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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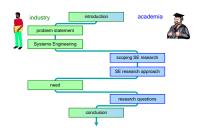
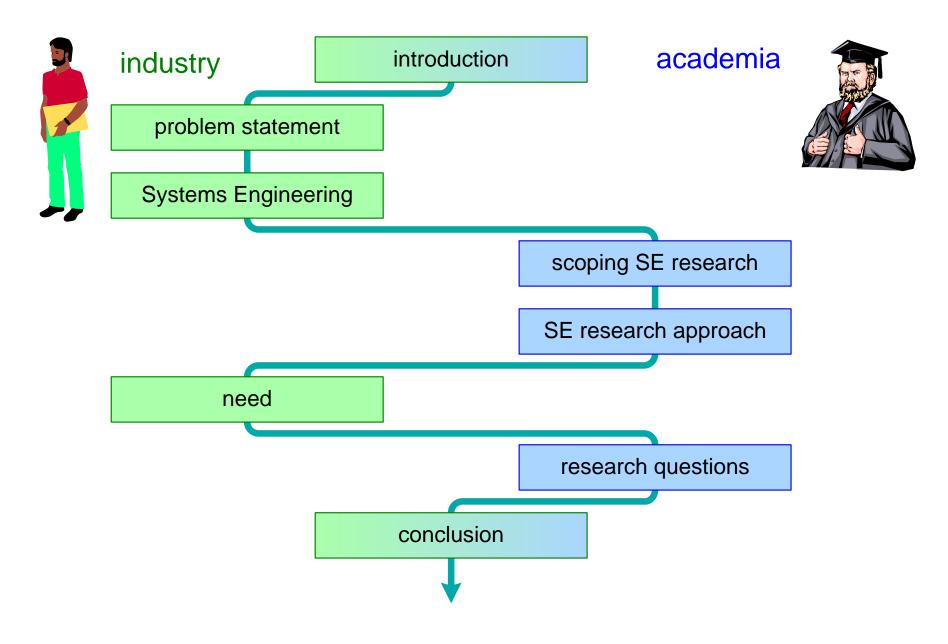
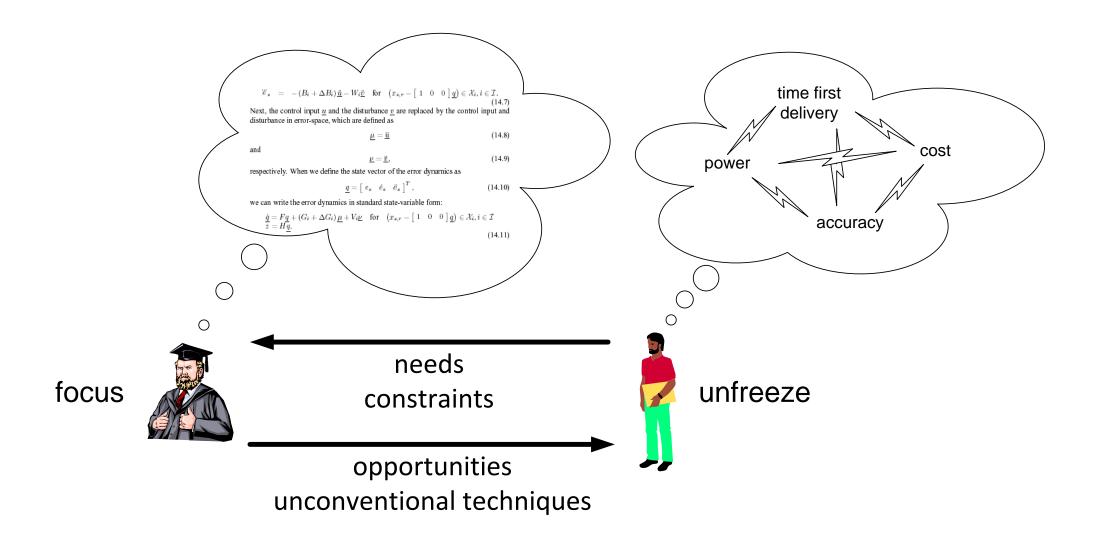


