Industry Needs for Academic Systems Knowledge

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Abstract

Many complex systems are multi-disciplinary. The multi-disciplinarity is further complicating the design of these systems. Academic knowledge tends to be developed within disciplinary fields. We will discuss what systems needs are present in industry to stimulate academia to research these multi-disiciplinary system needs.

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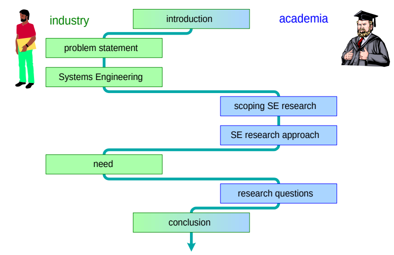

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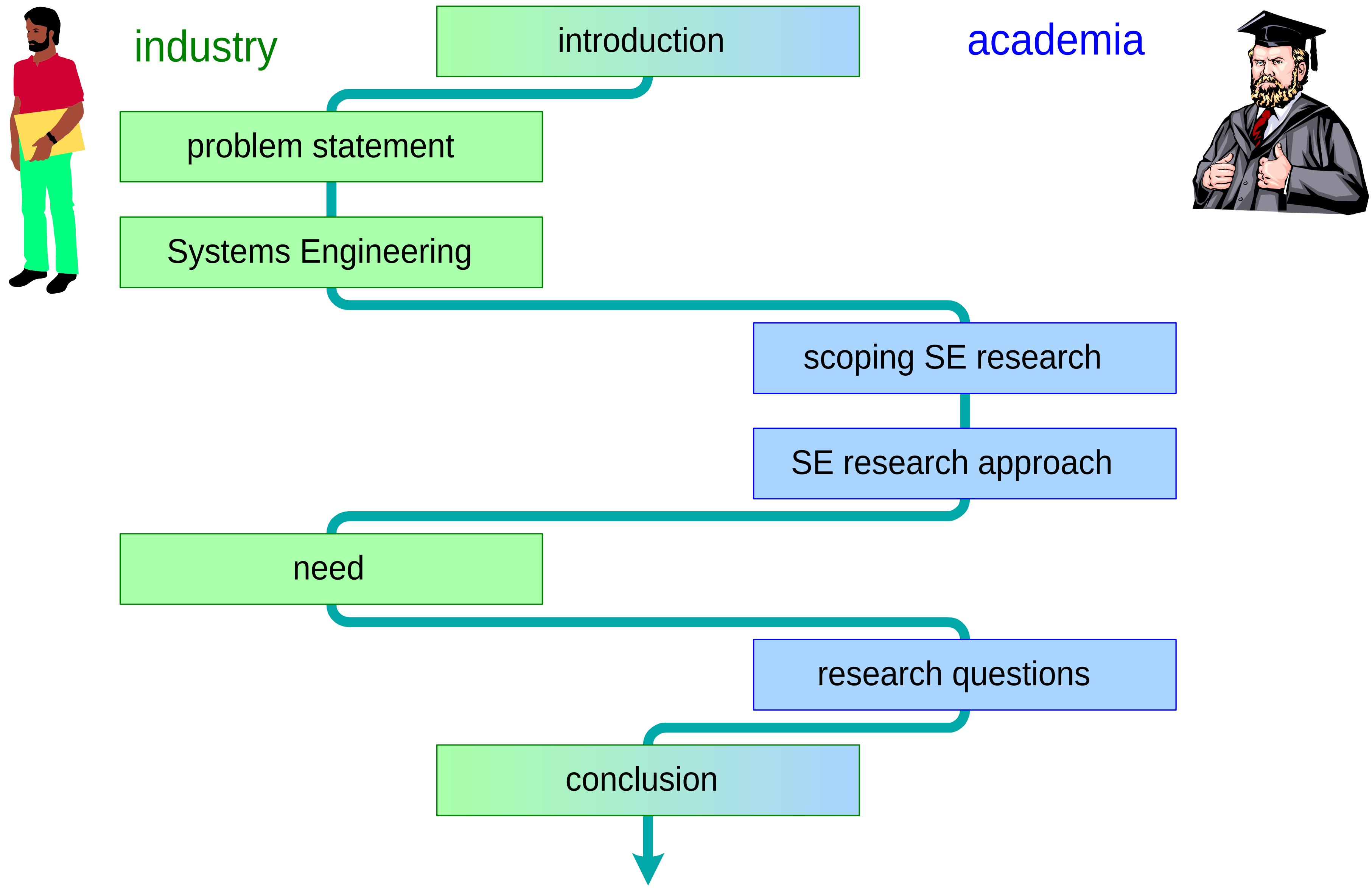
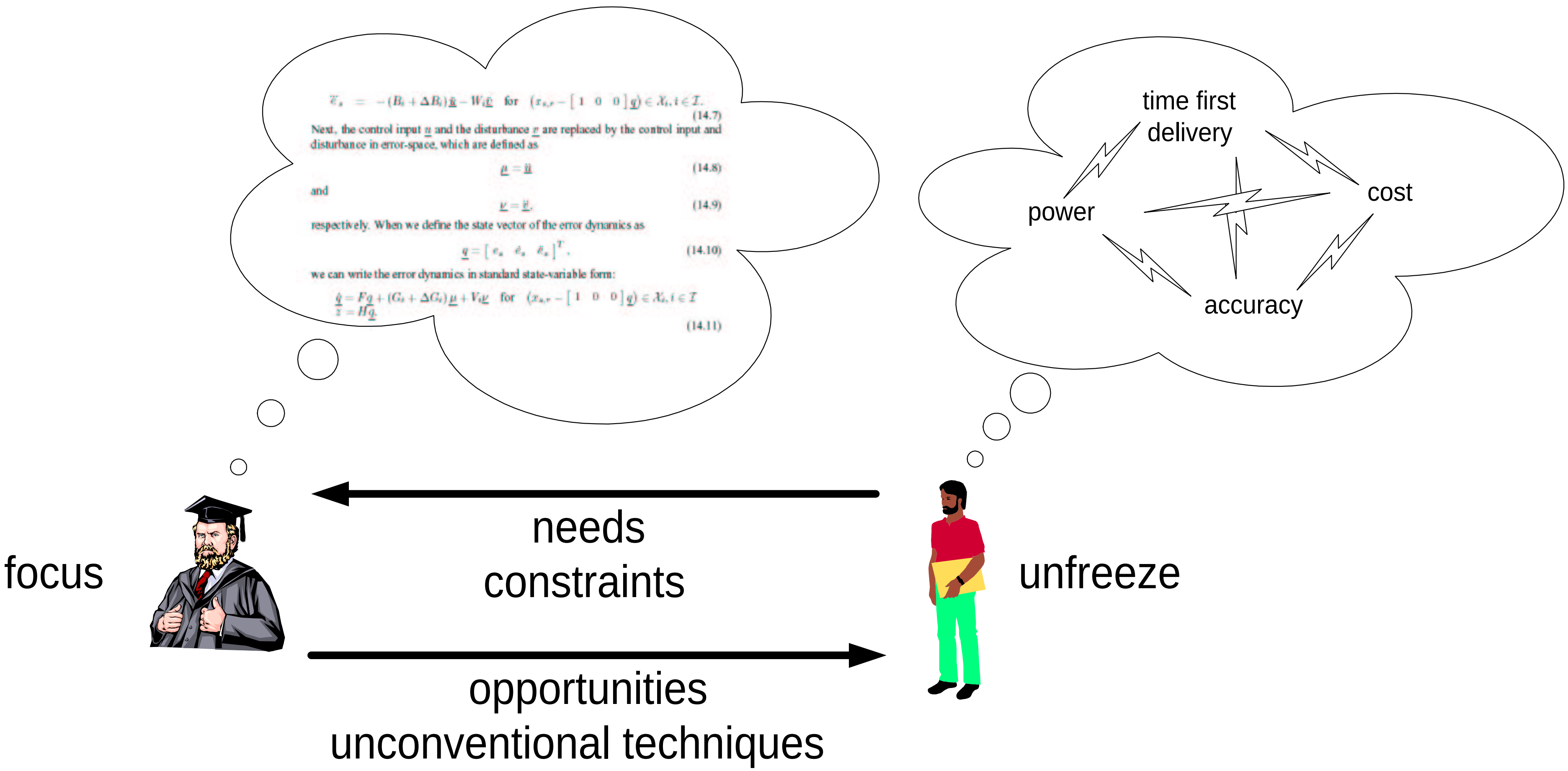
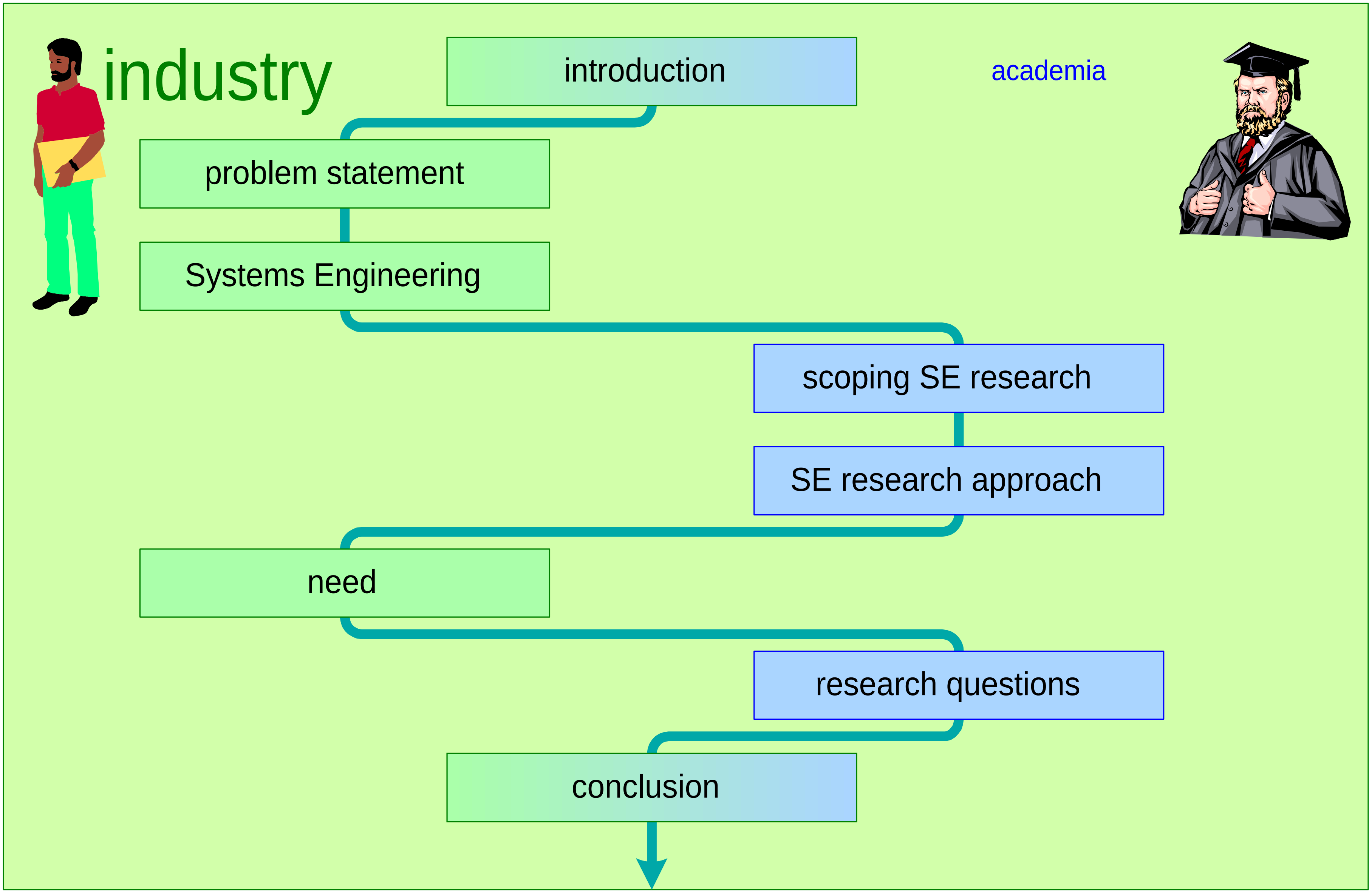


