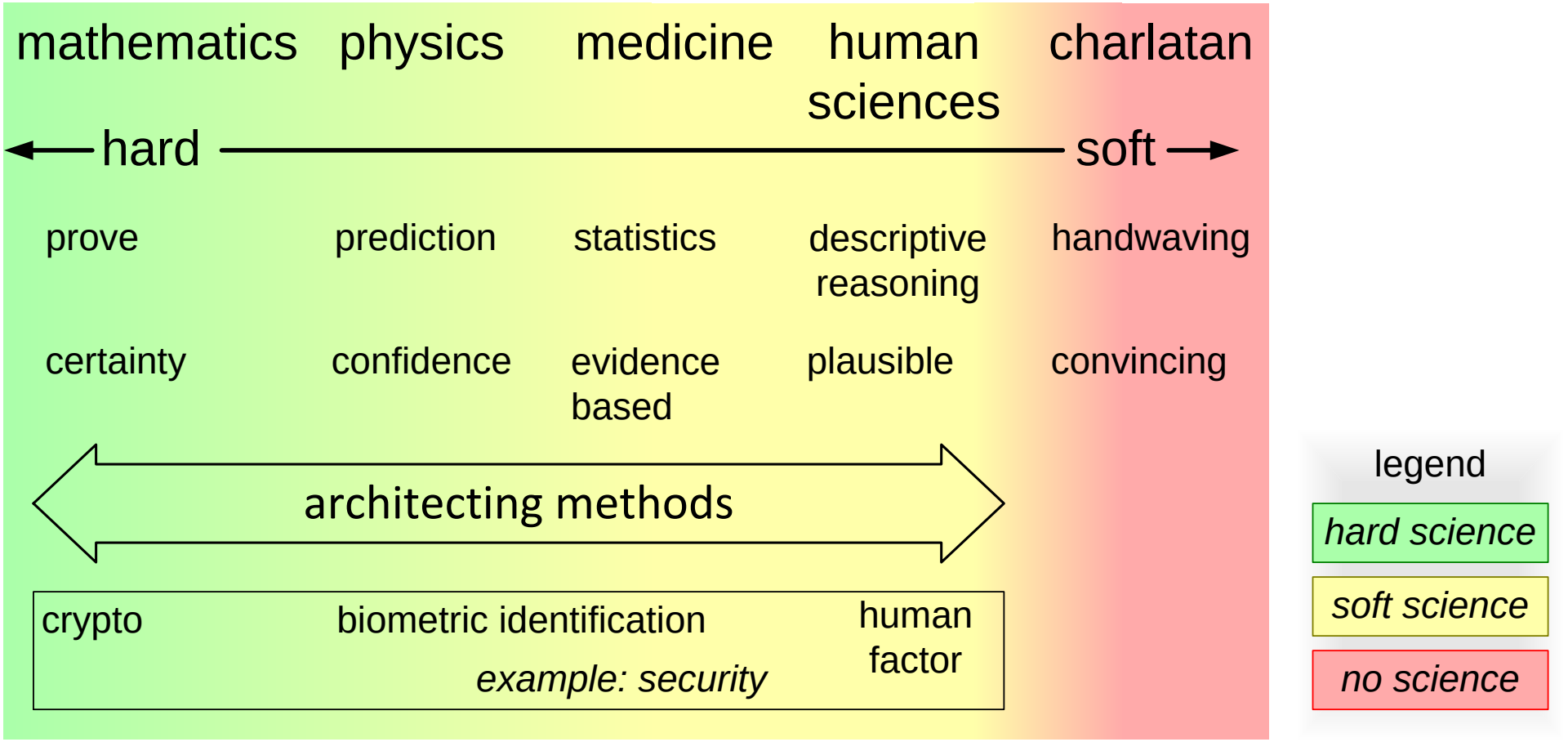