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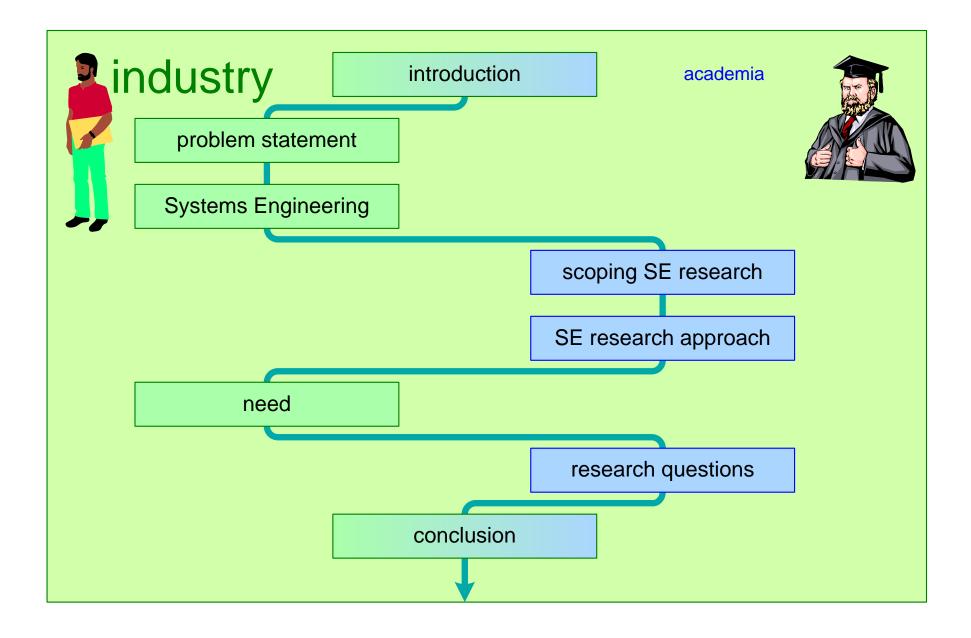


from Boderc: Tension or Opportunity?