from Boderc: Tension or Opportunity?

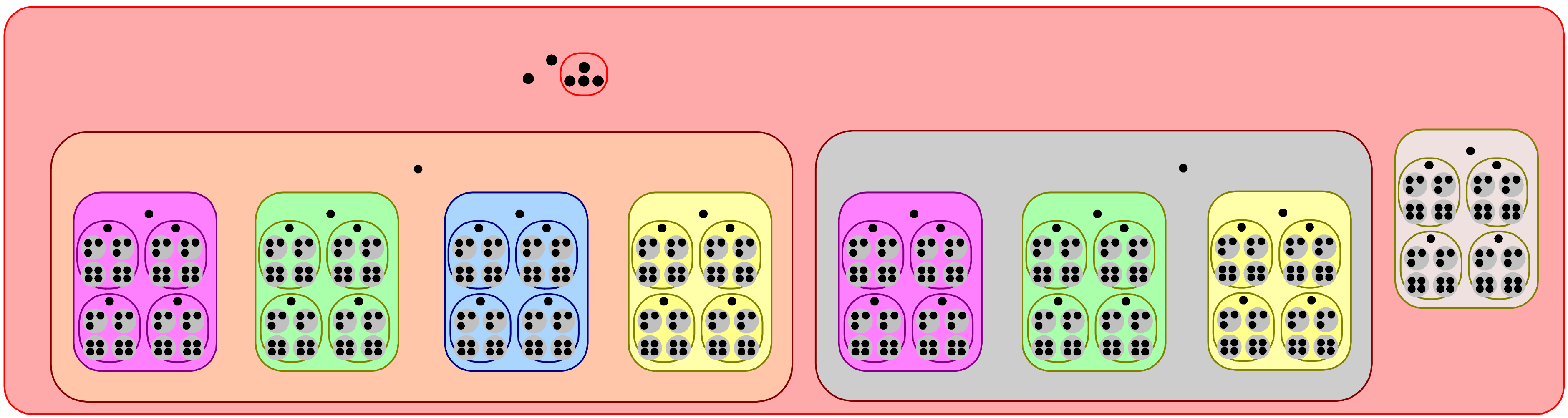


Problem Statement



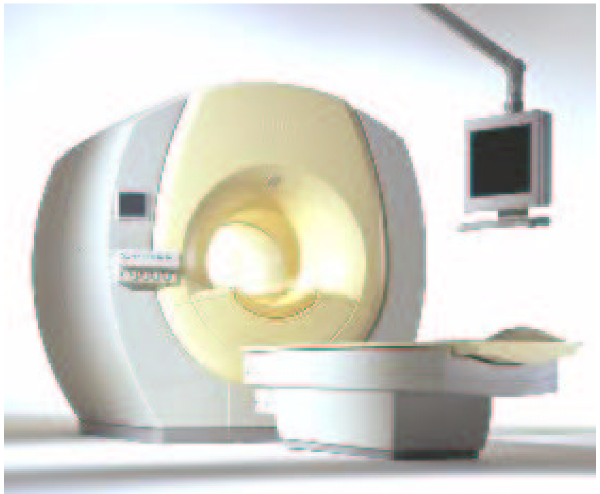
Problem Statement: Organization Size and Specialization

512 employees
many disciplines
distributed over multiple sites/countries



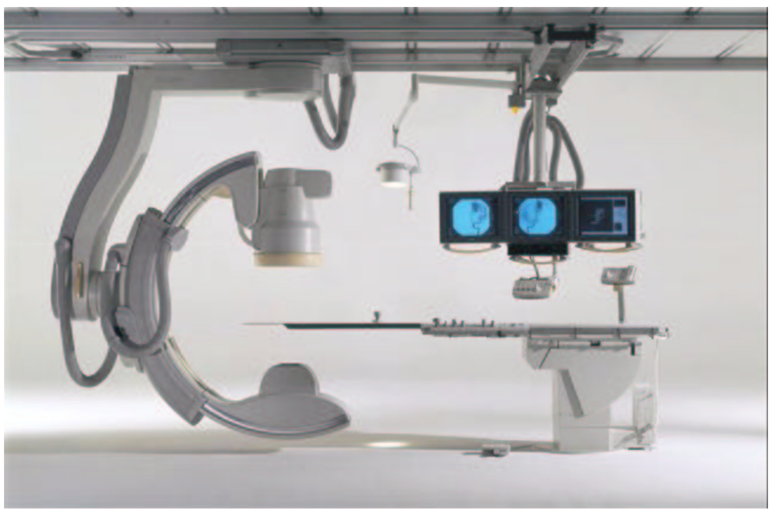
How will these 512 individual experts develop
a single consistent well-functioning system?