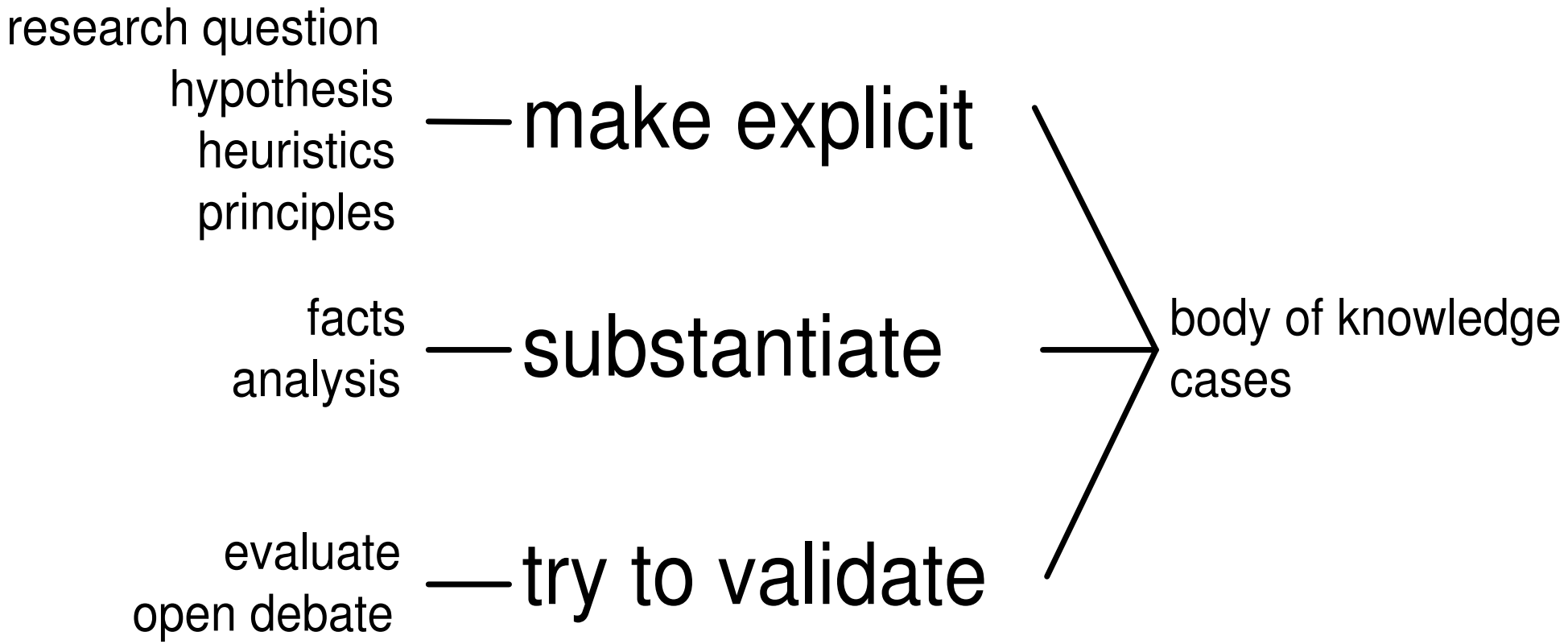
Spectrum of sciences

