

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-disciplinary system needs.

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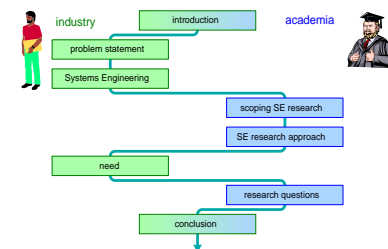


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from Boderc: Tension or Opportunity?

$$\dot{\tilde{x}}_s = -(B_s + \Delta B_s)\tilde{x} - W_s\tilde{u} \quad \text{for } (x_{s,r} - [1 \ 0 \ 0]\tilde{y}) \in \mathcal{X}_s, i \in \mathcal{I}. \quad (14.7)$$

Next, the control input \tilde{u} and the disturbance \tilde{x} are replaced by the control input and disturbance in error-space, which are defined as

$$\tilde{u} = \underline{\tilde{u}} \quad (14.8)$$

and

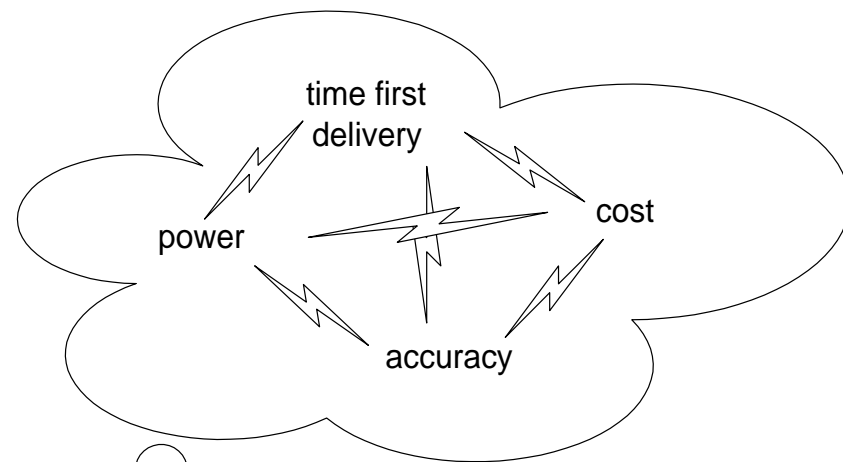
$$\tilde{x} = \underline{\tilde{x}}. \quad (14.9)$$

respectively. When we define the state vector of the error dynamics as

$$\underline{q} = [e_s \ e_s \ e_s]^T, \quad (14.10)$$

we can write the error dynamics in standard state-variable form:

$$\begin{aligned} \dot{\underline{q}} &= F\underline{q} + (G_s + \Delta G_s)\underline{\tilde{u}} + V_s\underline{\tilde{x}} \quad \text{for } (x_{s,r} - [1 \ 0 \ 0]\tilde{y}) \in \mathcal{X}_s, i \in \mathcal{I} \\ \tilde{z} &= H\underline{q}. \end{aligned} \quad (14.11)$$