Examples of Complex Systems



MRI scanner

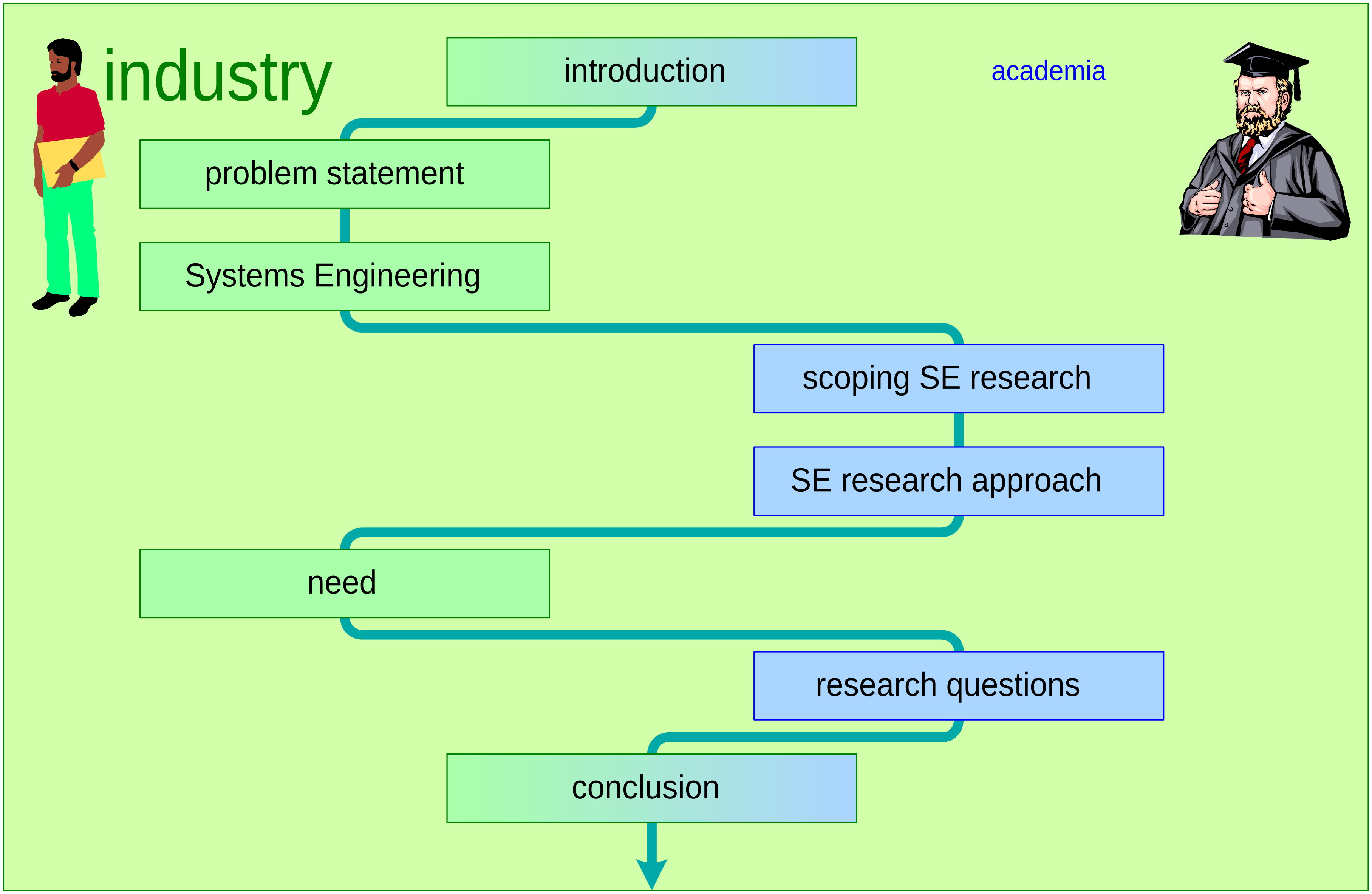
wafer stepper



Cardio Vascular Xray

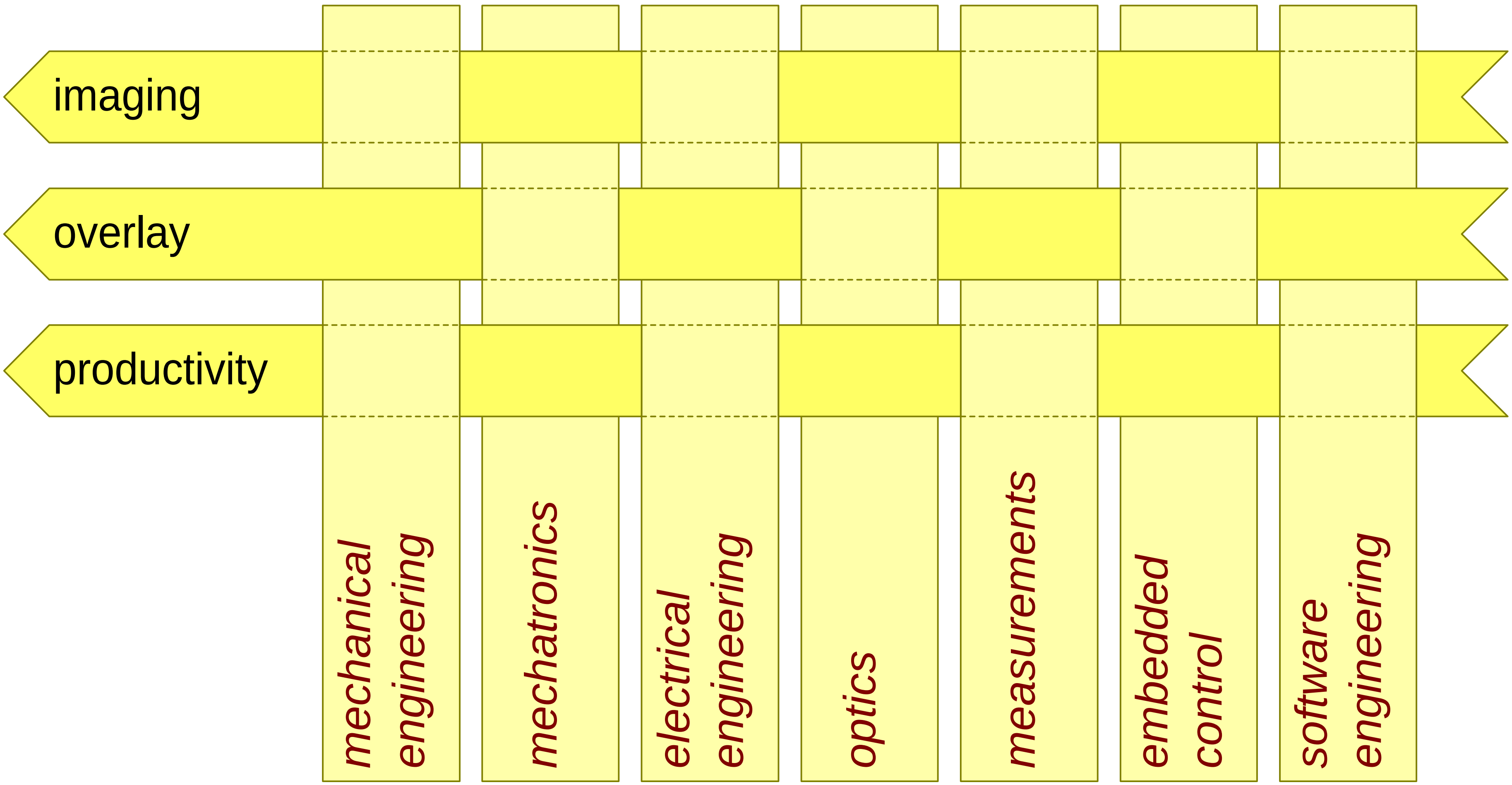
volume printer

Systems Engineering



Systems Engineering Contribution

Systems Engineering: responsible for customer key drivers
and key performance parameters of system