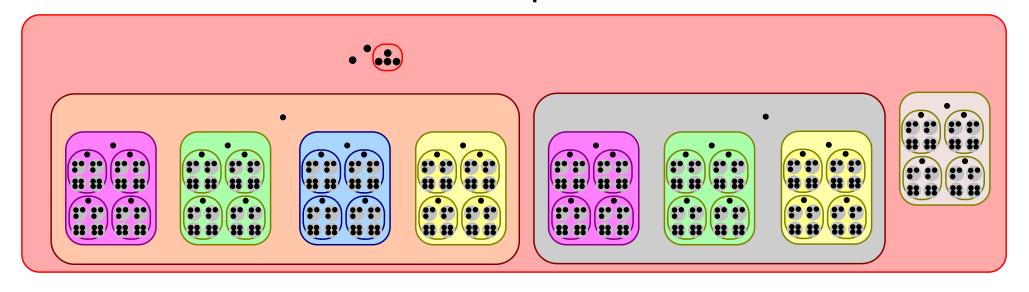
Problem Statement





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



Cardio Vascular Xray



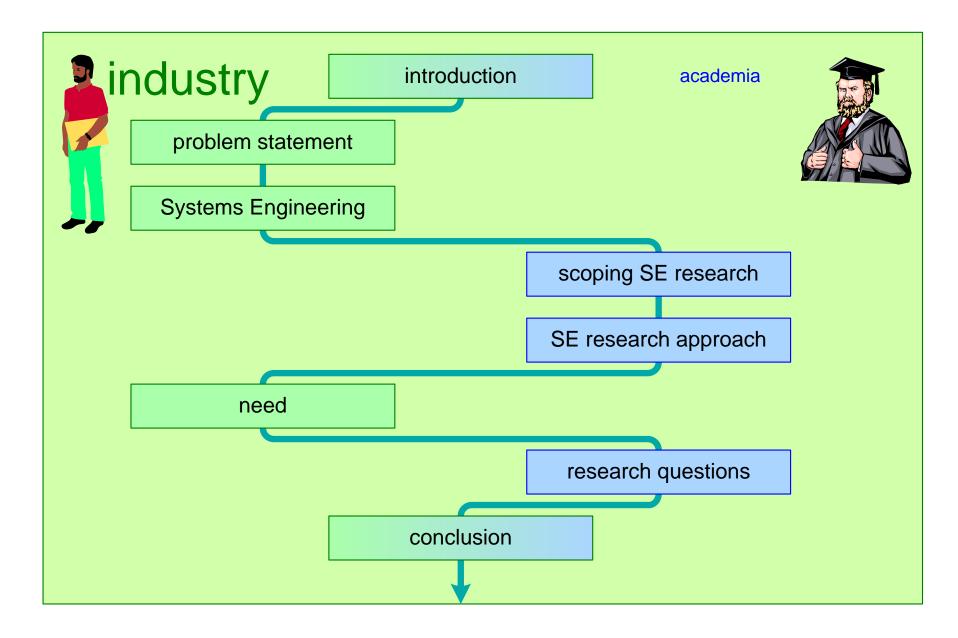
wafer stepper



volume printer



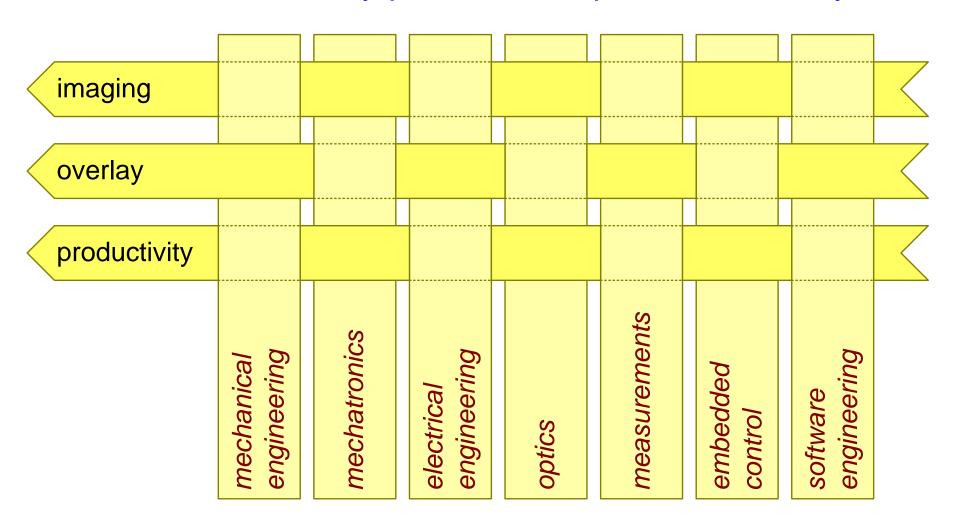
Systems Engineering





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

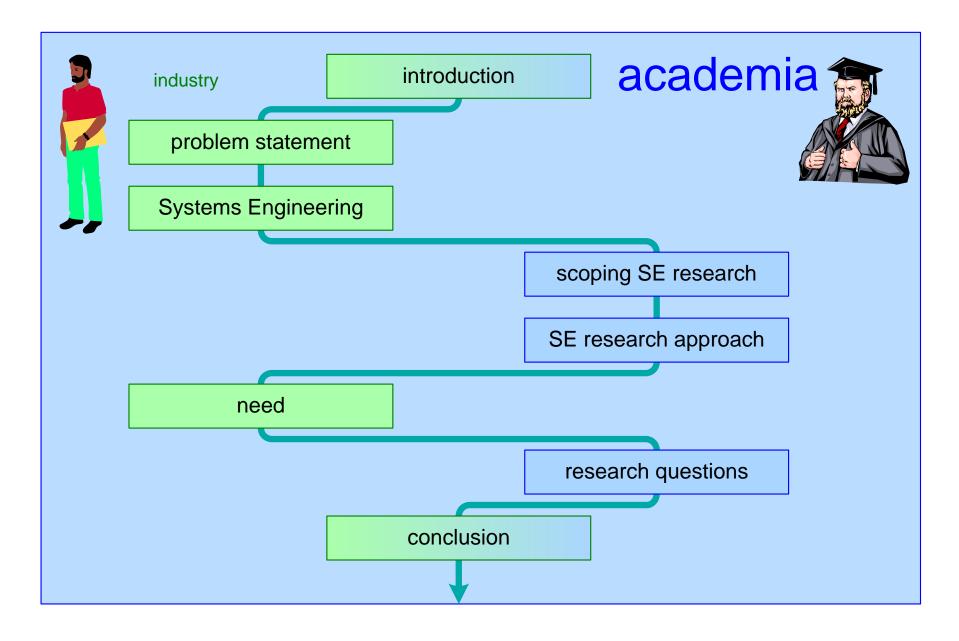
