

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

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## Abstract

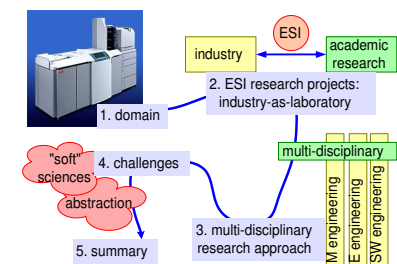
Research of Multi-Disciplinary subjects is complicated by its nature. Systems Engineering is the application area of the research results. Systems Engineering is applied in industrial or commercial domains. The drivers and culture in these domains differ quite a lot from the drivers of the (academic) 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.

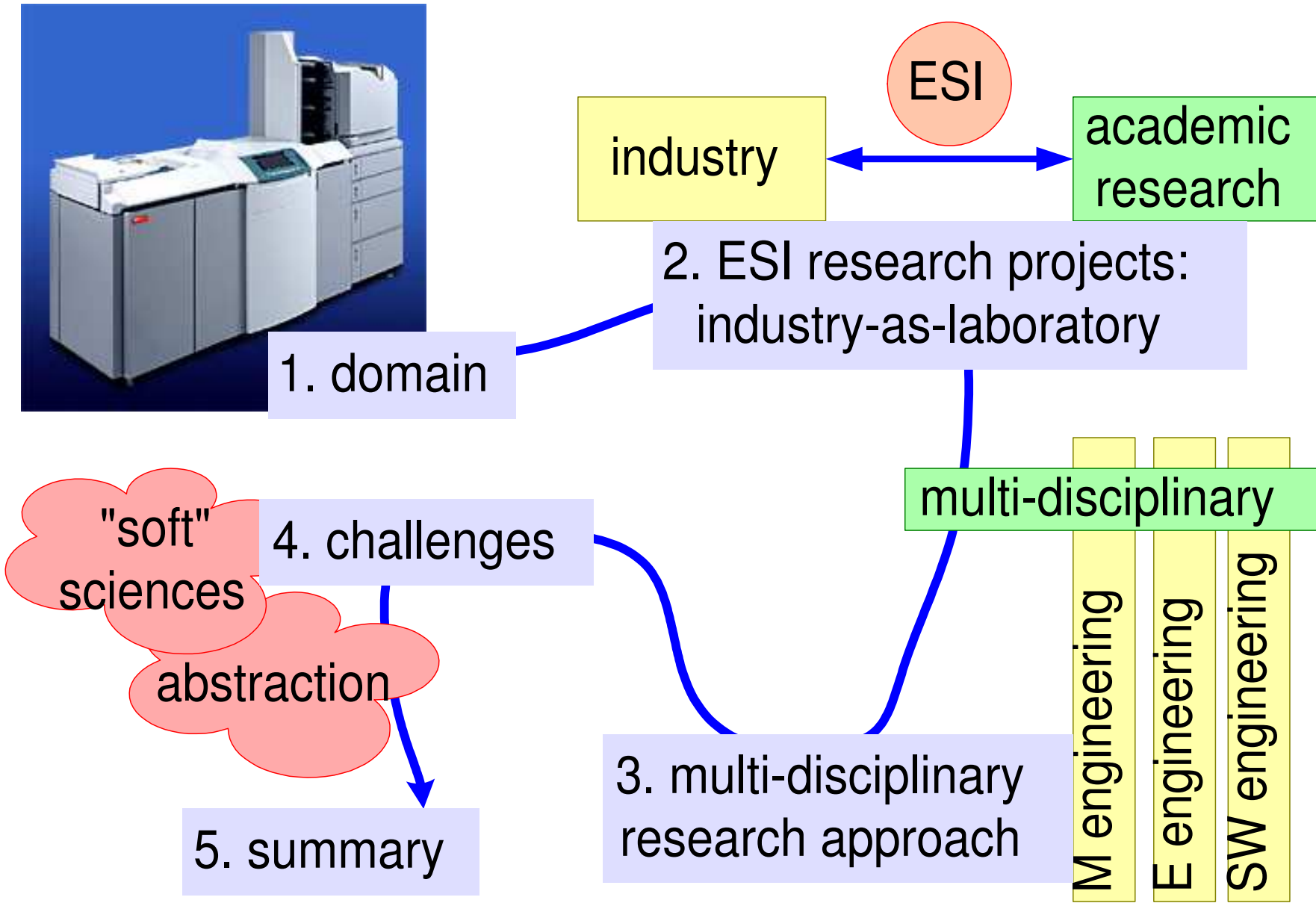
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# Figure Of Contents™



# The Domain: Printers and Copiers by Océ

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31x5E



2050



2090

# Typical Industrial Problem in Mechatronic Systems

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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

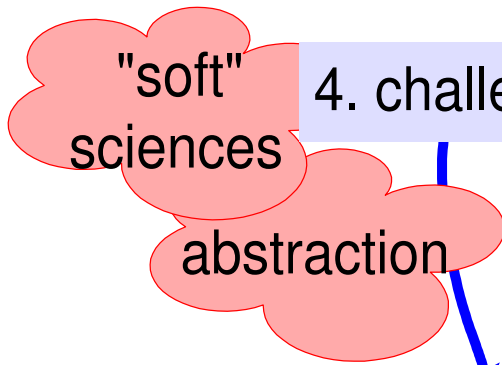
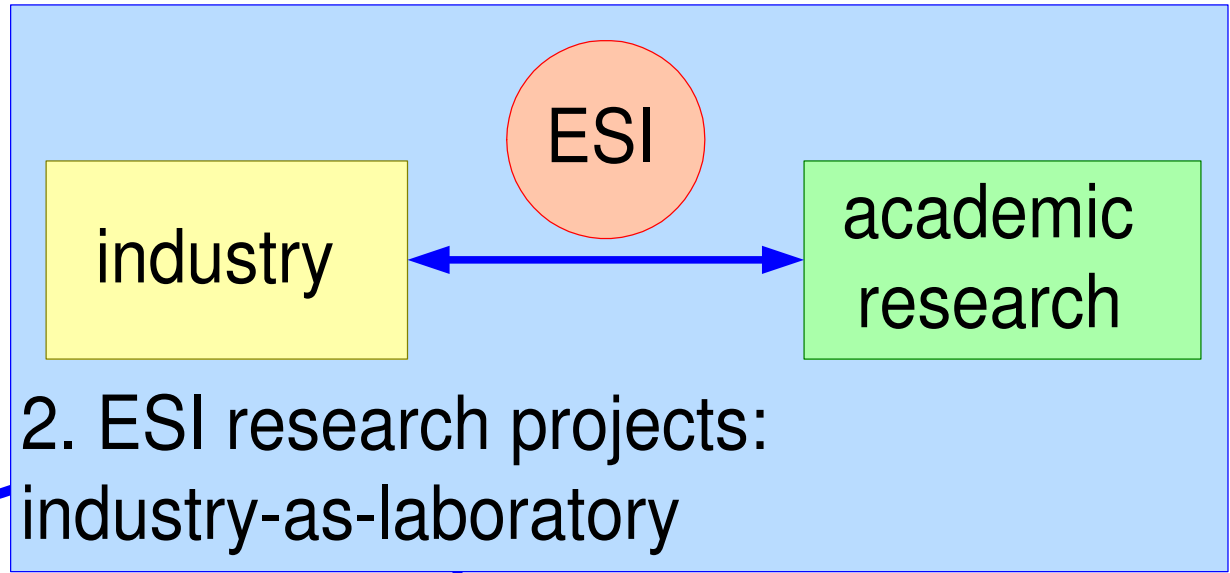
For instance mechatronics assumes 1 ms response  
Software promises 10 ms response