Example of SE job

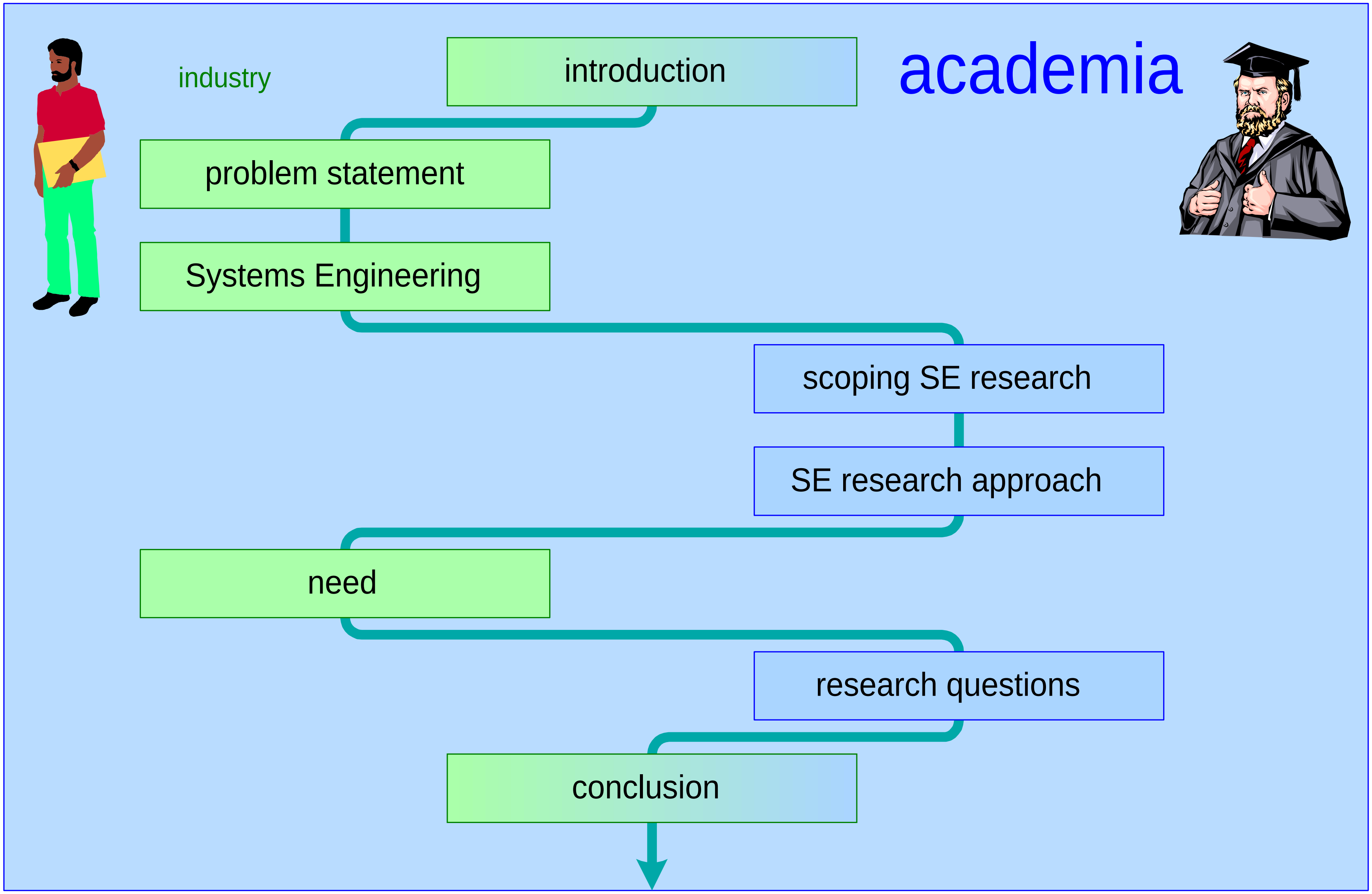
daily meeting
at 4 o'clock (natural pressure to make progress)
on invitation:

- system engineers
- project leaders
- relevant experts

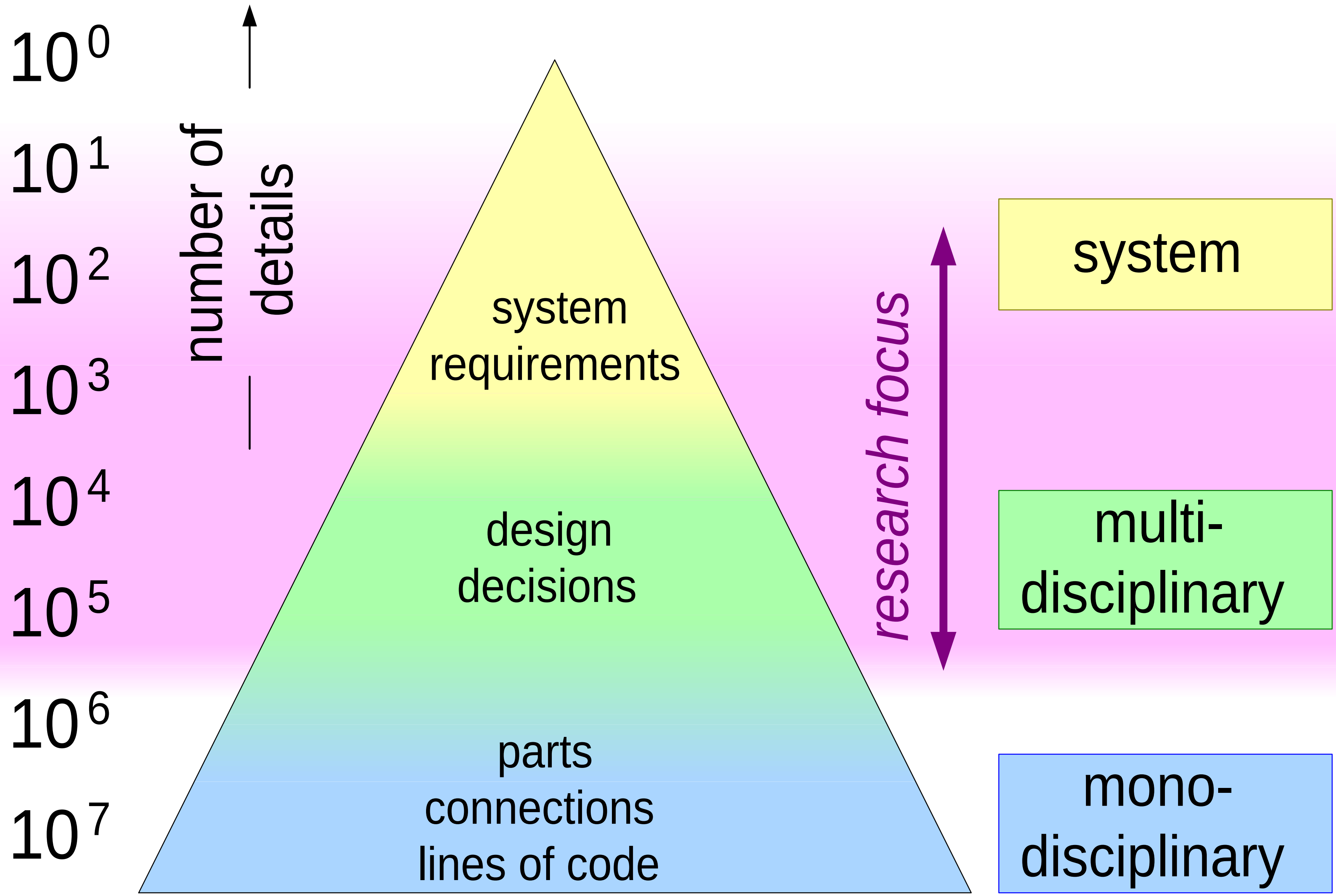
result oriented

overlay budget
wafer flatness
transport
stage concept
synchronization
system adjustments
lens specification
productivity model
integration plan
sensor concept