productivity model

integration plan

sensor concept

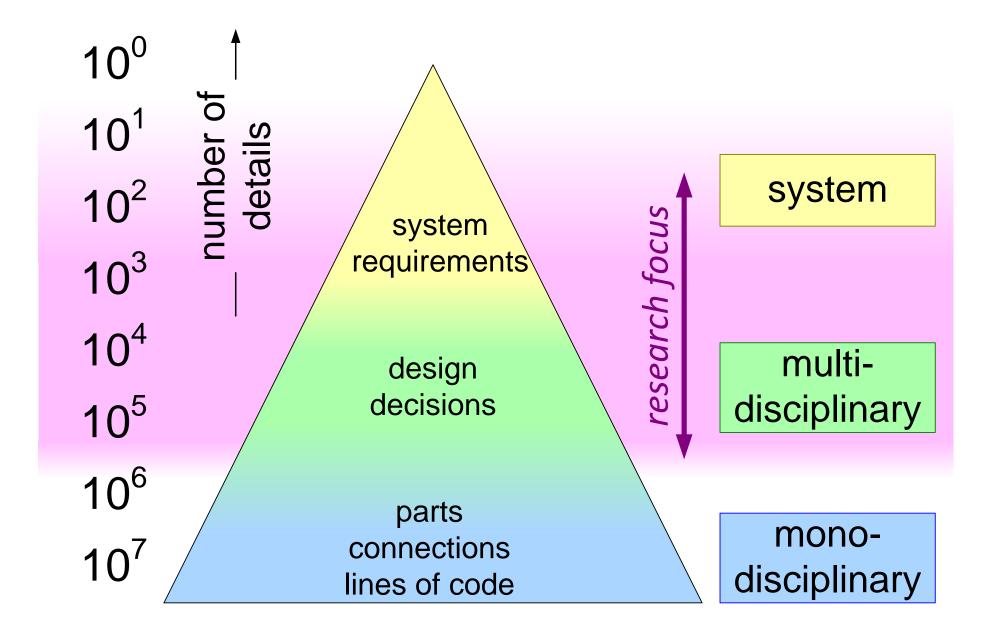


Scoping SE Research



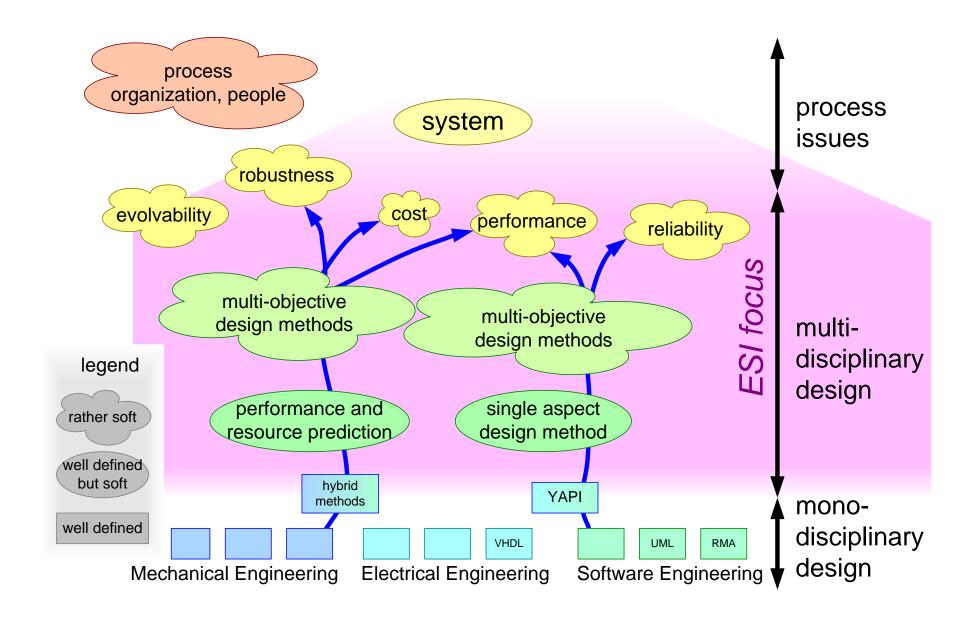


Exponential Pyramid, from requirement to bolts and nuts



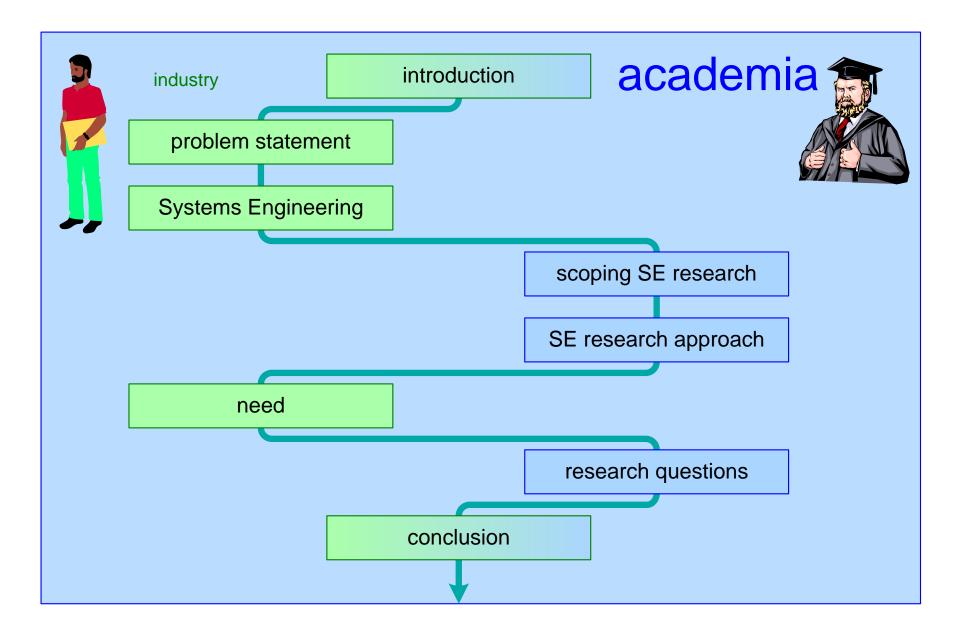


From Mono-Disciplinary to System



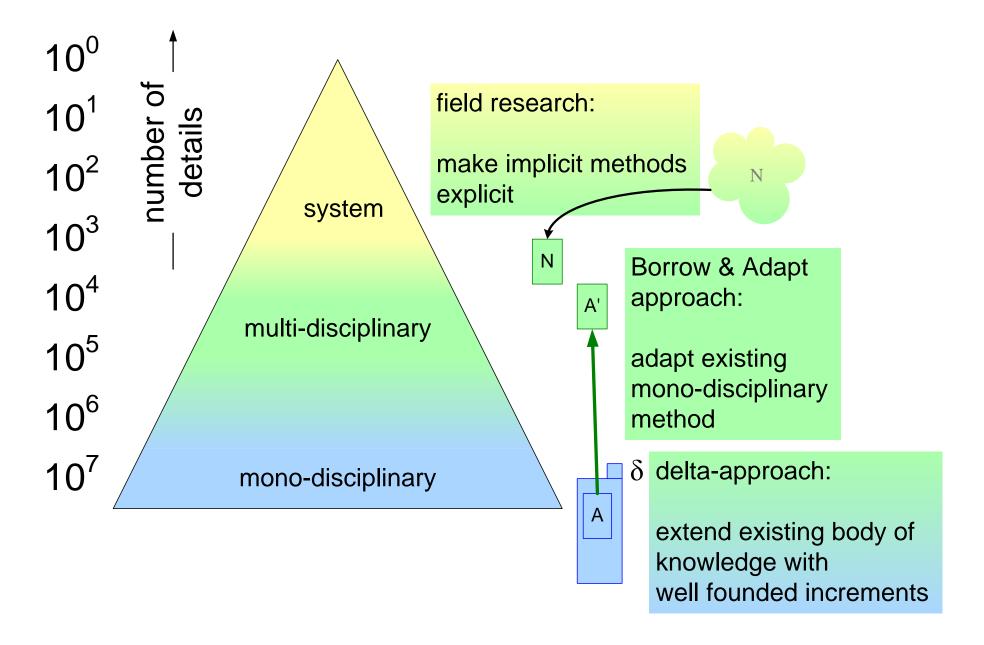


SE Research Approach