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

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

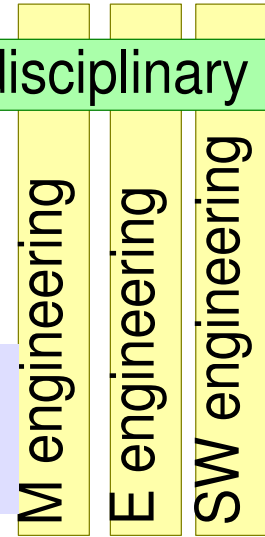


1. domain

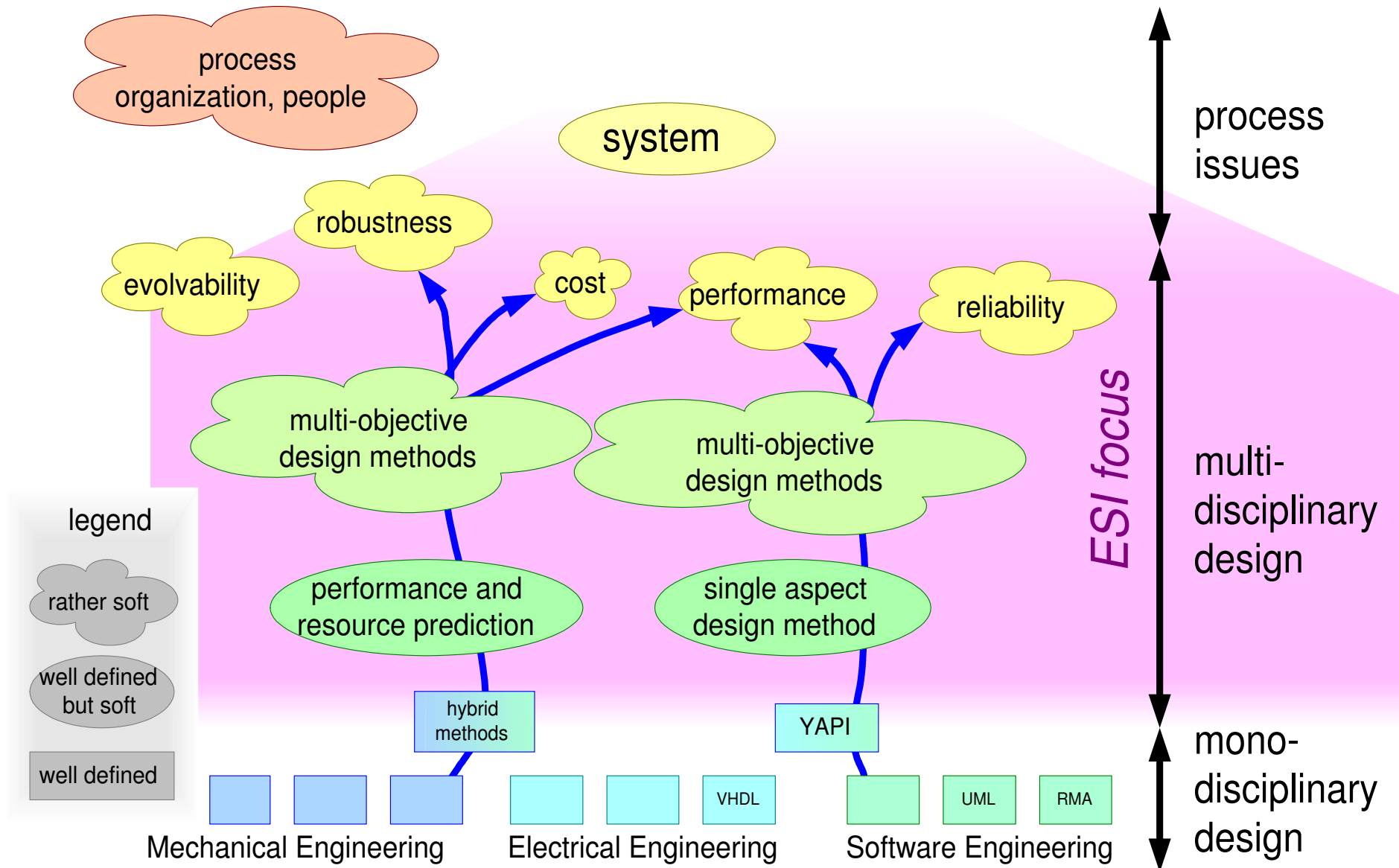