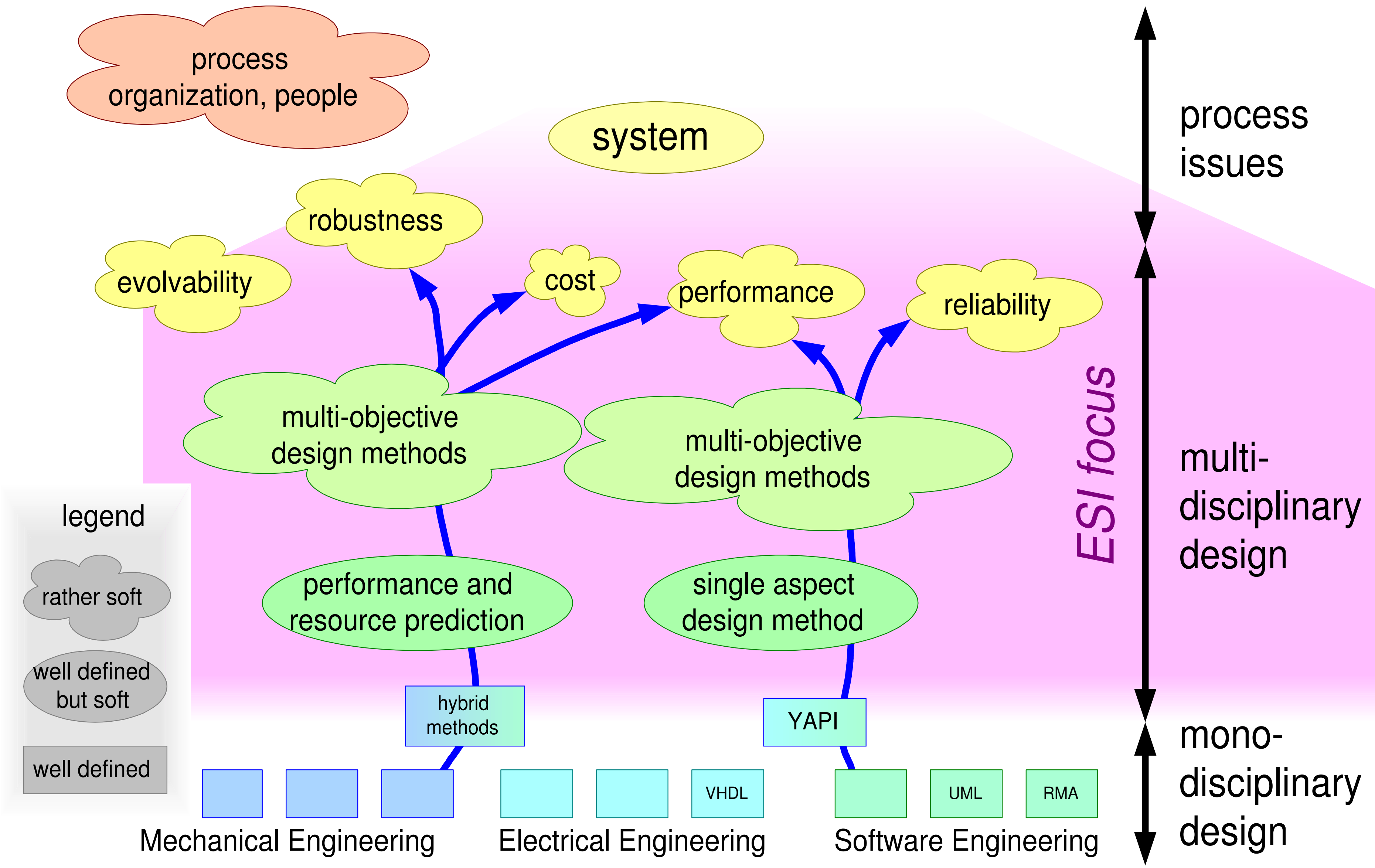
Scoping SE Research



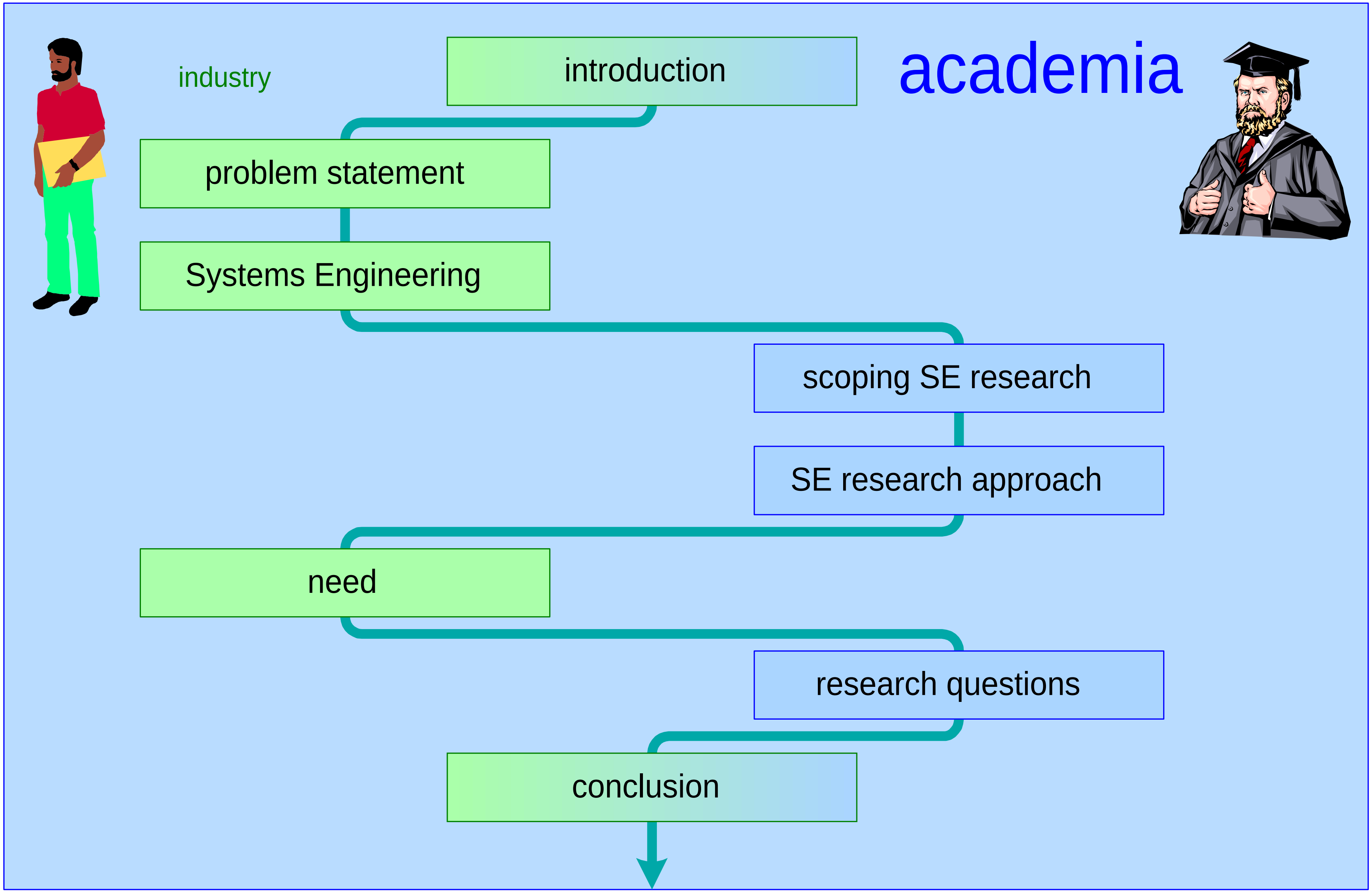
Exponential Pyramid, from requirement to bolts and nuts