focus



needs
constraints

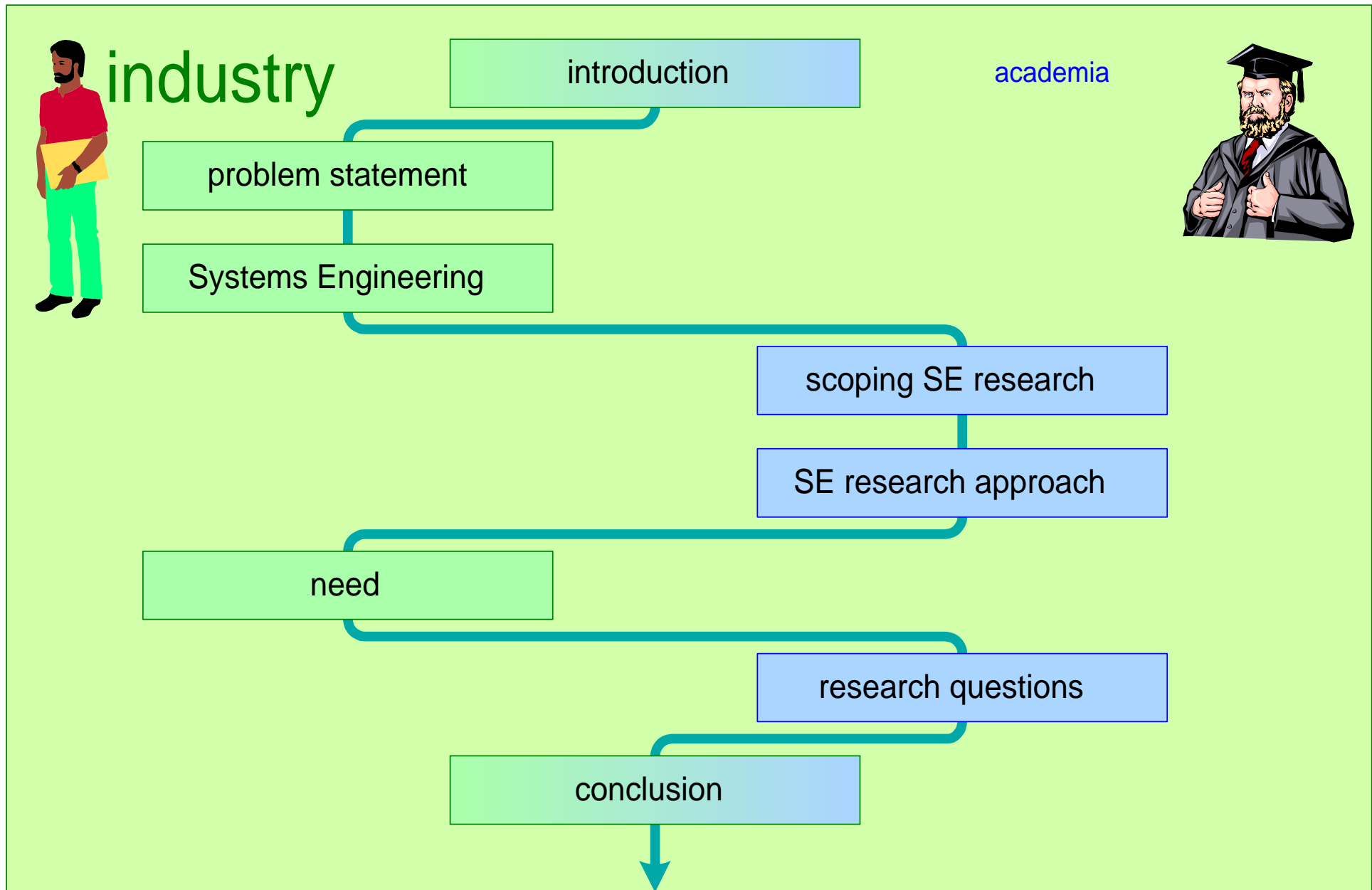


opportunities
unconventional techniques

unfreeze

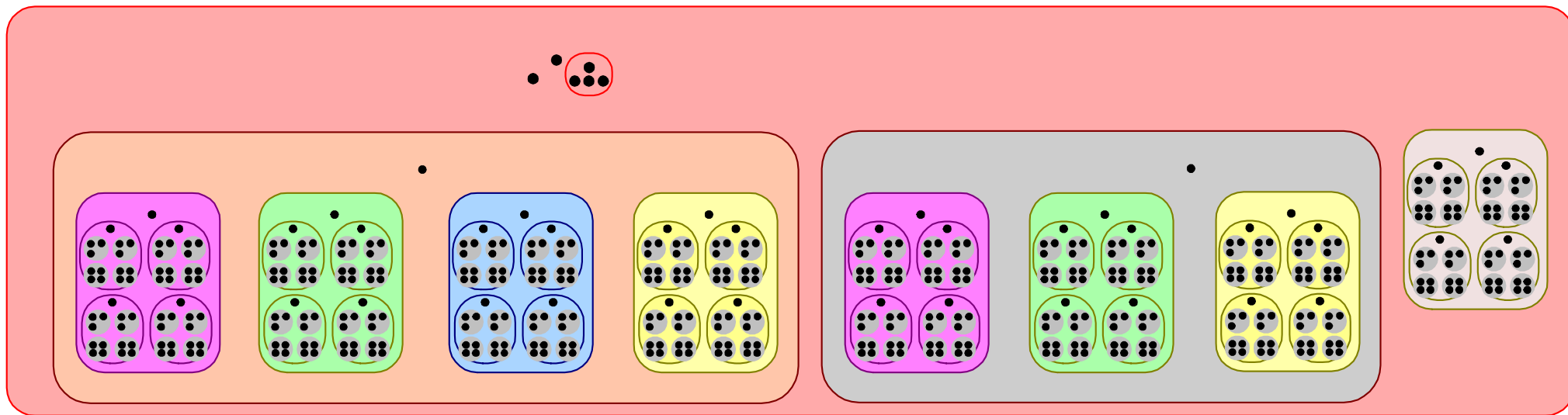


Problem Statement



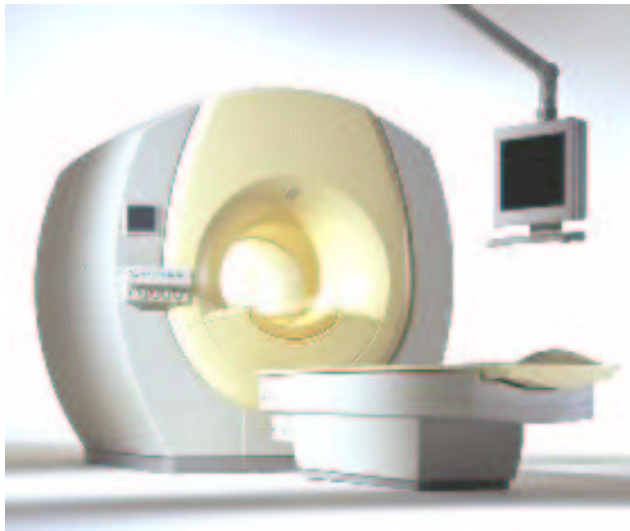
Problem Statement: Organization Size and Specialization