3. multi-disciplinary research approach

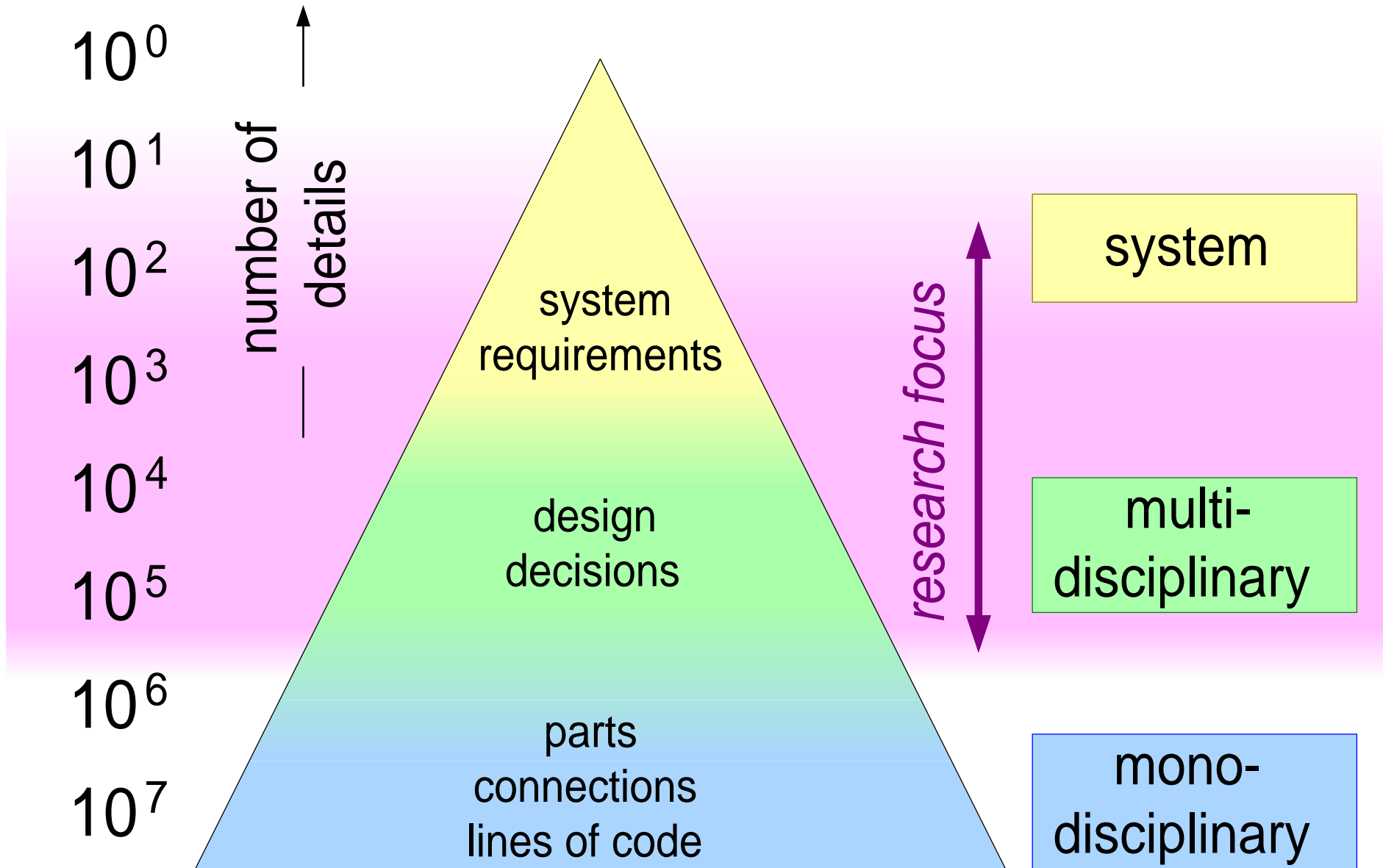
multi-disciplinary



# From Mono-Disciplinary to System

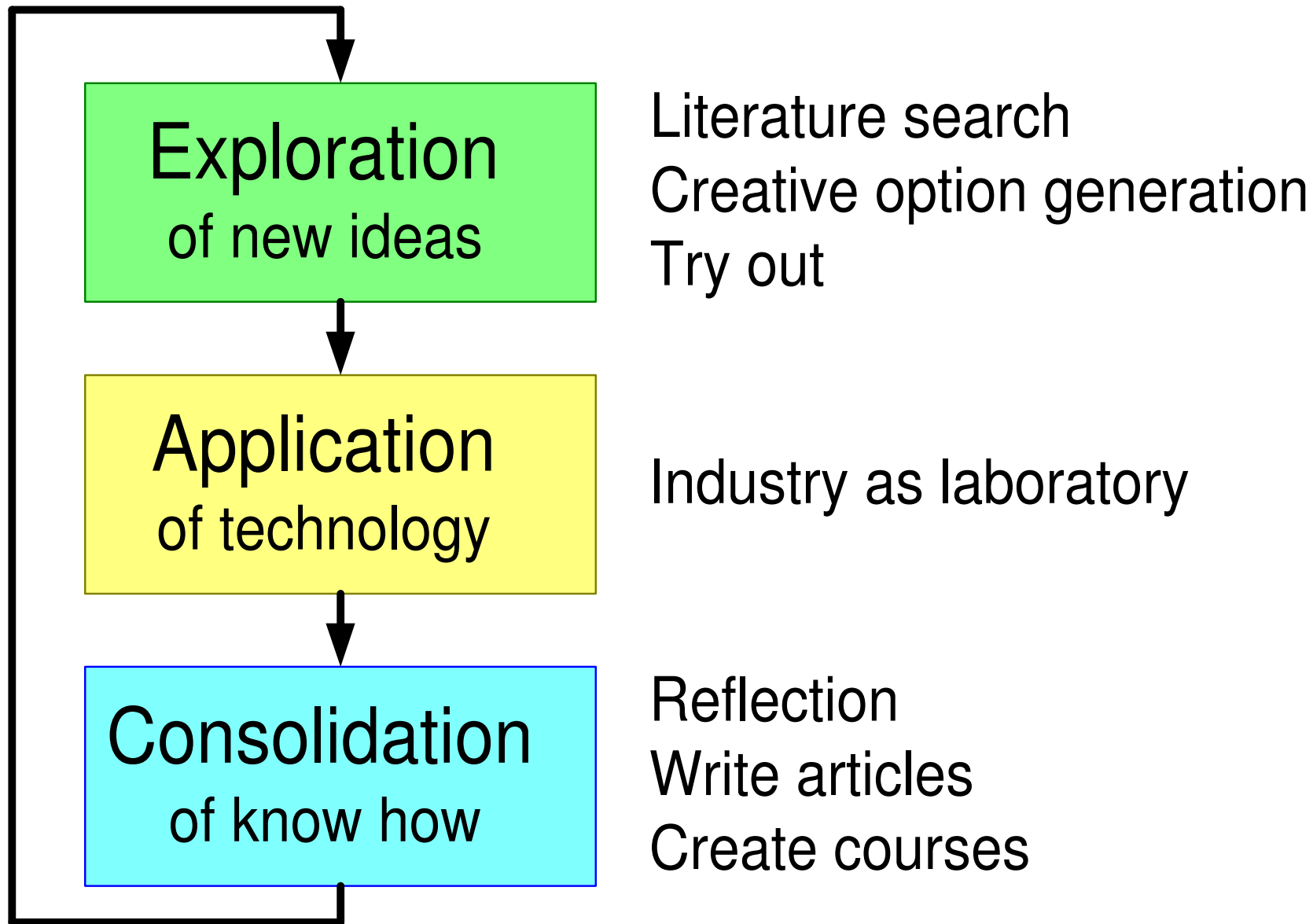


# Exponential Pyramid, from requirement to bolts