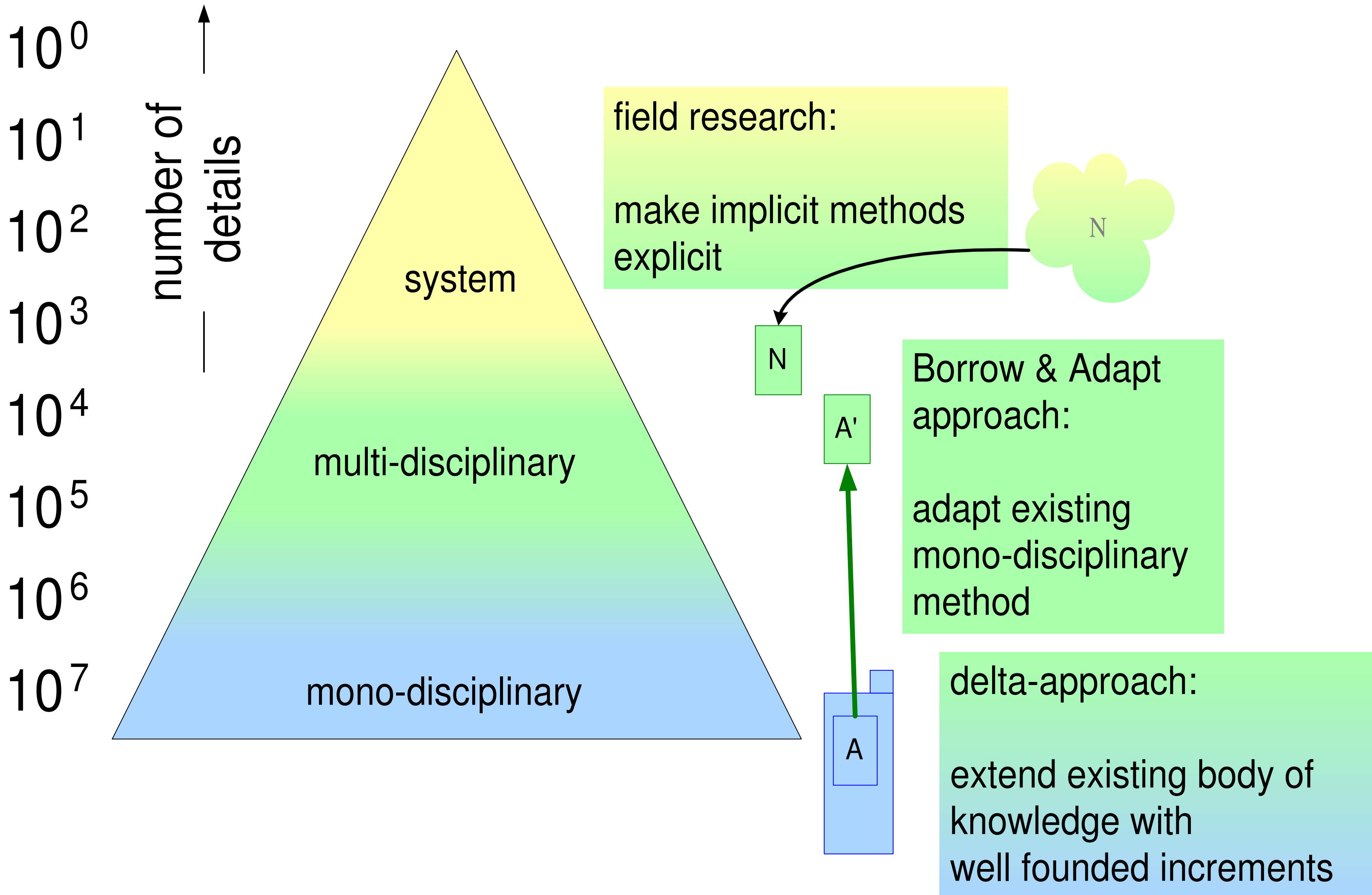
From Mono-Disciplinary to System



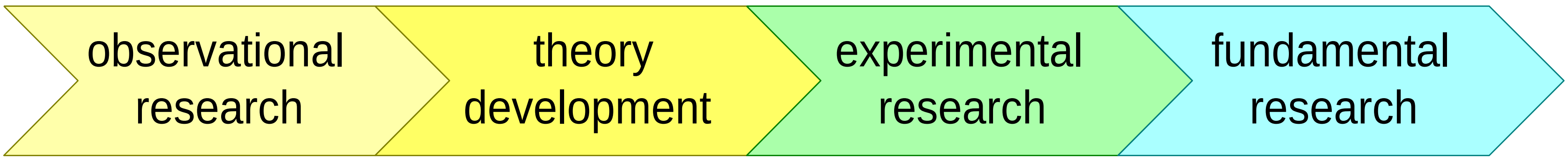
SE Research Approach



Research Methods



Systems Engineering is Young Field



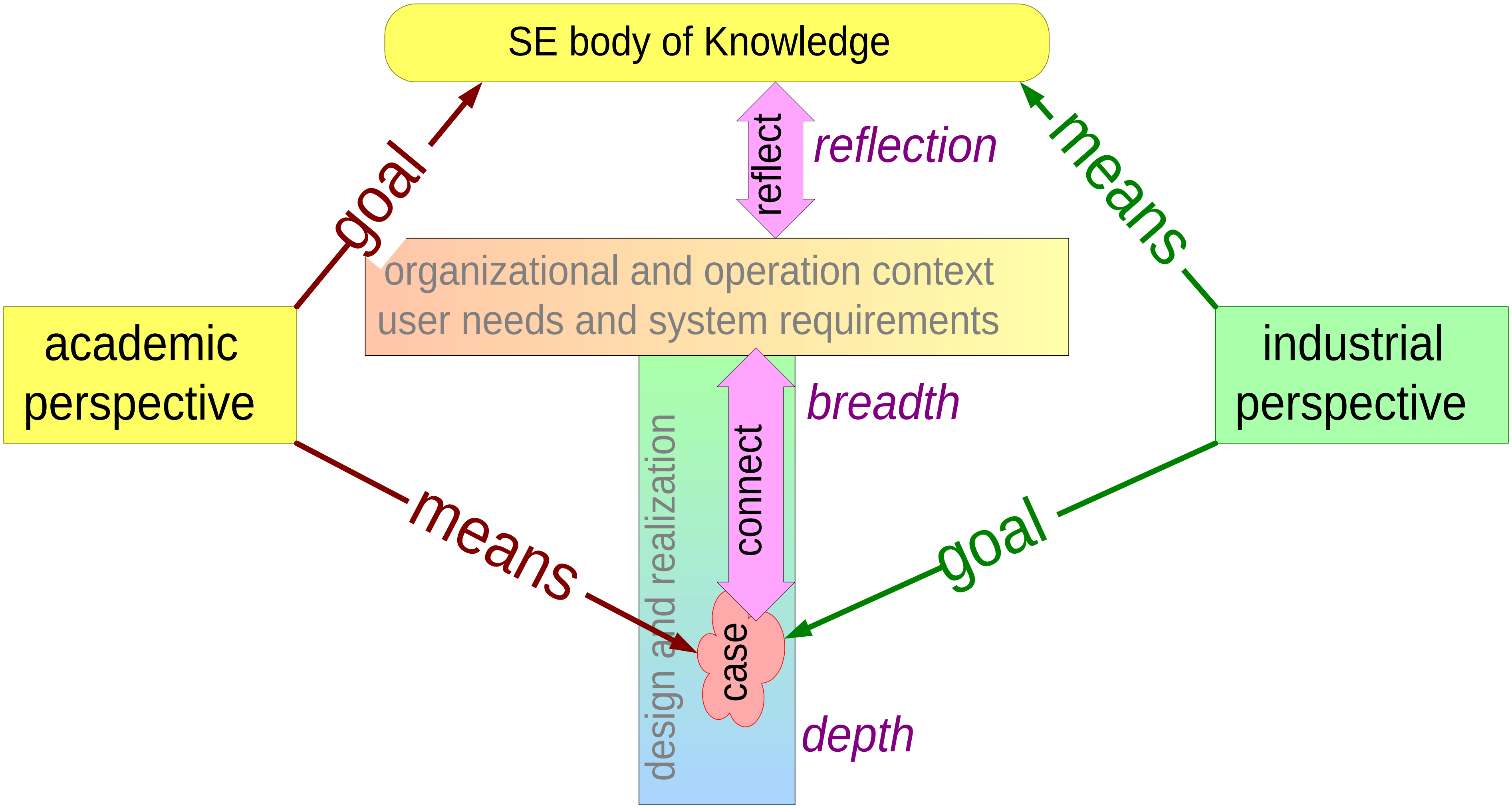
best practices
heuristics
classification
ontology