512 employees
many disciplines
distributed over multiple sites/countries



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

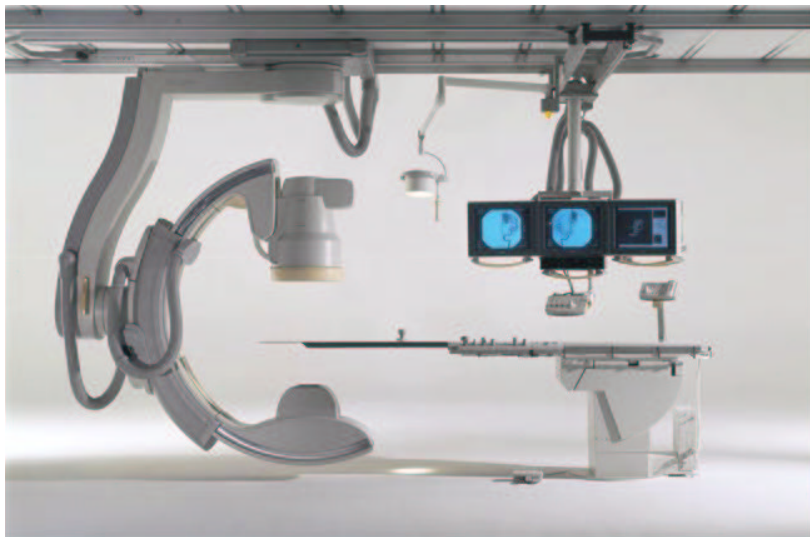
Examples of Complex Systems



MRI scanner



wafer stepper

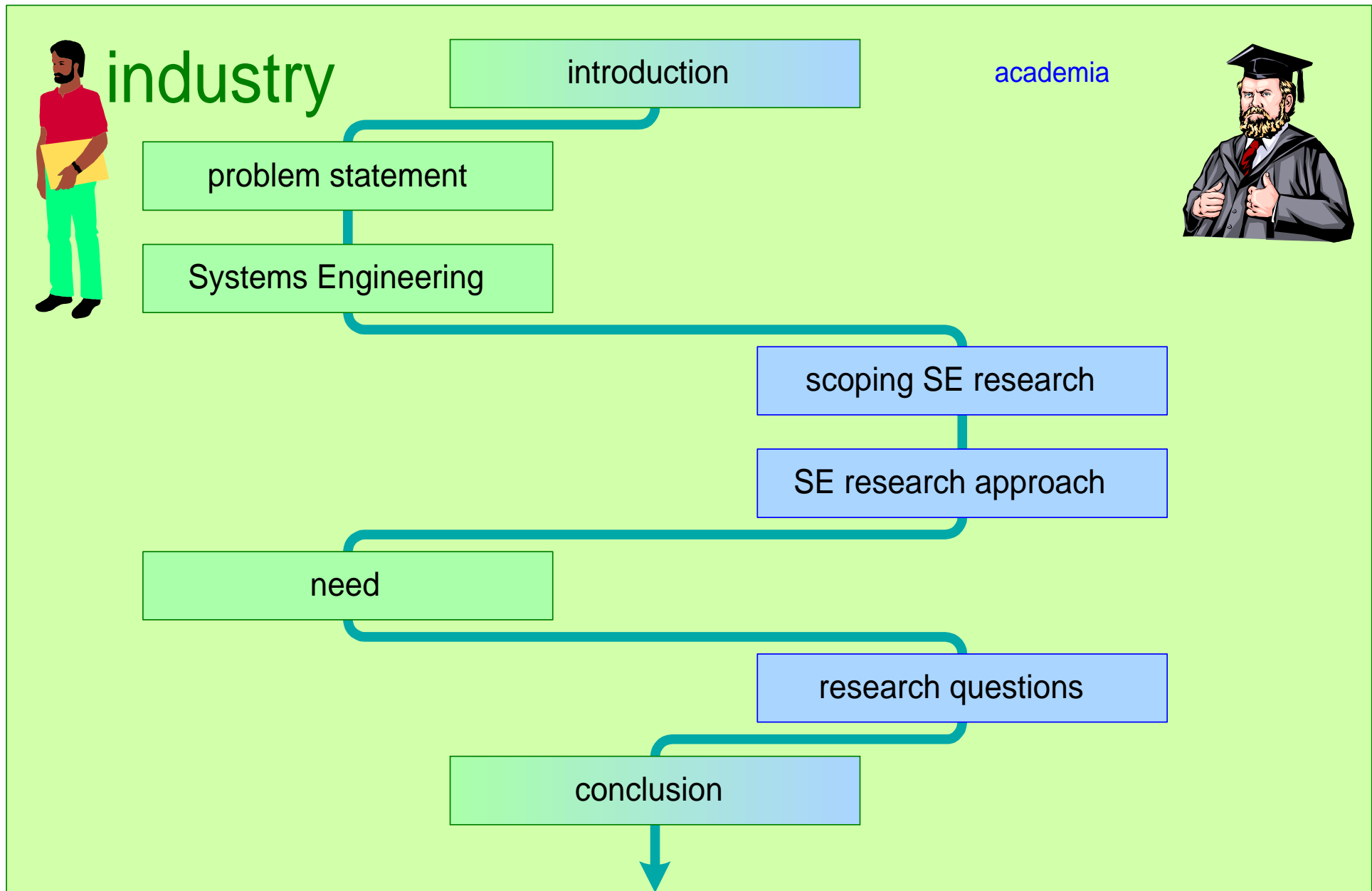


Cardio Vascular Xray