and nuts

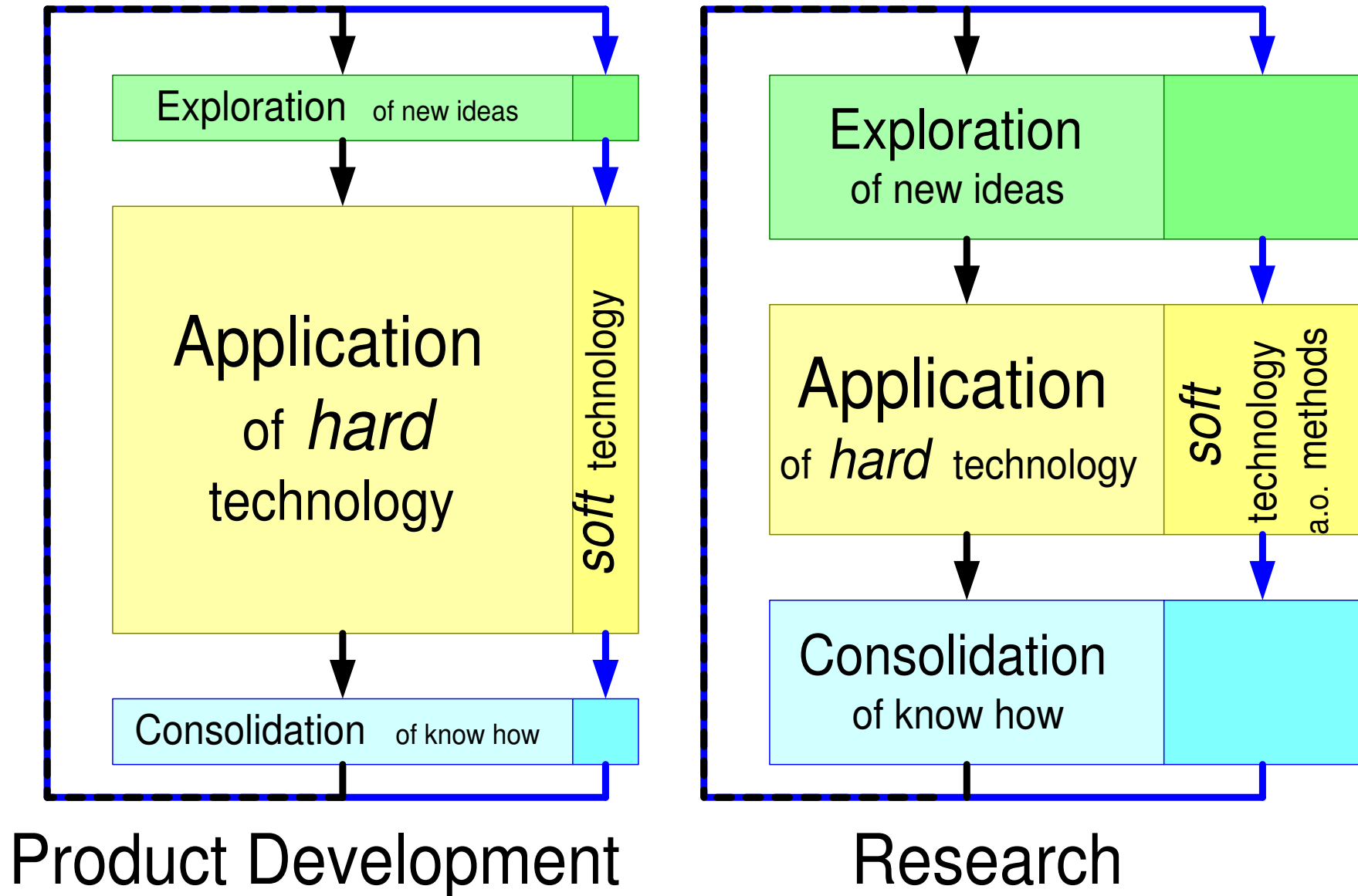


# Technology Management Cycle

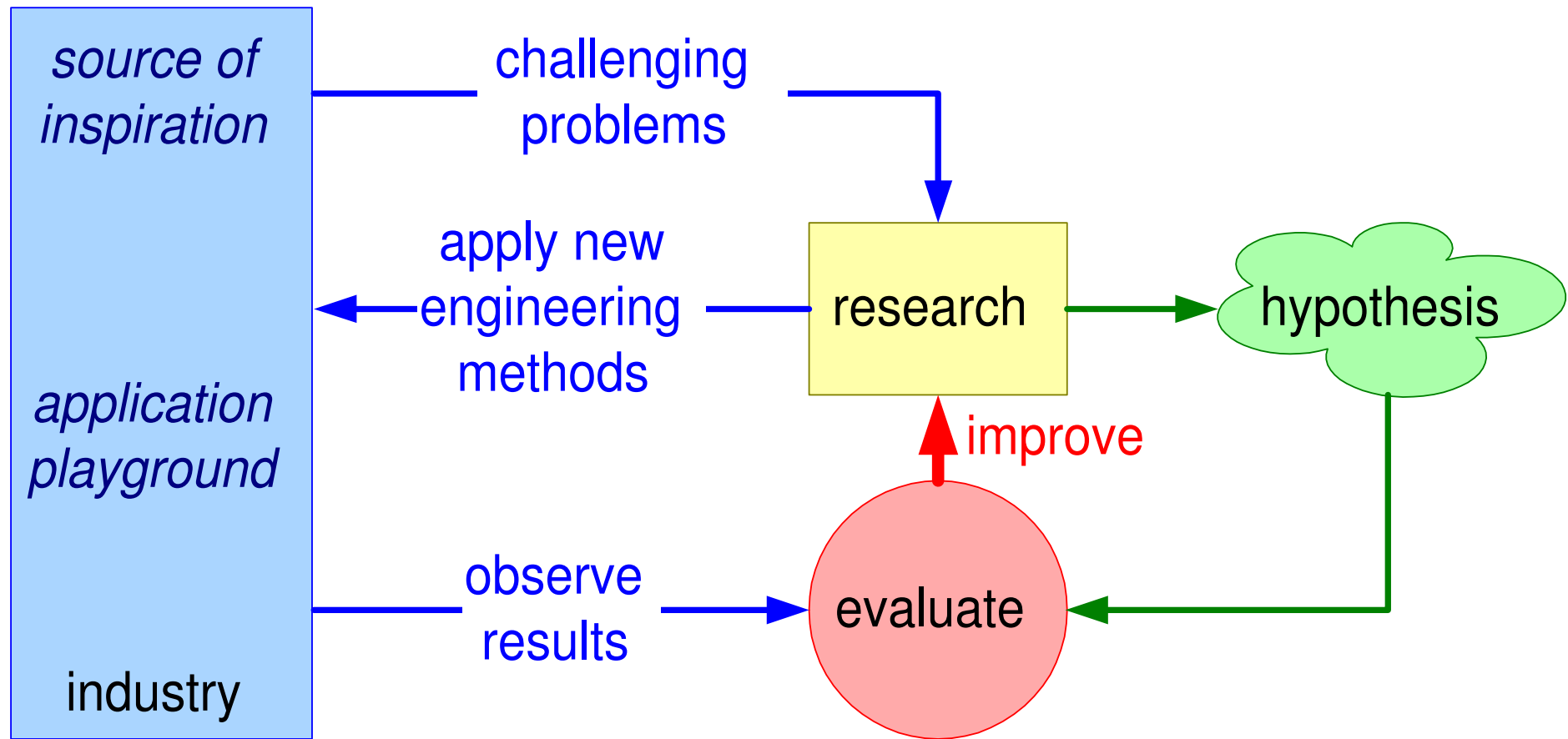
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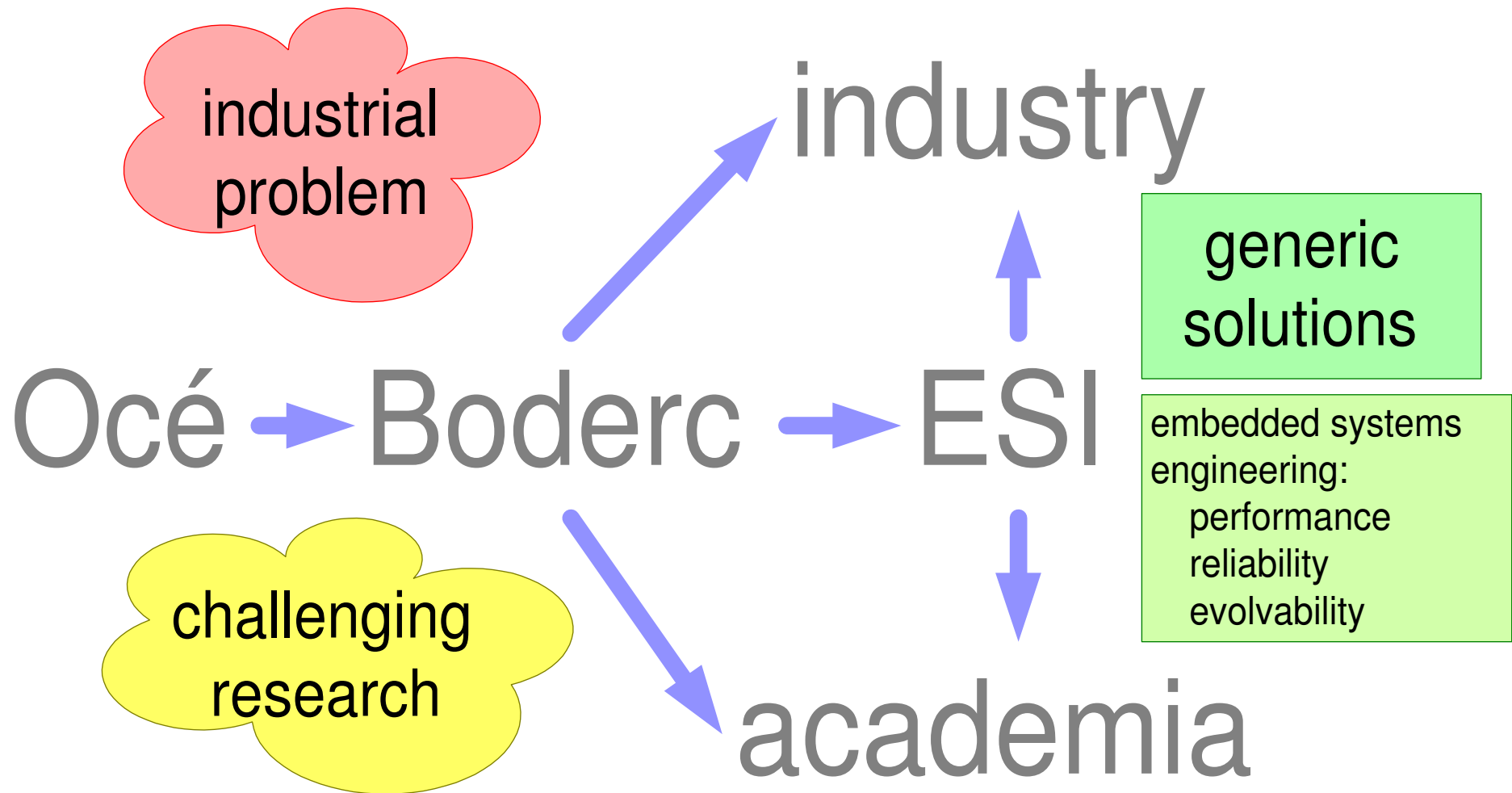