Research Methods



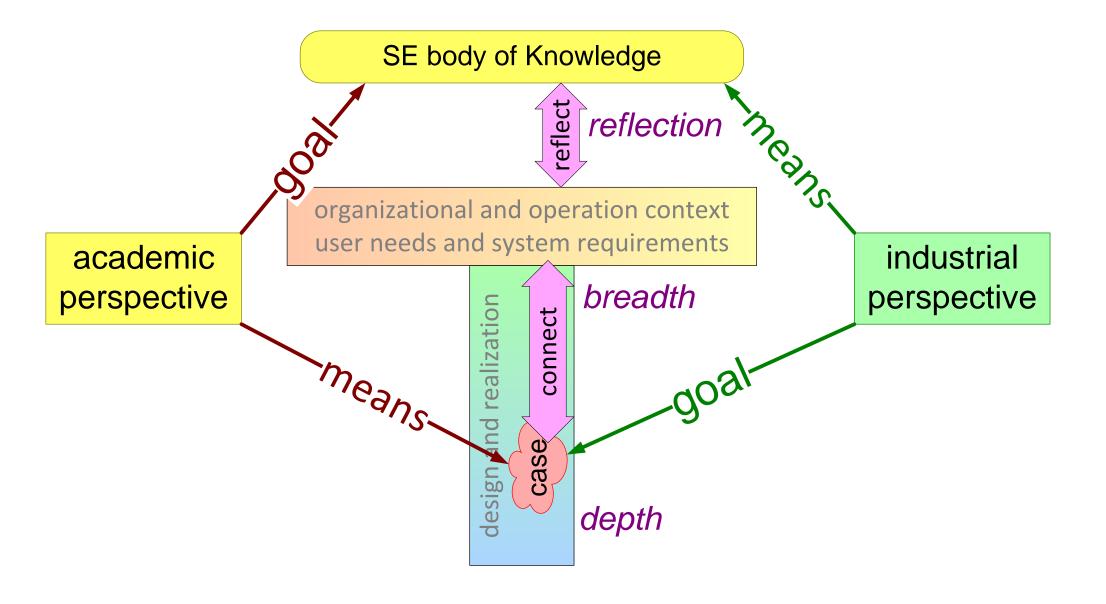


Systems Engineering is Young Field

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



Goal-Means Inversion





Counter Intuitive Spending of Time/Effort

SE body of Knowledge

reflect

reflection

organizational and operation context user needs and system requirements

design and realization

case connect

breadth