metrics
formalisms
techniques
models
methods

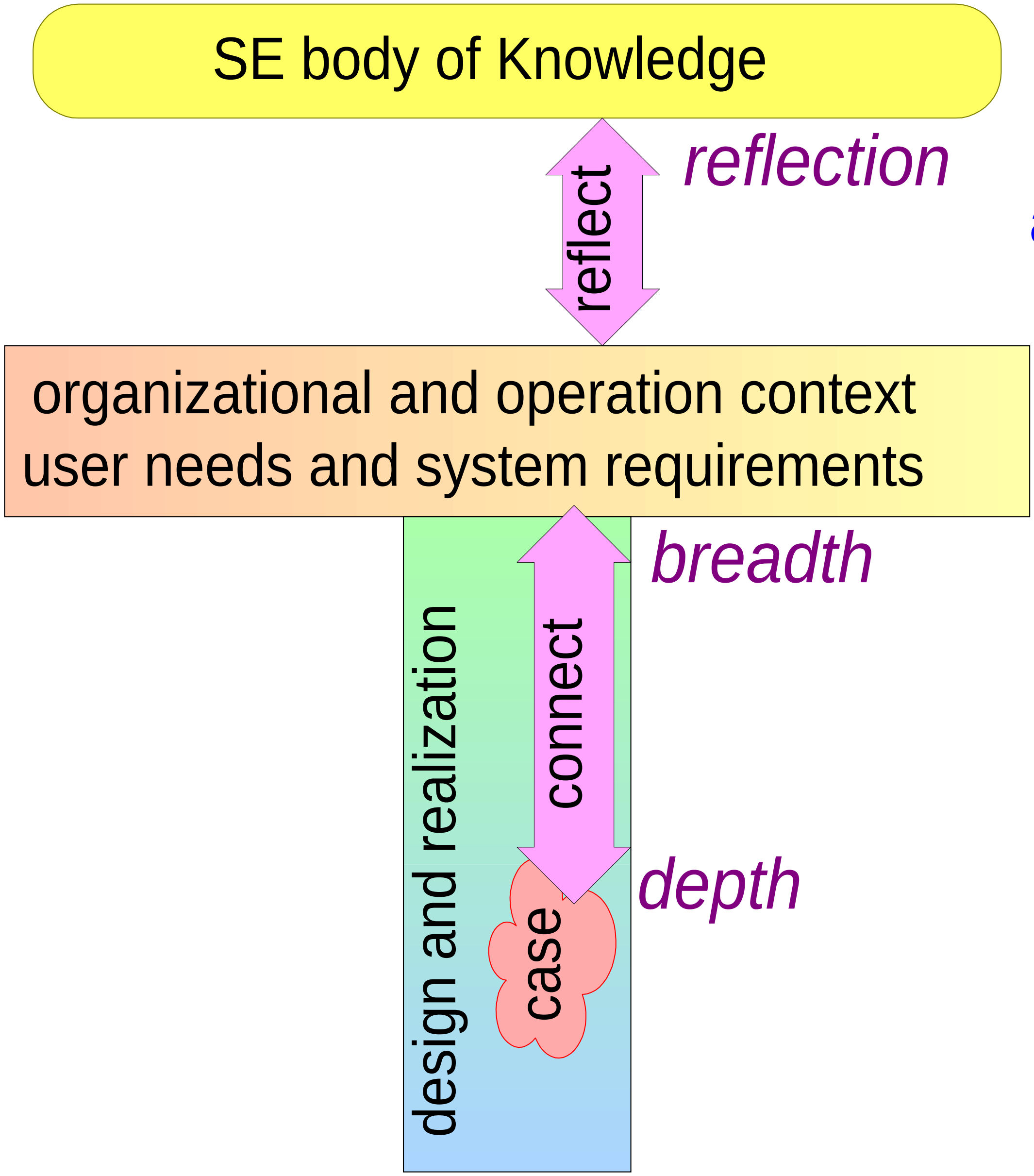
theory evaluation
theory evolution
fundamentals
principles
methodologies

optimizations
rigorous proofs
first principle based

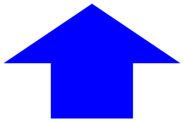
Goal-Means Inversion



Counter Intuitive Spending of Time/Effort



10%
reflection
academic achievement

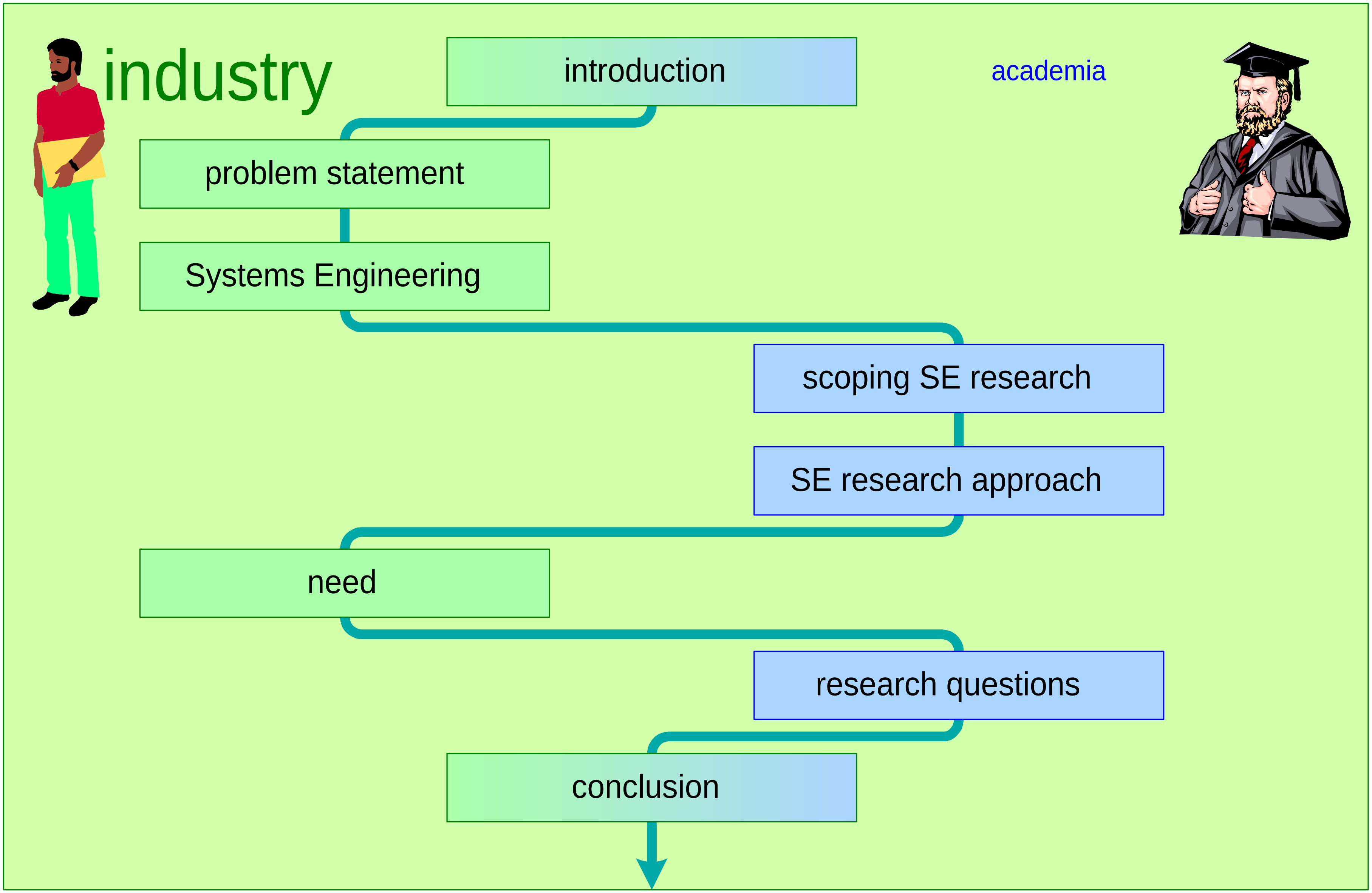


20%
context
facilitation
lubrication

+

70%
blood, sweat,
and tears

Need


industry
introduction
academia
problem statement
Systems Engineering
scoping SE research
SE research approach
need
research questions
conclusion

Designers in the Field (Industry)

How many views are used during design?