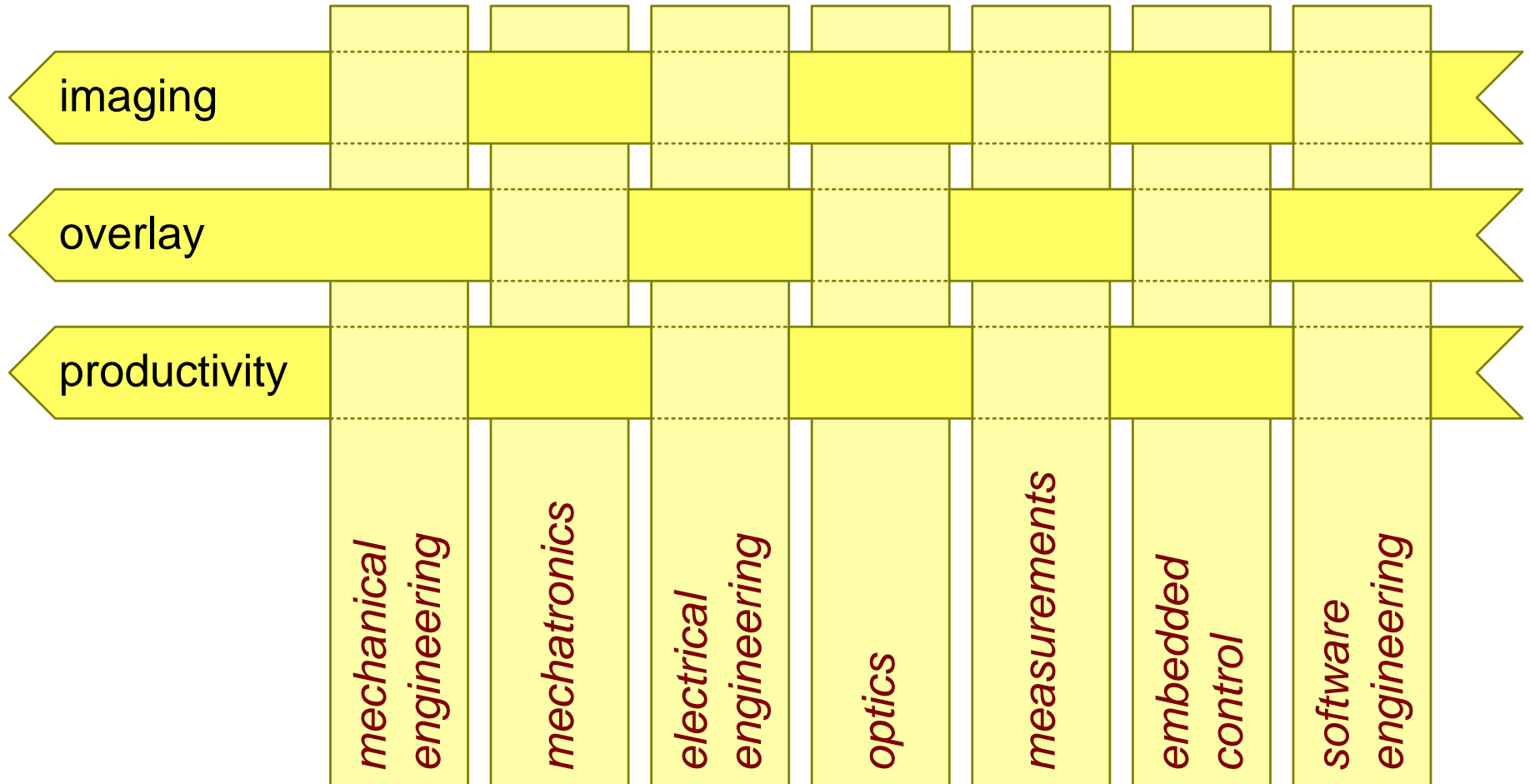
volume printer

Systems Engineering

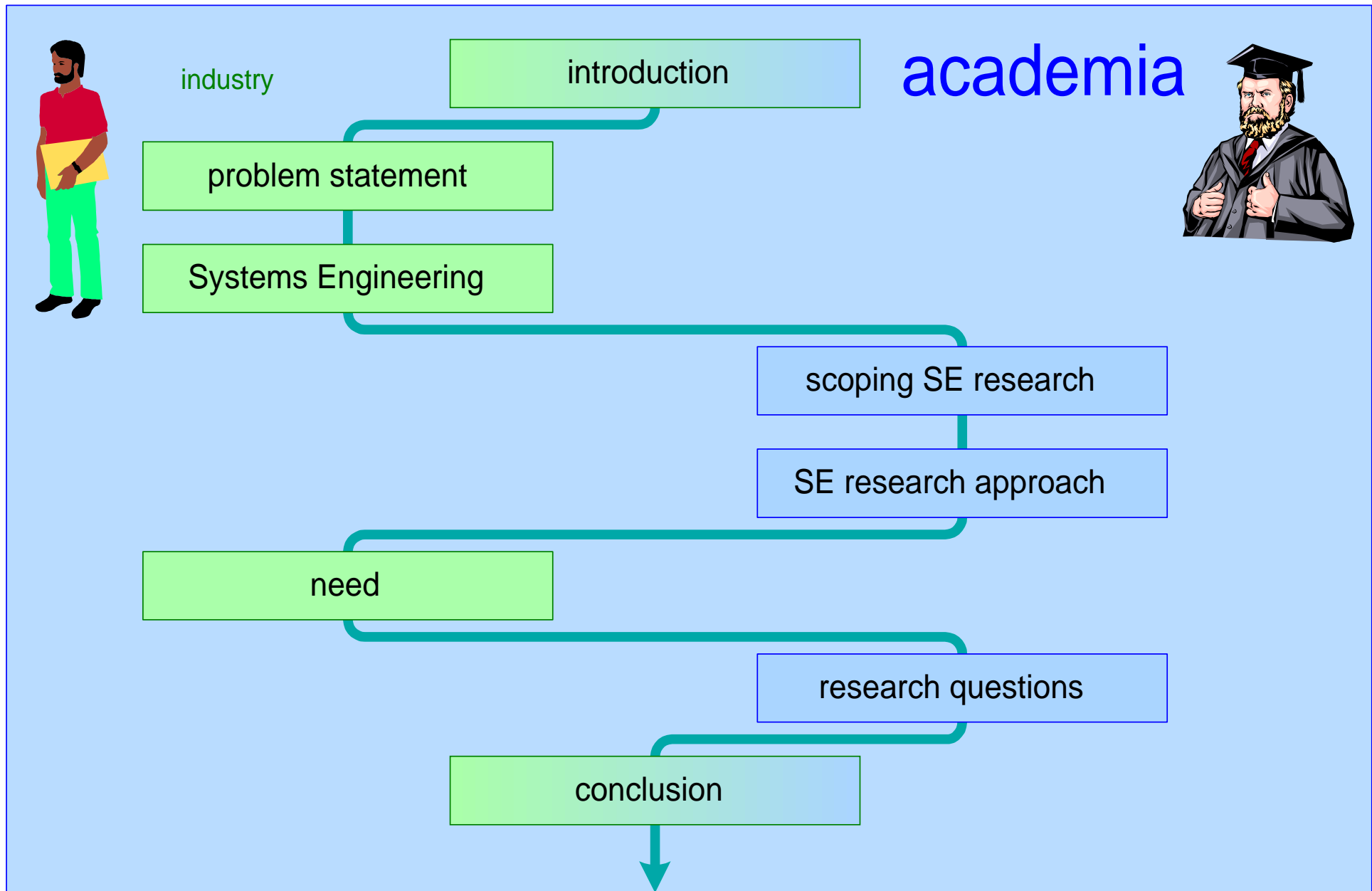


Systems Engineering Contribution

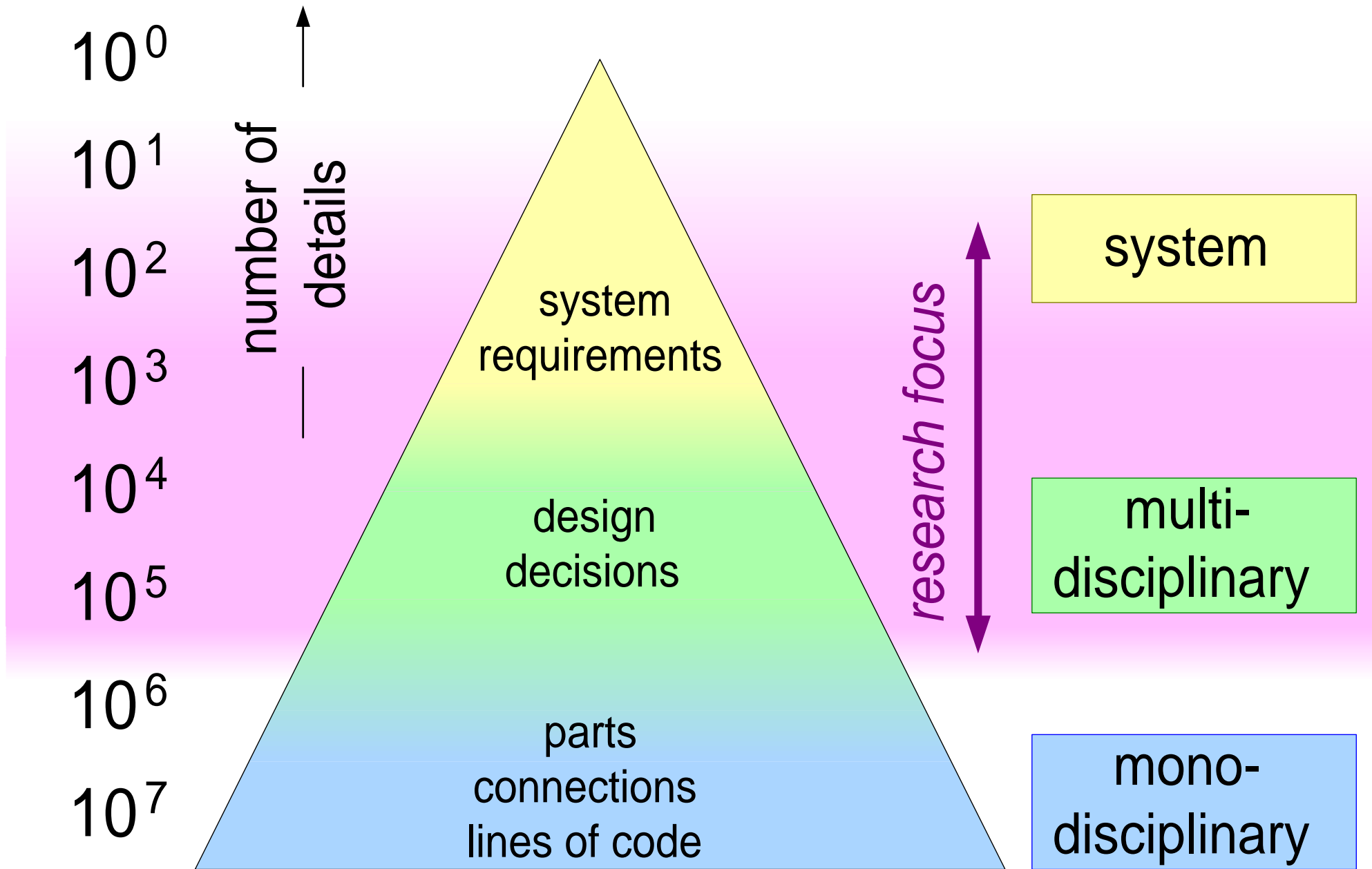
Systems Engineering: responsible for customer key drivers and key performance parameters of system