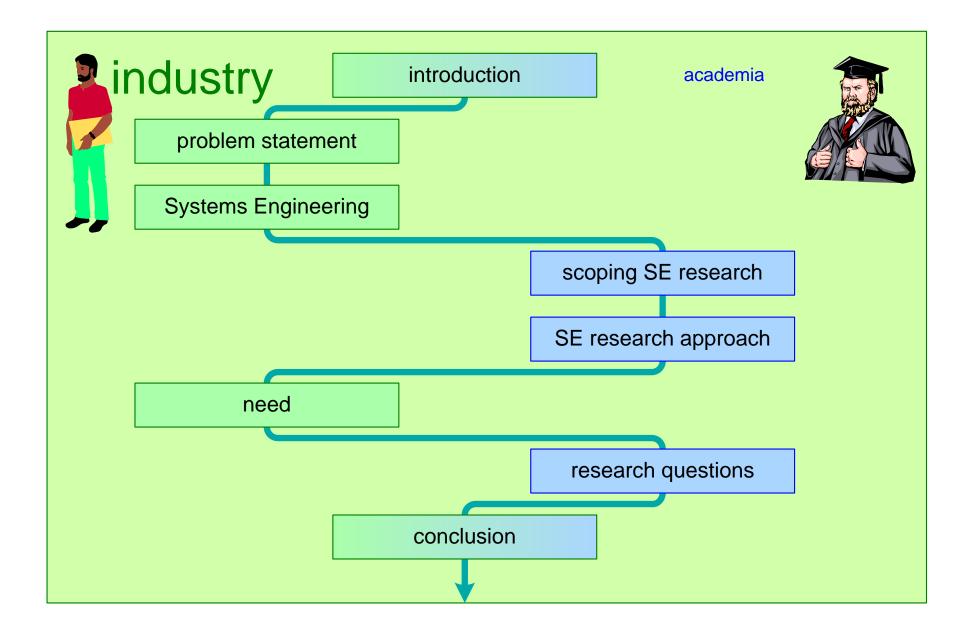
depth

10% reflection academic achievement

20% context facilitation lubrication

70% blood, sweat, and tears







Designers in the Field (Industry)

How many views are used during design?

"one"-dimensional e.g. one of

few dimensional e.g. three of

many dimensional e.g. ~10 of

too many e.g. >20

chaotic e.g. >50

object oriented interfaces functional physical behavioral vibrations planning

time space work break down flow cost

maintenance life cycle reliability installation safety manufacturing security et cetera, et cetera

performance business process organization people

power energy cooling

operations exceptions disposal efficiency sustainability

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)