# Method research requires application of methods

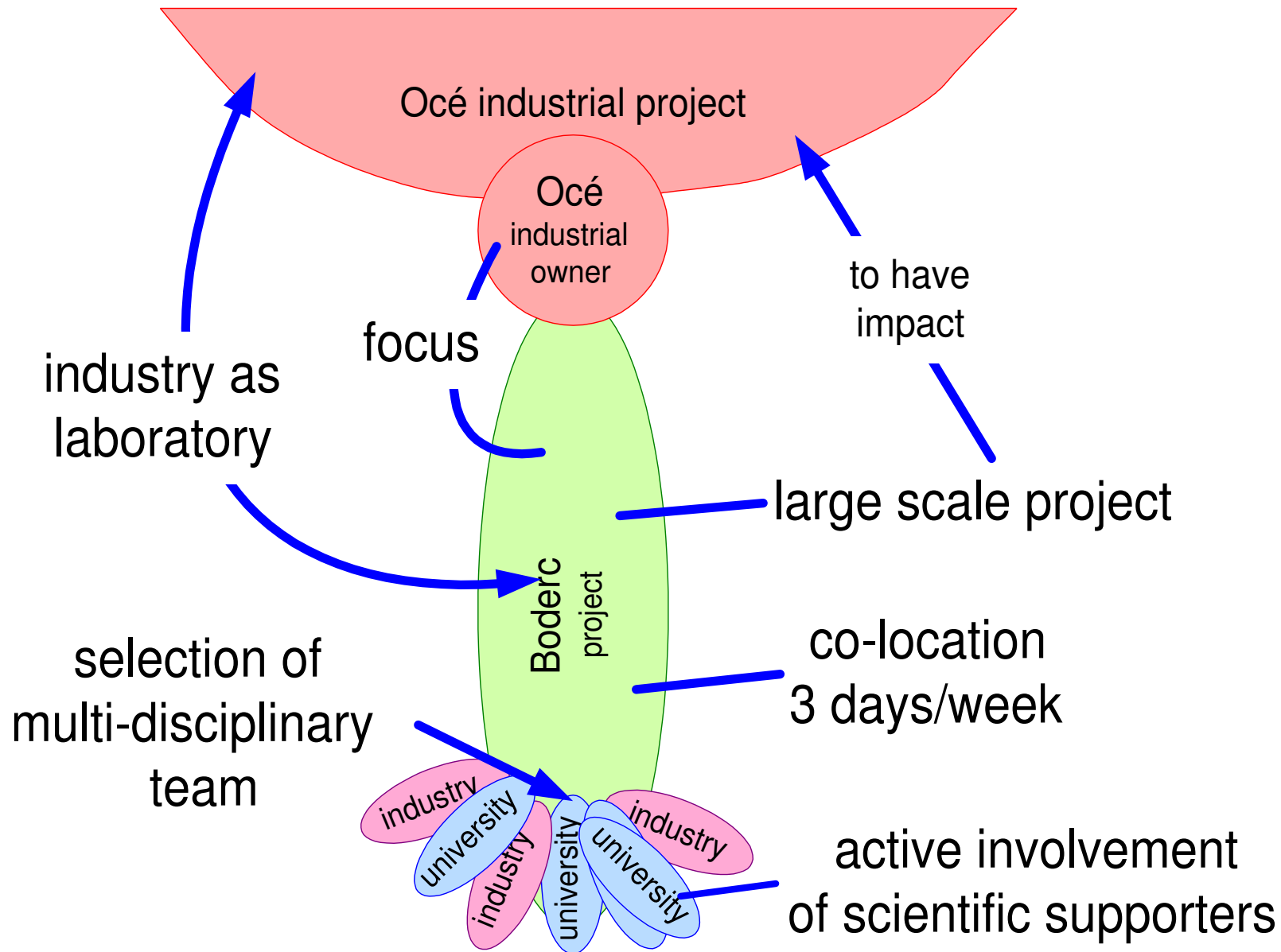


# Industry as Laboratory

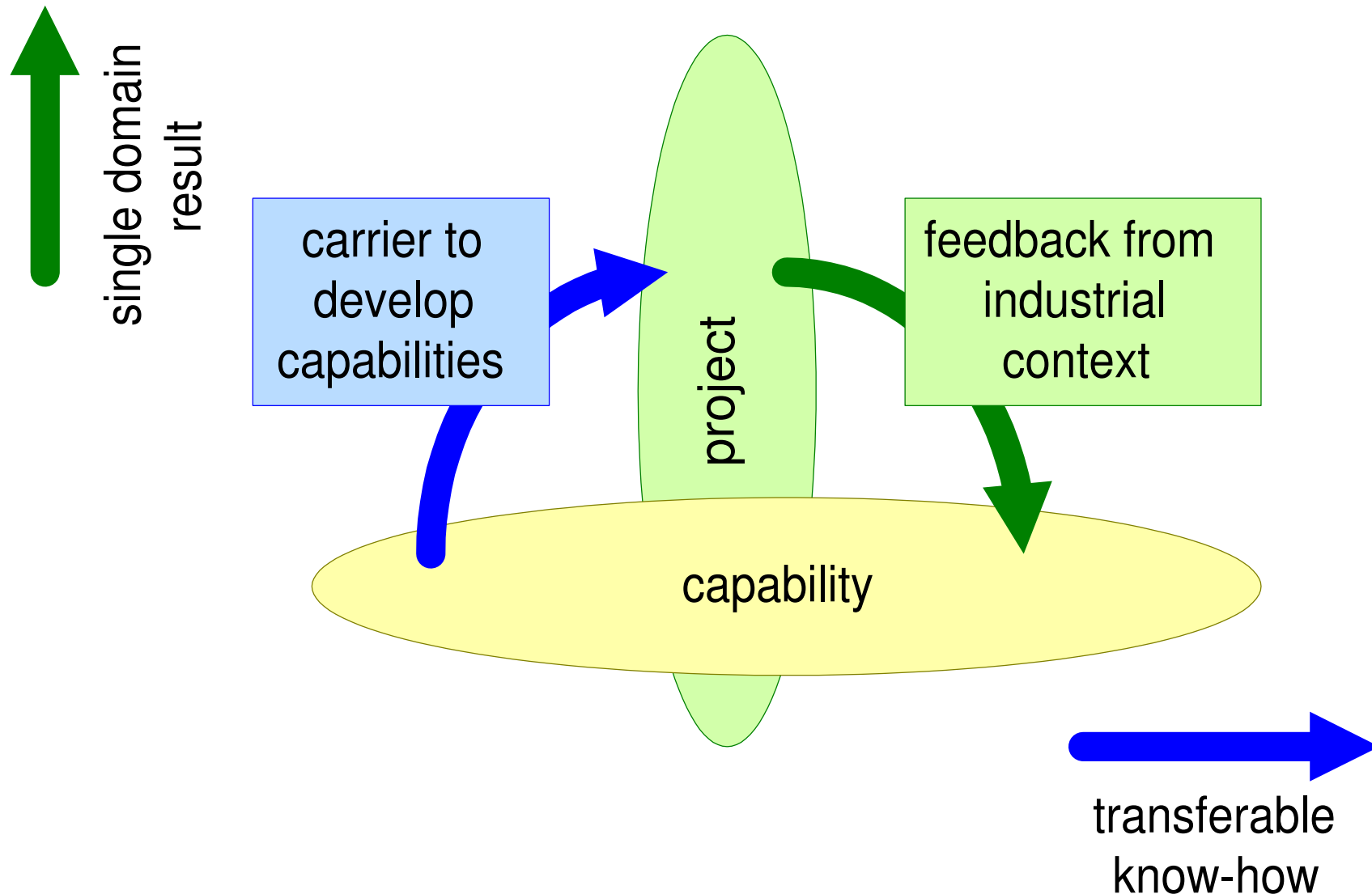




# Critical Success Factors for projects



# Project as Carrier for Capability Development





1. domain

industry

ESI

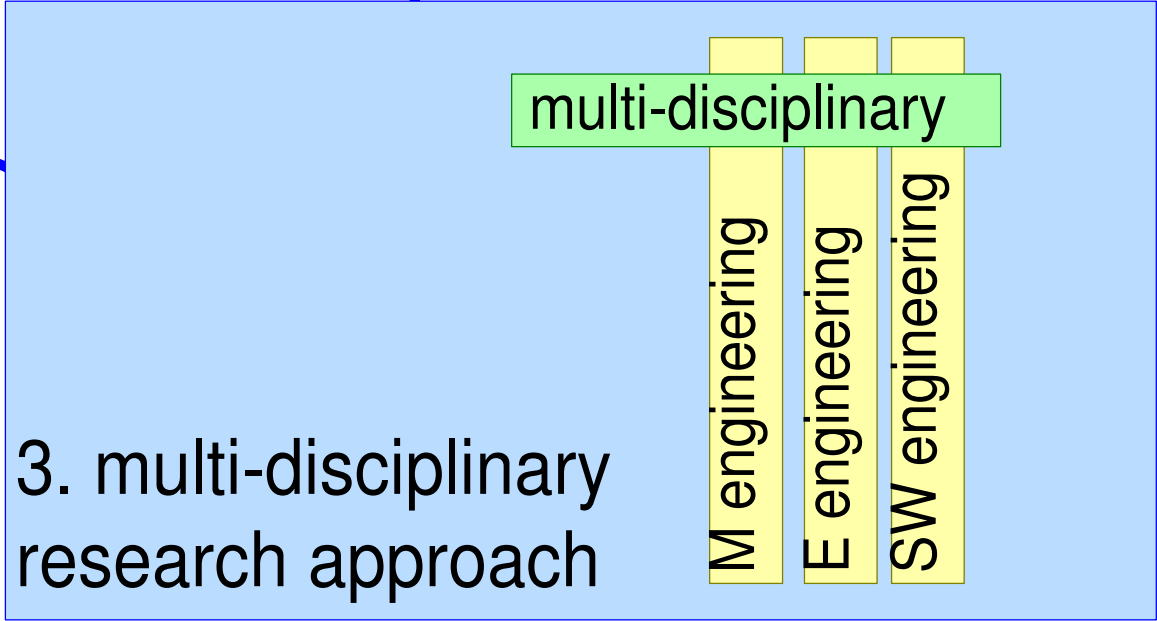
academic research

2. ESI research projects:  
industry-as-laboratory

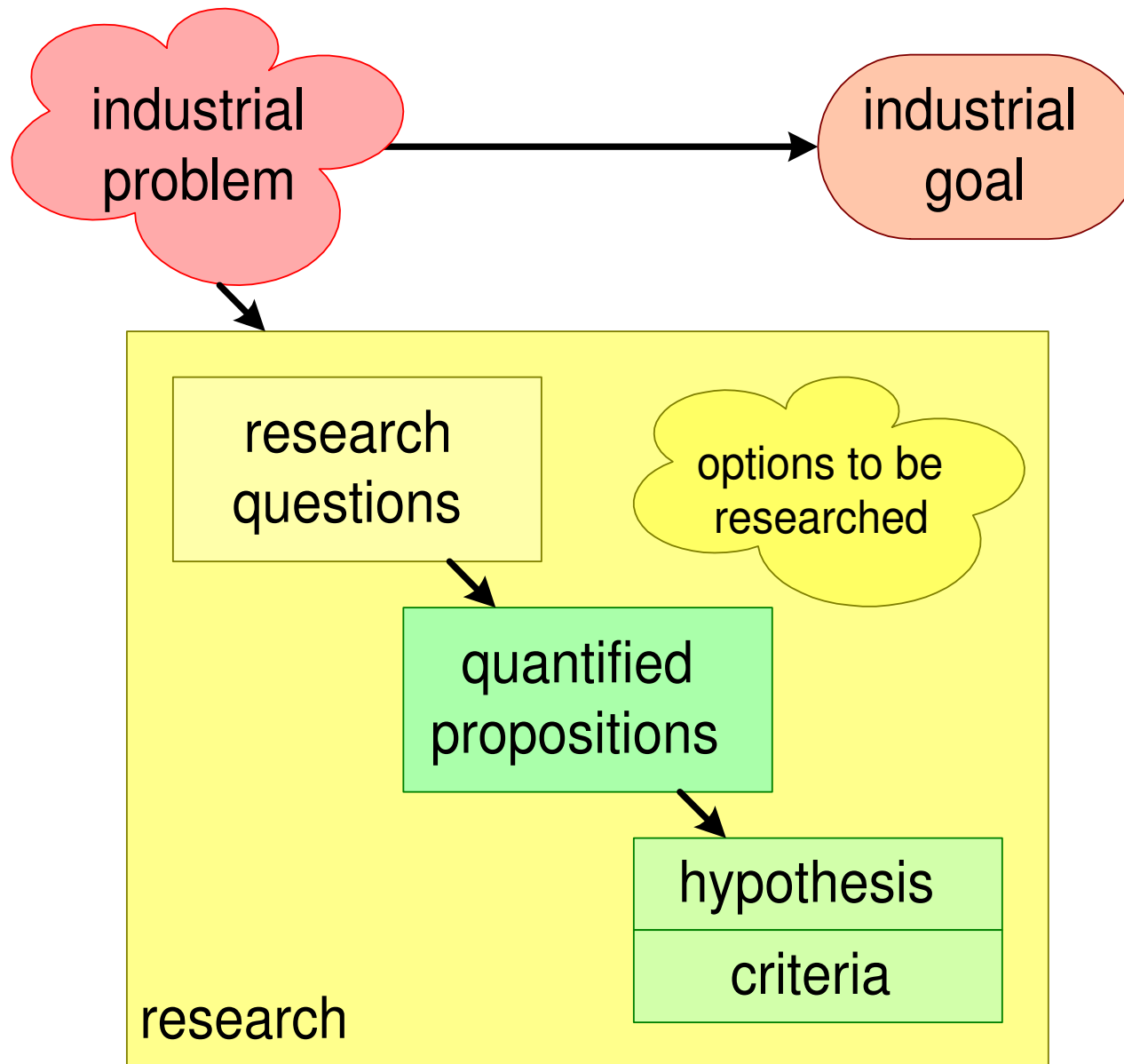
"soft" sciences  
abstraction

4. challenges

5. summary



# From Industrial Problem to Validated Research



# Boderc Research Project Goal

Boderc goal =

A specific methodology

to predict

system performance

based on modeling

and analyze, discuss, document, and communicate

multi-disciplinary

throughput, quality

within industrial constraints and restricted design space

people, process, project duration, and cost

power computing response time

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?

**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 product creation lead time  
will be reduced significantly by  
the use of multi-disciplinary models  
during the early product development phases.