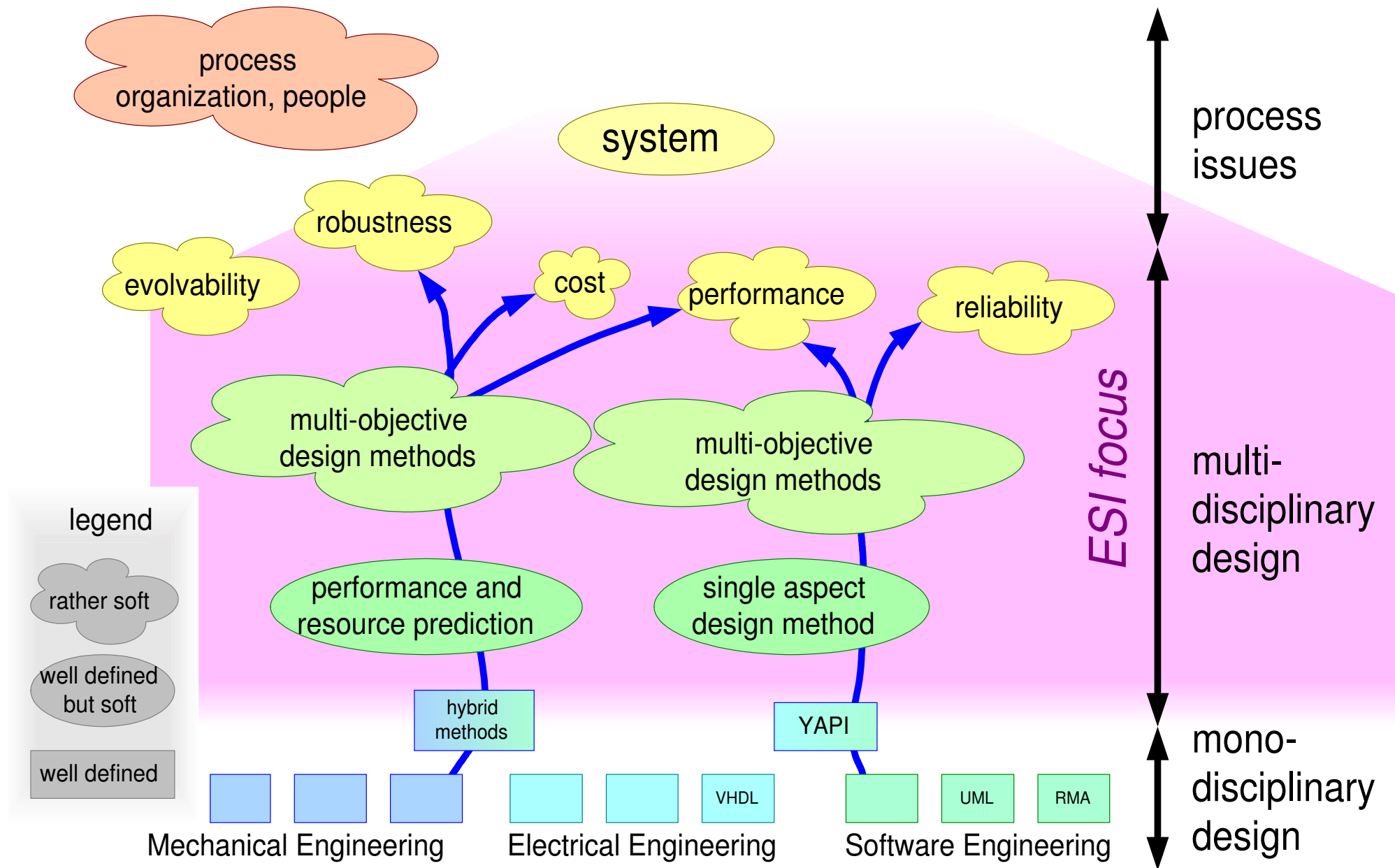
Scoping SE Research



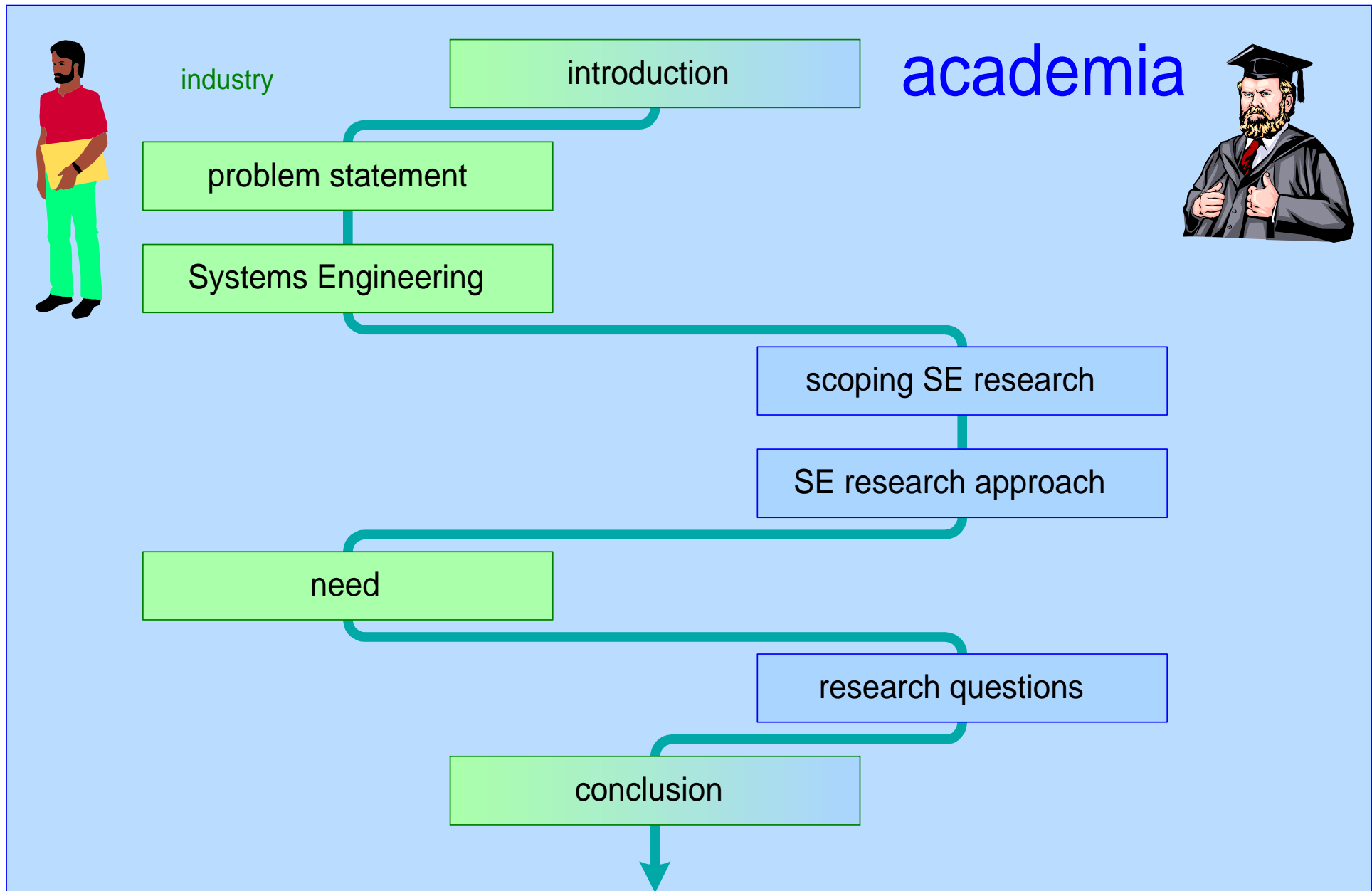
Exponential Pyramid, from requirement to bolts and nuts