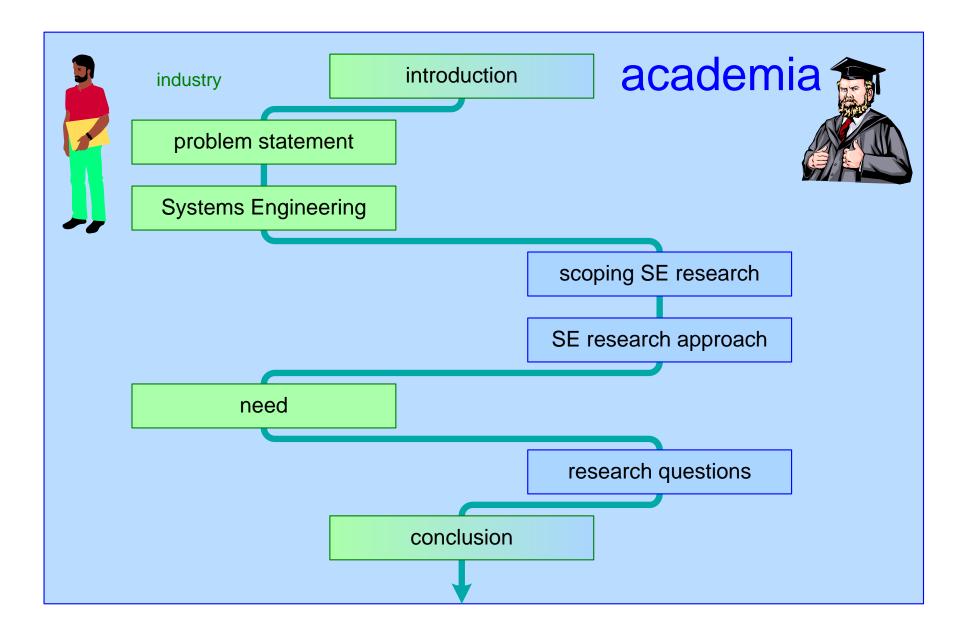
subsystems, e.g. wafer stage, reticle stage, lens, illuminator, laser, ... = h(1k+ of)n

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?

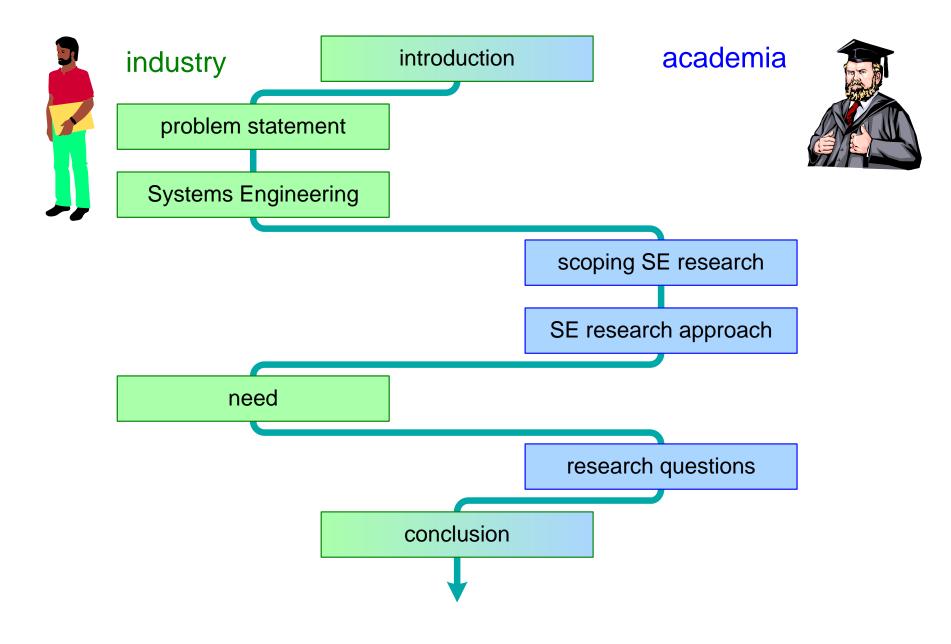
What models support the multi-disciplinary design?

et cetera

et cetera



Conclusion





Industry and Systems Research

industry

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field (to be observed)
laboratory (to experiment)
customer (to benefit)

systems reseach
requires:
open/perceptive attitude
critical attitude
large dynamic range

isn't that the meaning of academic?