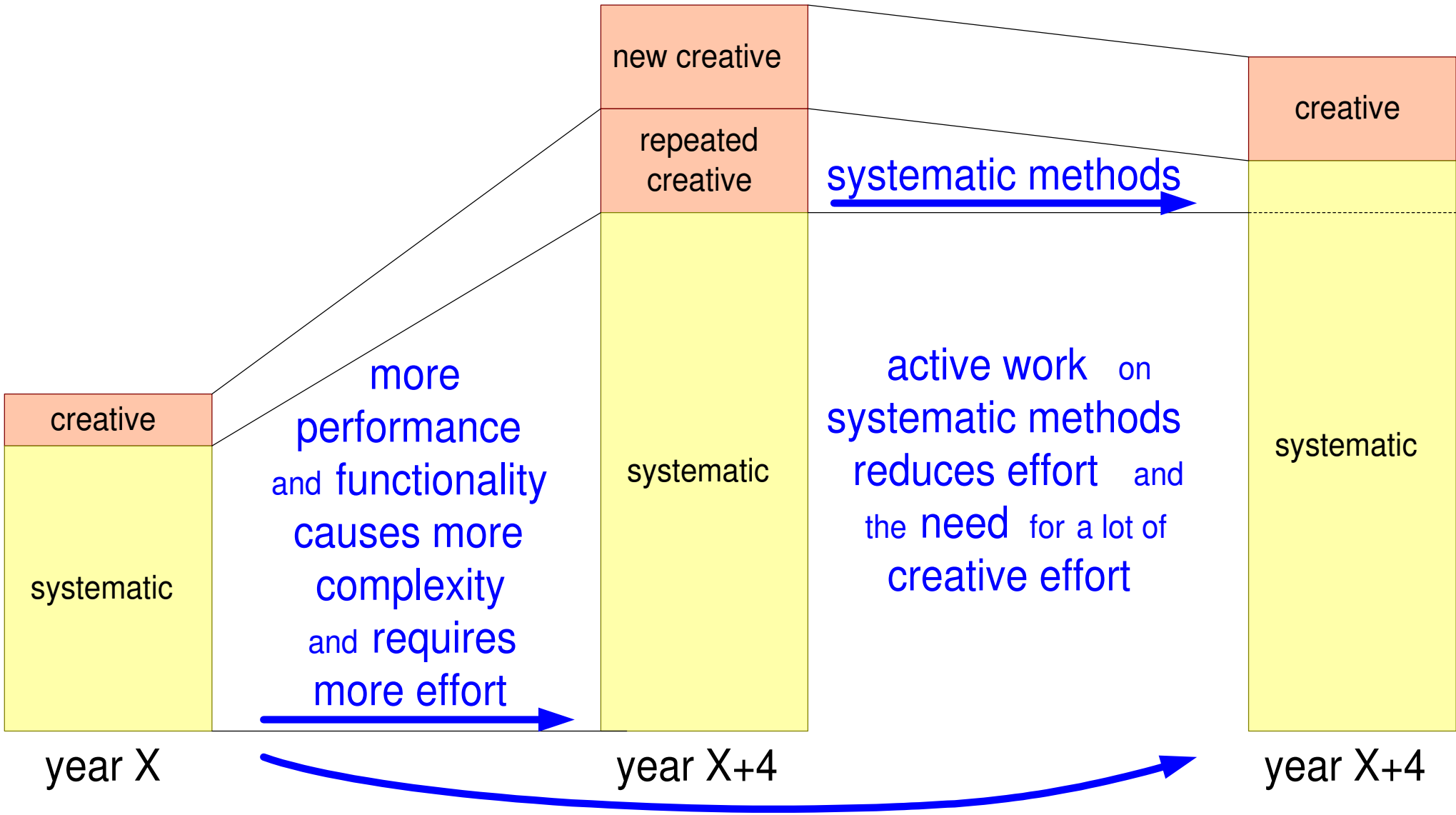


Soft problems can be approached with a scientific attitude

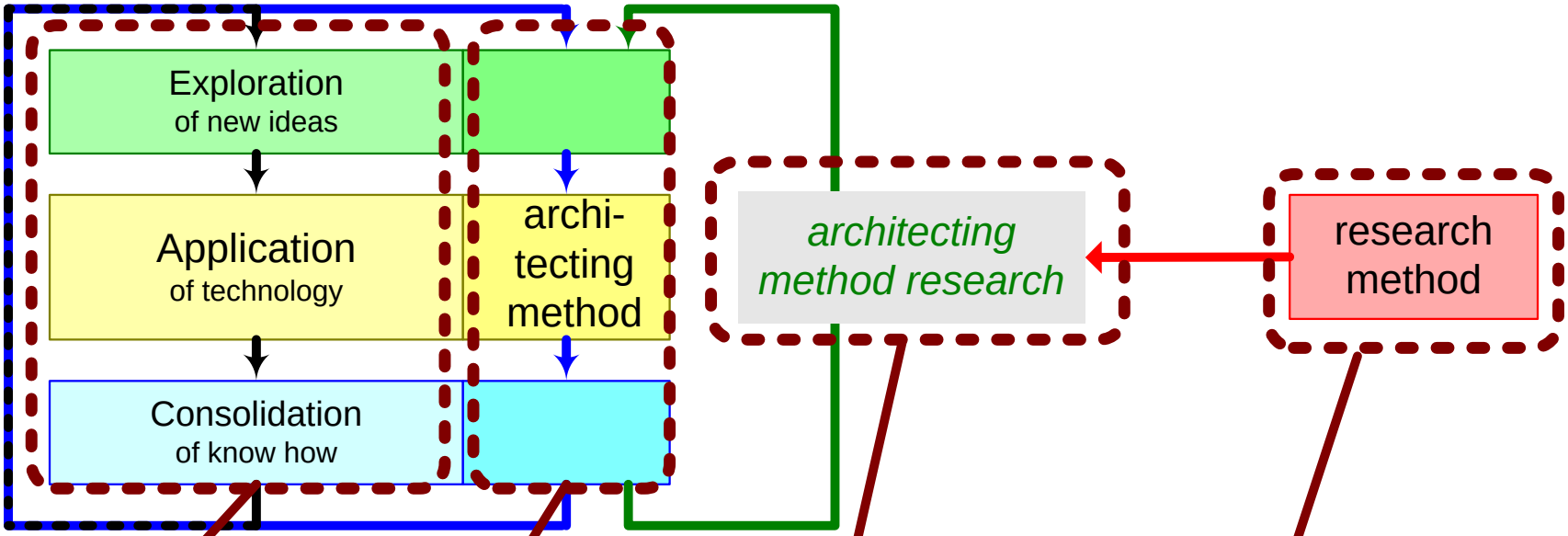
soft is not in conflict with scientific attitude