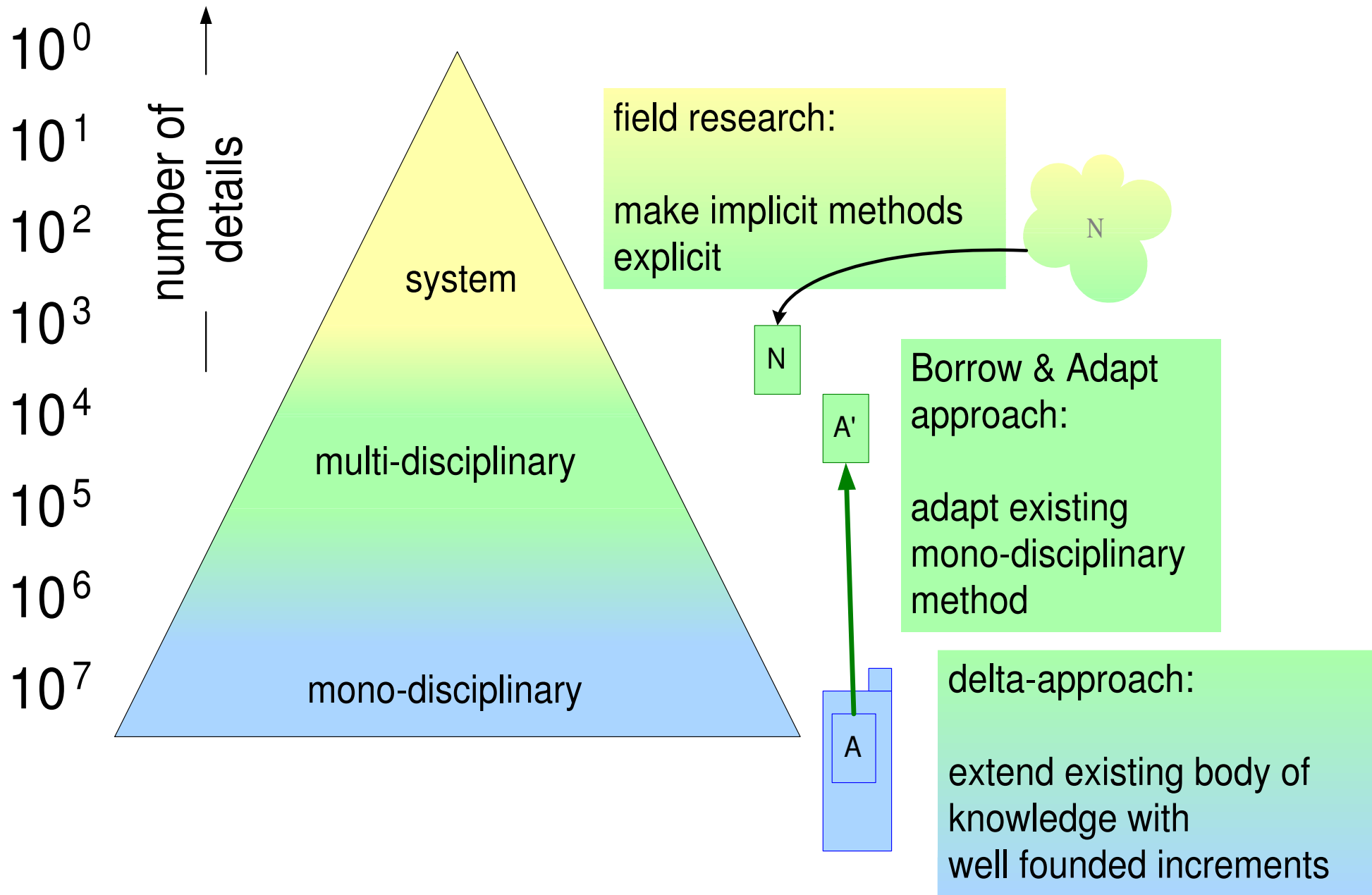
From Mono-Disciplinary to System



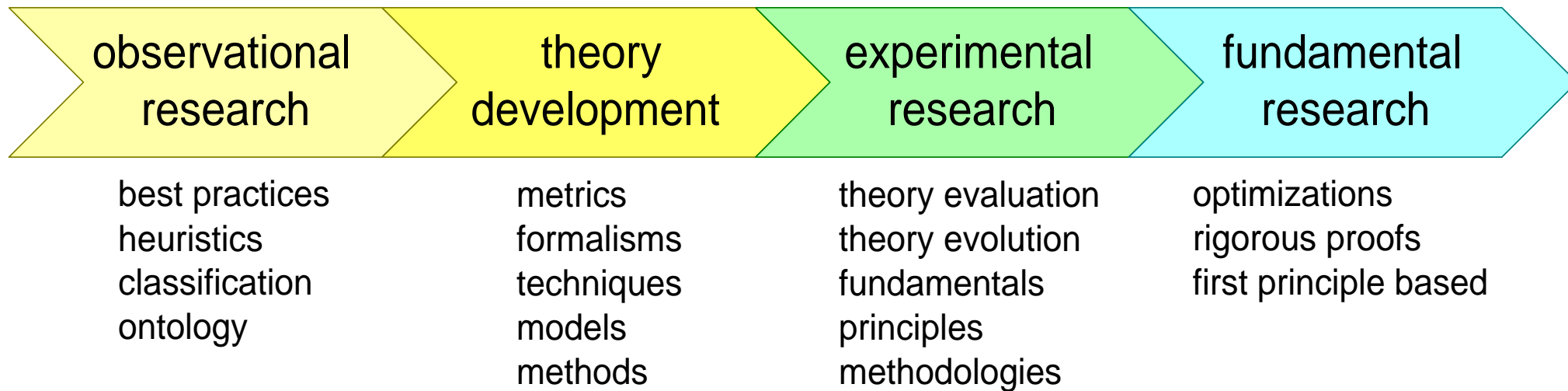
SE Research Approach



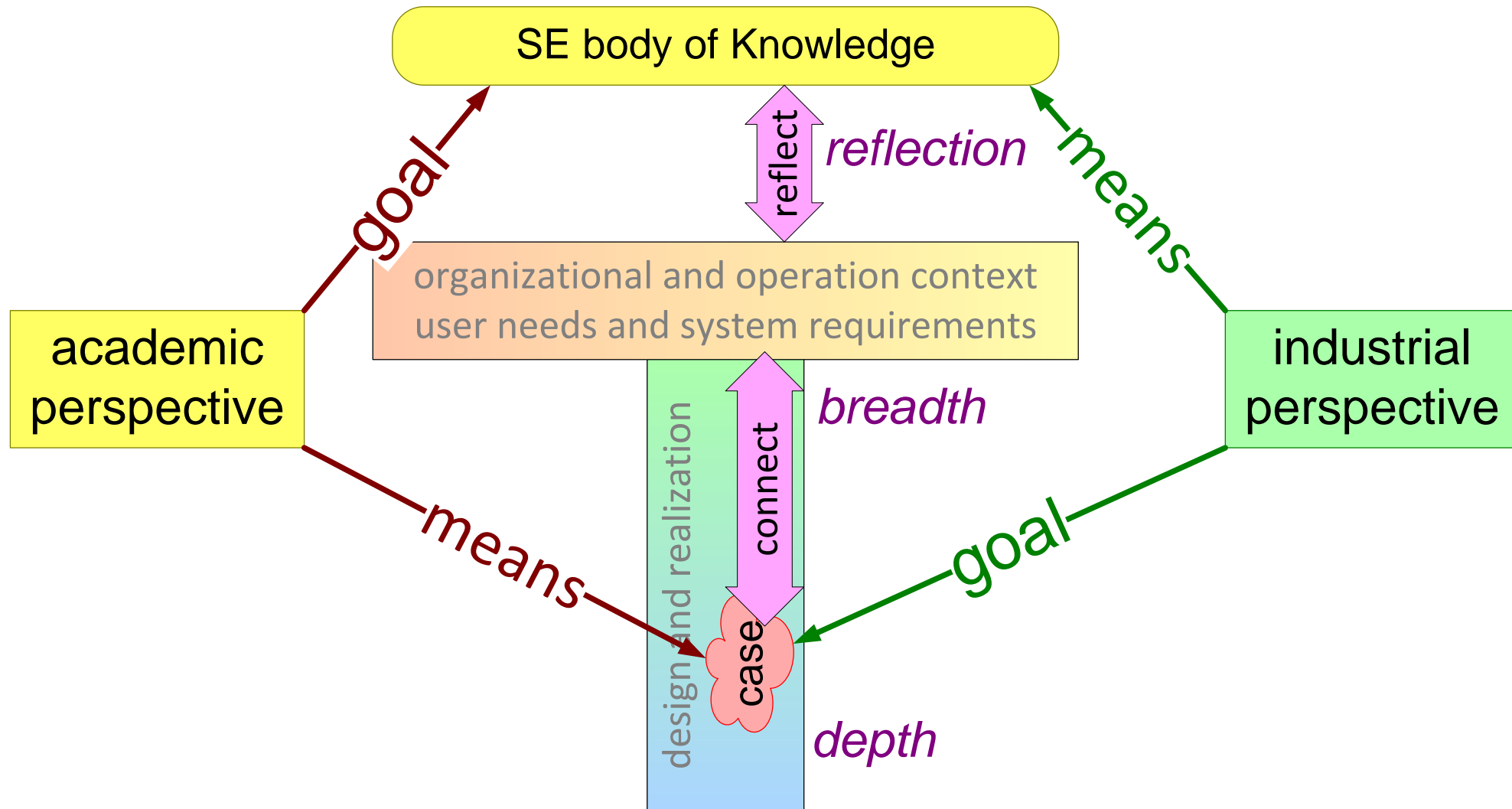
Research Methods



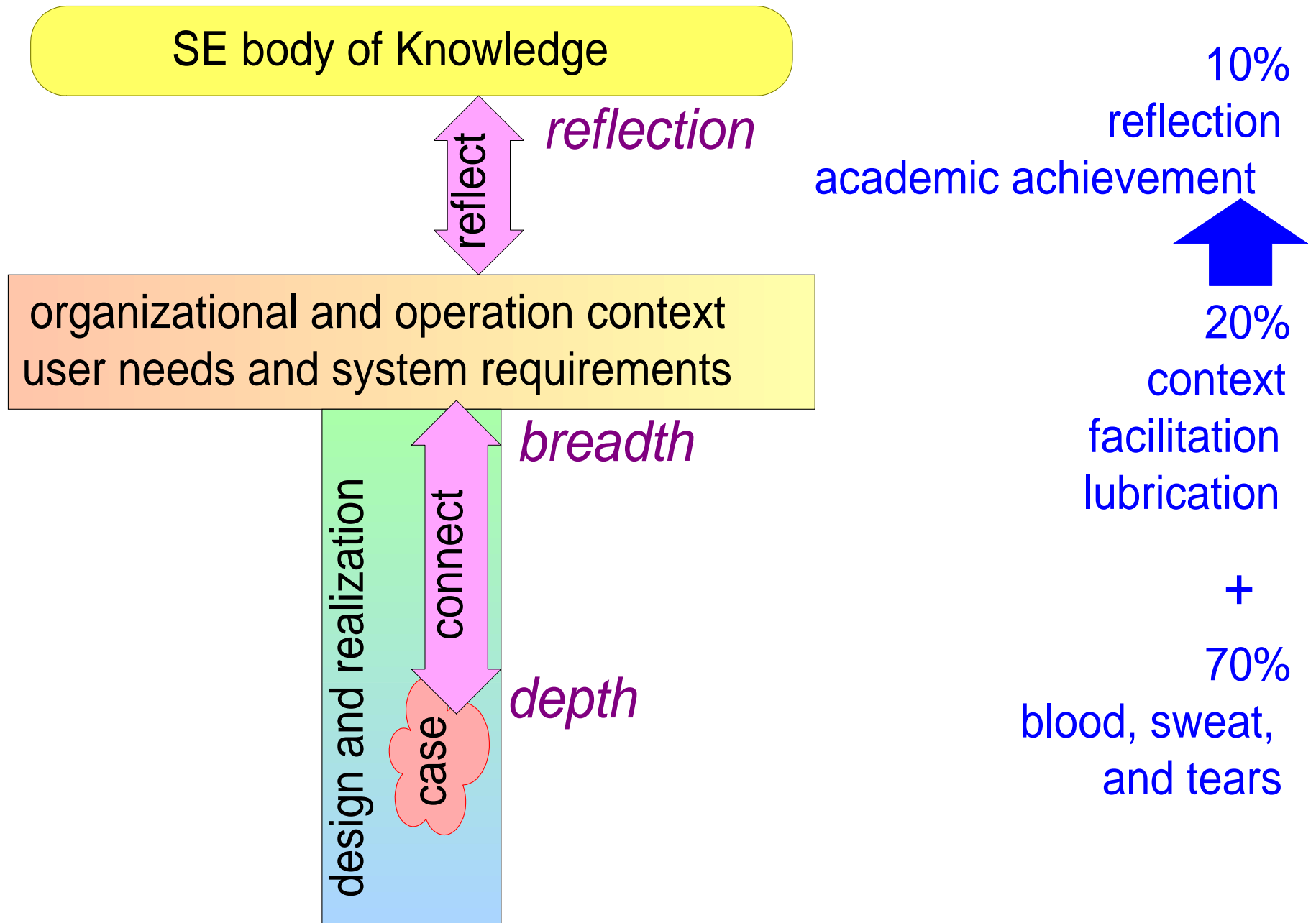