1. domain

industry

ESI

academic  
research

2. ESI research projects:  
industry-as-laboratory

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multi-disciplinary

3. multi-disciplinary  
research approach

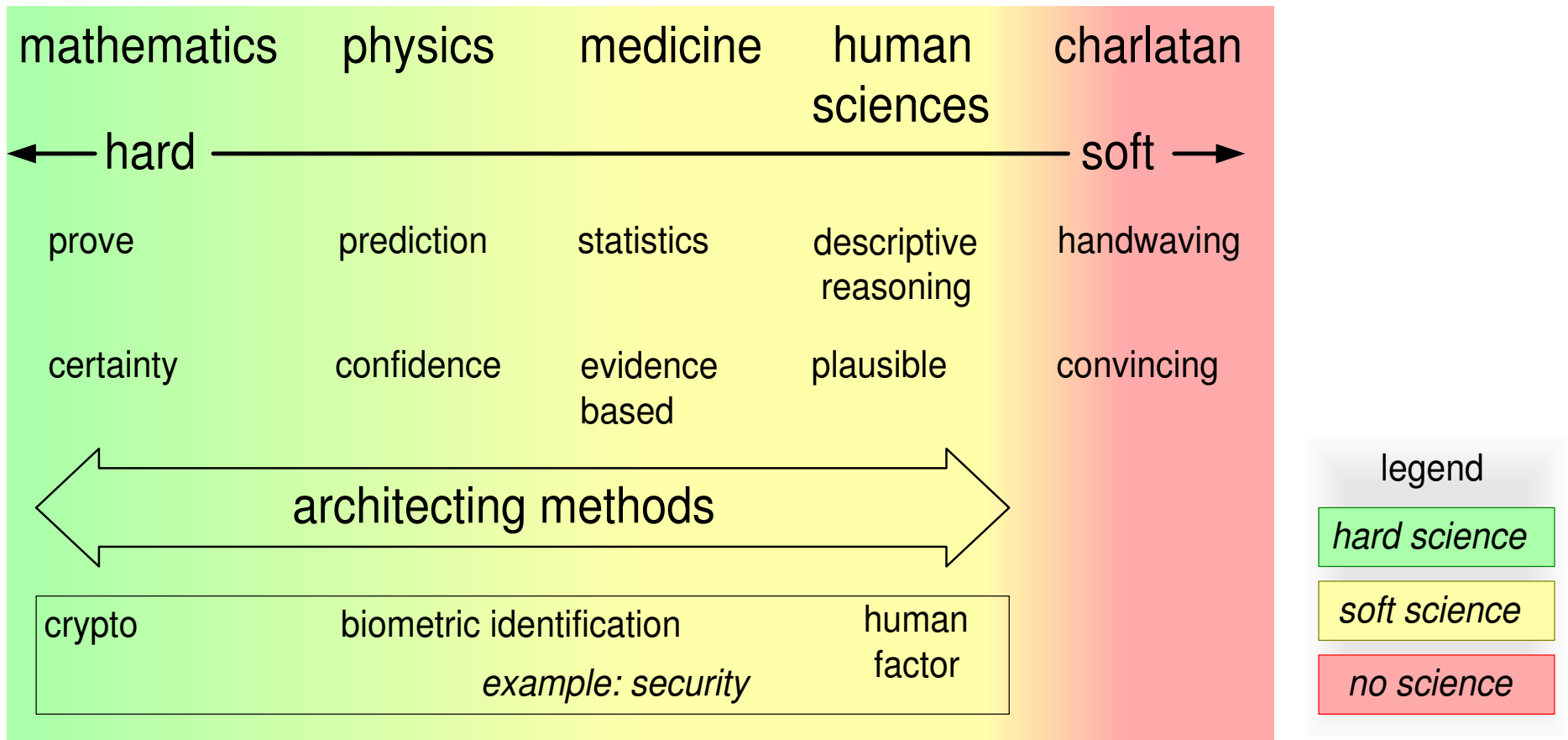
M  
engineering

E  
engineering

SW  
engineering

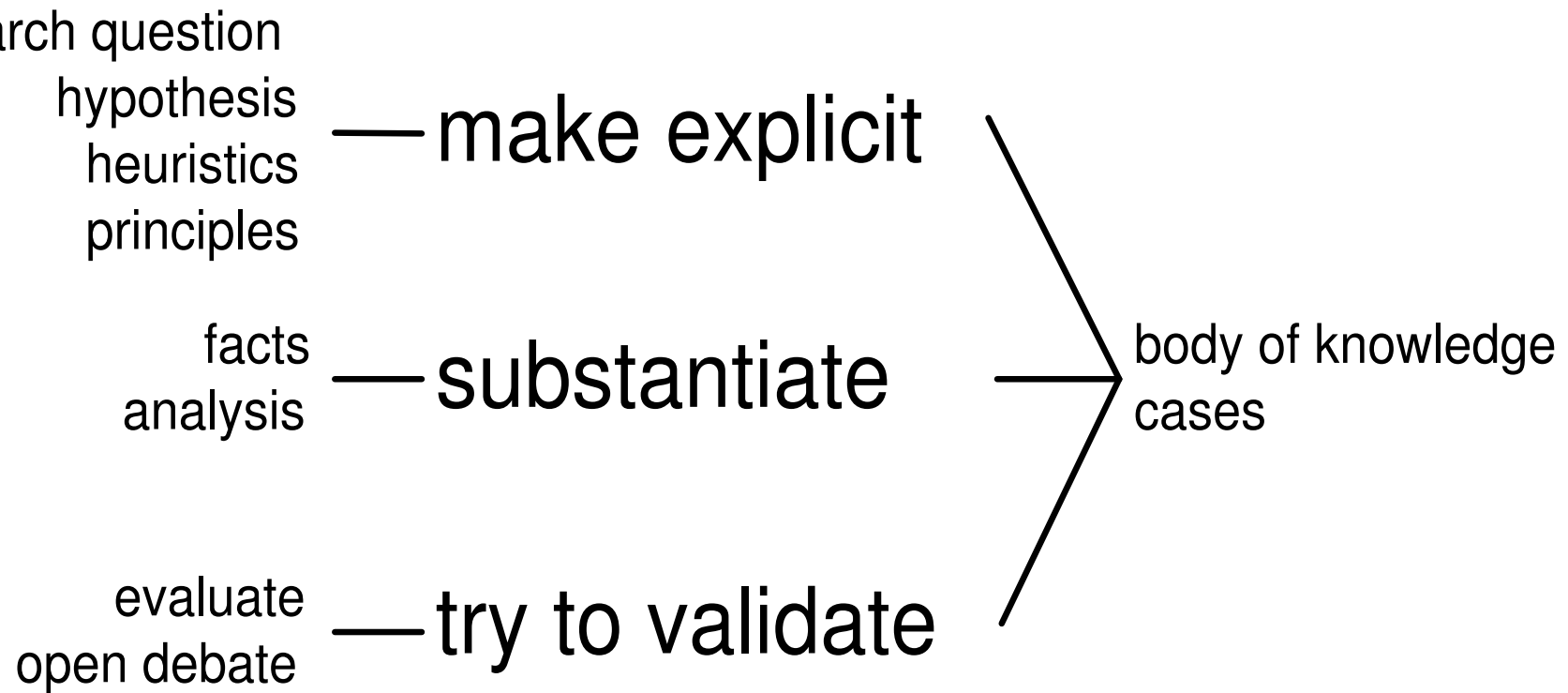
5. summary

# Spectrum of sciences

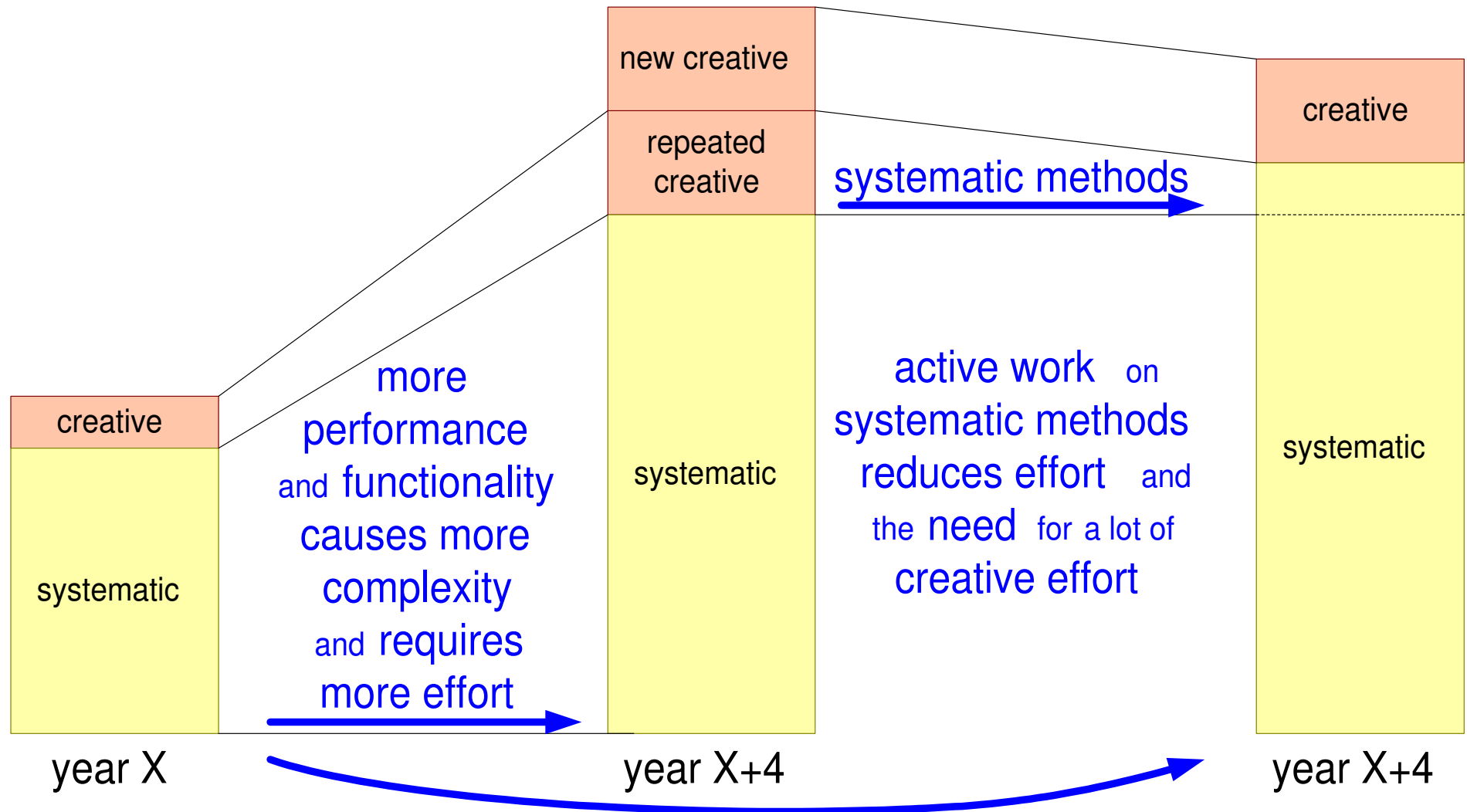