"one"-dimensional	few dimensional	many dimensional	too many	chaotic
e.g. one of	e.g. three of	e.g. ~10 of	e.g. >20	e.g. >50

object oriented, functional, behavioral, vibrations
interfaces, physical, work break down, planning
time, space, flow, cost
maintenance, life cycle, installation, manufacturing
performance, reliability, safety, security
business, process, organization, people
power, energy, cooling, efficiency
operations, exceptions, disposal, sustainability

et cetera, et cetera

majority of designers — better designers — experienced architects — *analysis paralysis*

Many Steps from Key Performance to Engineering Detail

context : other systems, environment, fab-infrastructure,
operators, IC-products, wafers, reticles, process, ...

productivity, overlay, imaging = f(*context* , ~10 main *functions*)

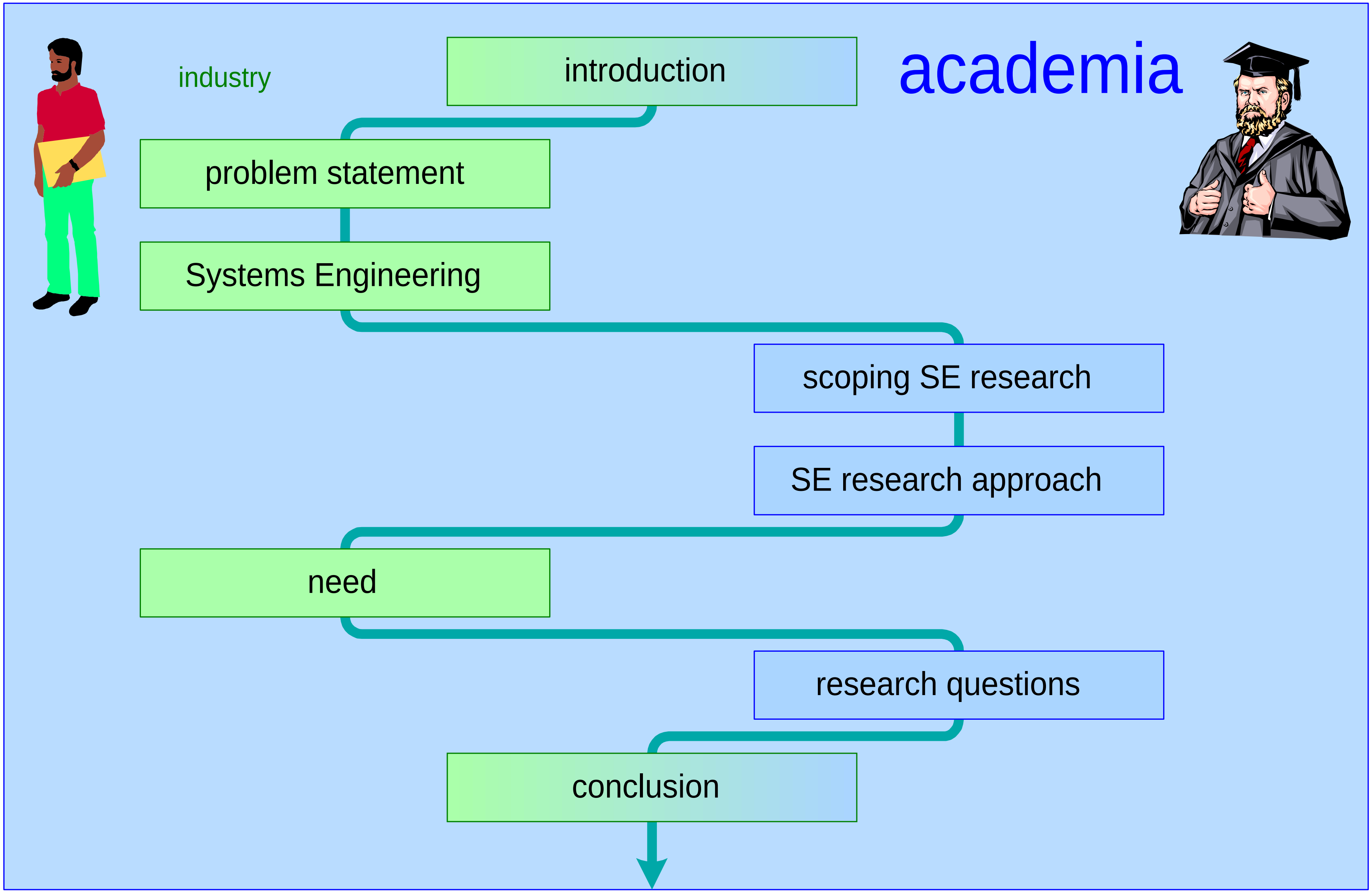
functions , e.g. align, position, level, focus, expose, load,
unload, climate condition, ... = g(15 *subsystems*)

subsystems , e.g. wafer stage, reticle stage, lens,
illuminator, laser, ... = h(1k+ of *subsubsystems*)

subsubsystems = i(10k..100k+ of hardware and
software *components*)

components = j(1M+ *statements* , *connections* , *sizes* ,
materials , ...)

Research Questions



Example Research Questions

What makes good systems architects successful?

How to design in many dimensional space?

How to cope with heterogeneous dimensions?

How to distribute work over many designers?

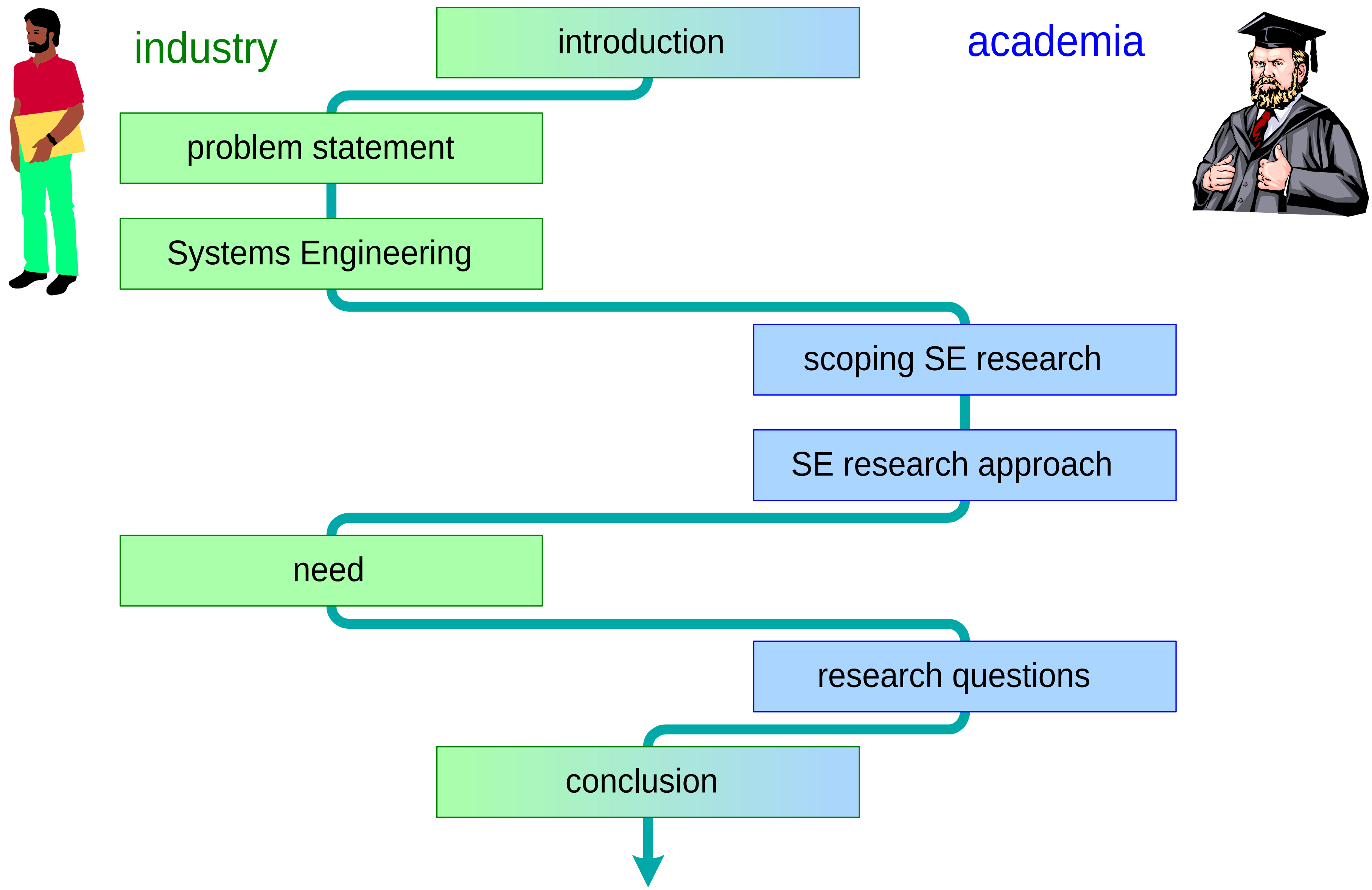
What design methods prevent integration surprises?

What models support the multi-disciplinary design?

et cetera

et cetera

Conclusion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Industry and Systems Research

industry	systems reseach
=	requires:
field (to be observed)	open/perceptive attitude
laboratory (to experiment)	critical attitude
customer (to benefit)	large dynamic range

isn't that the meaning of academic?