Systems Engineering is Young Field



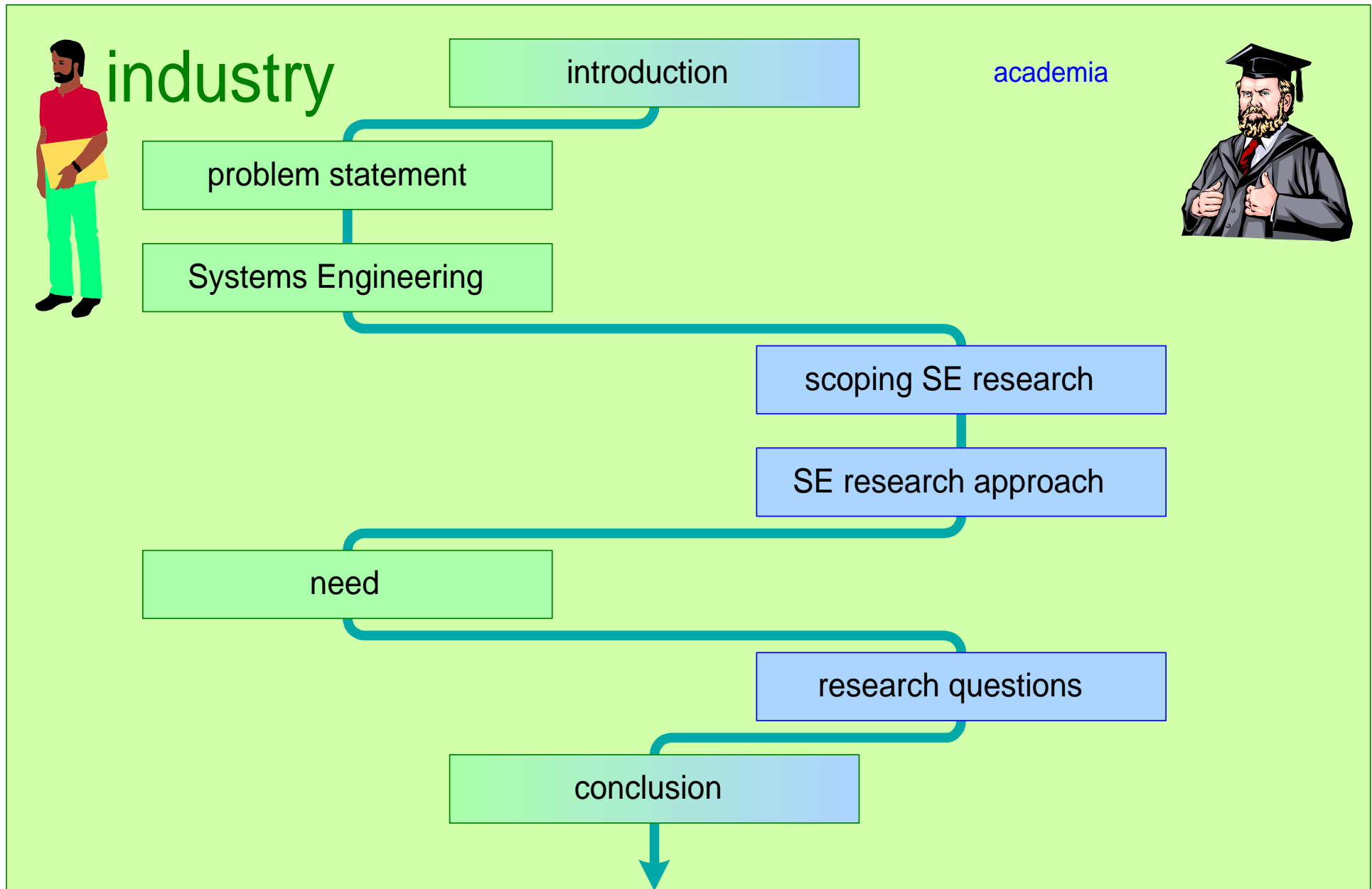
Goal-Means Inversion



Counter Intuitive Spending of Time/Effort

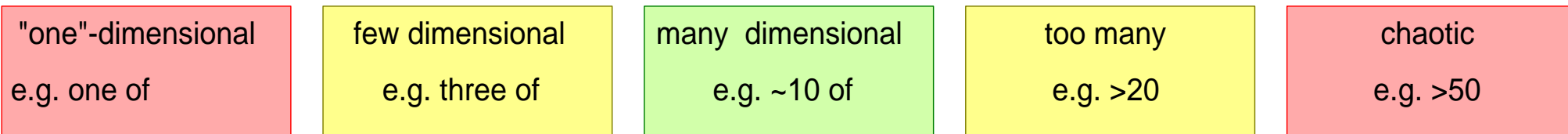


Need



Designers in the Field (Industry)