# Soft problems can be approached with a scientific attitude

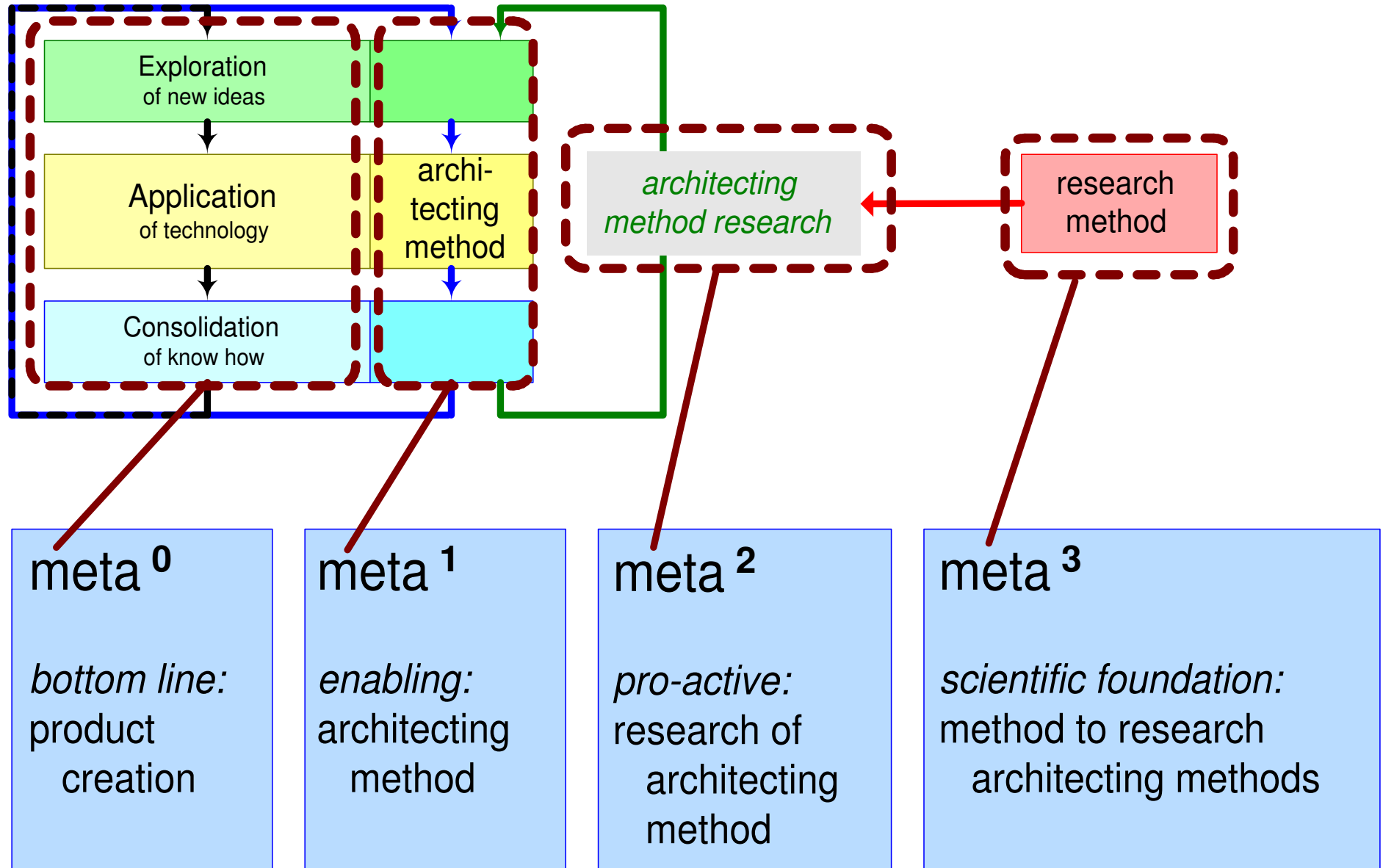
*soft is not in conflict with scientific attitude*



# Systematic Know-how to cope with Growing Complexity



# Moving in the *meta* direction





1. domain

industry

ESI

academic  
research

2. ESI research projects:  
industry-as-laboratory

multi-disciplinary

M engineering

E engineering

SW engineering

3. multi-disciplinary  
research approach

4. challenges

"soft"  
sciences

abstraction

5. summary

# Summary