Systematic Know-how to cope with Growing Complexity



Moving in the *meta* direction



meta^0

bottom line:
product creation

meta^1

enabling:
architecting method

meta^2

pro-active:
research of architecting method

meta^3

scientific foundation:
method to research architecting methods

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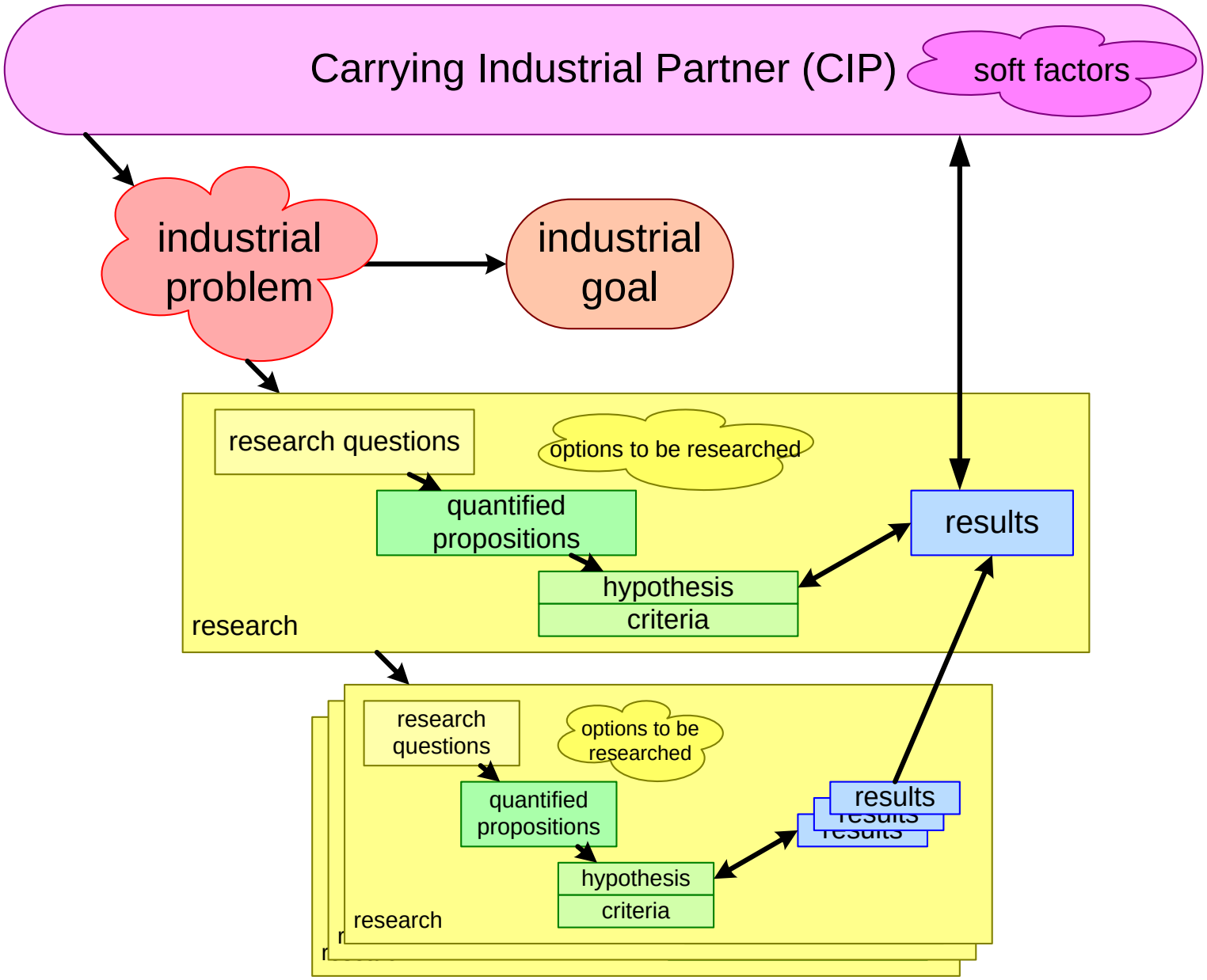
Carrying Industrial Partner (CIP)
soft factors
industrial problem
industrial goal
research questions
options to be researched
quantified propositions
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