How many views are used during design?



object oriented interfaces time maintenance performance business power operations
 functional physical space life cycle reliability process energy exceptions
 behavioral work break down flow installation safety organization cooling disposal
 vibrations planning cost manufacturing security people efficiency 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 = $f(\text{context}, \sim 10 \text{ main functions})$

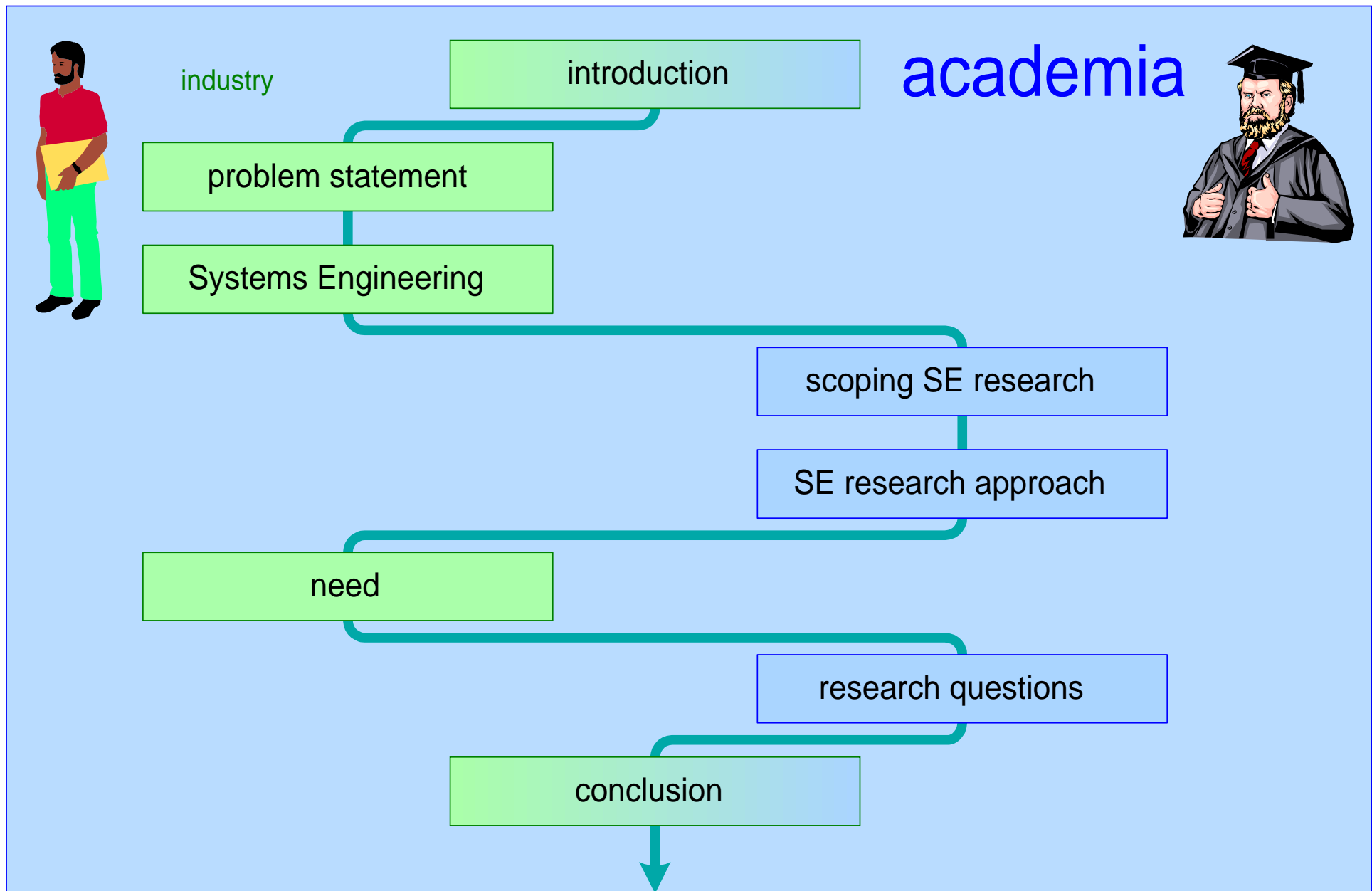
functions, e.g. align, position, level, focus, expose, load,
unload, climate condition, ... = $g(15 \text{ subsystems})$

subsystems, e.g. wafer stage, reticle stage, lens,
illuminator, laser, ... = $h(1\text{k}+ \text{ of subsubsystems})$

subsubsystems = $i(10\text{k}..100\text{k}+ \text{ of hardware and software components})$

components = $j(1\text{M}+ \text{ statements, connections, sizes, materials, ...})$

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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problem statement

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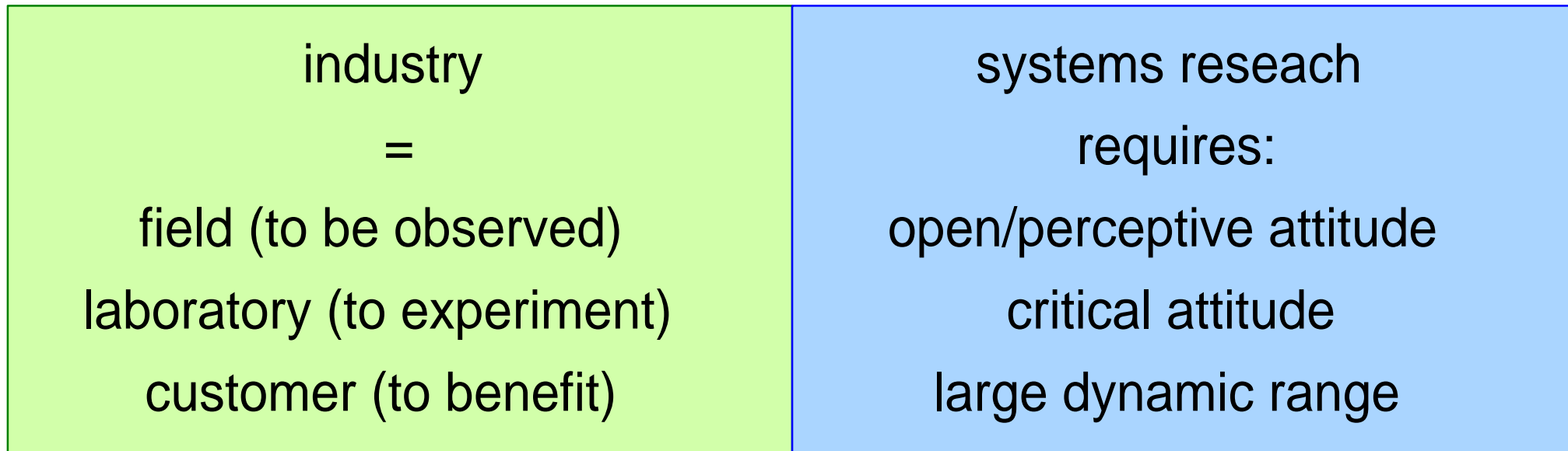
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Industry and Systems Research



isn't that the meaning of academic?