

Systems Engineering and Modeling at Start-Up Company

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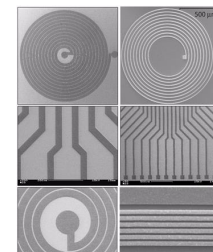
Abstract

We have been assisting in applying Systems Engineering techniques and methods in a small (tens of persons) start-up company in the semiconductor process and equipment market. We report our observations in this start-up company with an innovative product operating in a dynamic environment. Start-up companies in general explore new applications or new technologies: an environment full of unknowns, uncertainties and other surprises. In the specific case of semiconductor process and equipment the system is highly multi-disciplinary, amongst others: high precision mechanical, control, optics, chemical, signal processing, and power electronics.

Distribution

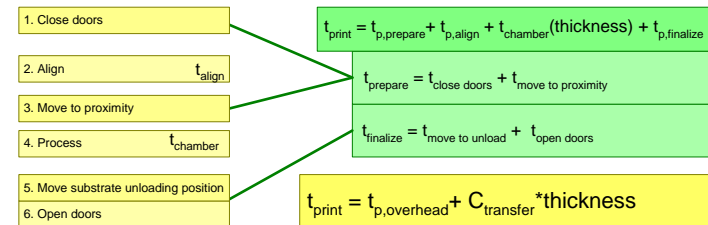
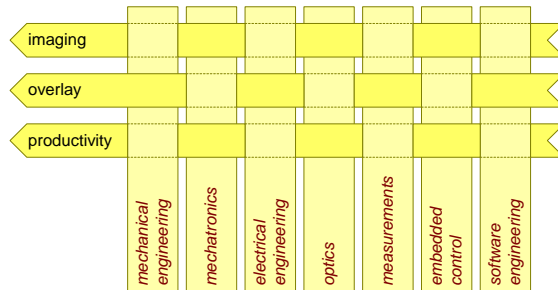
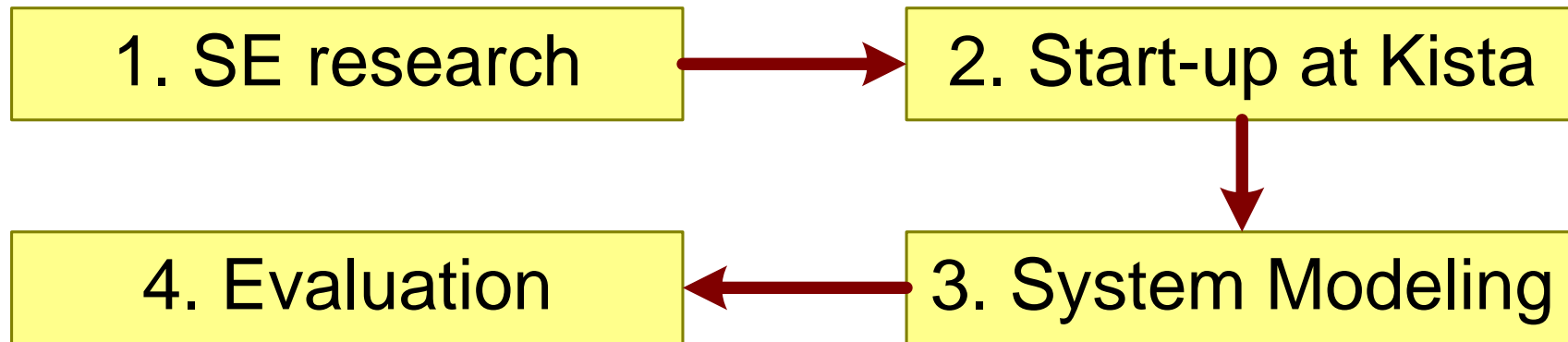
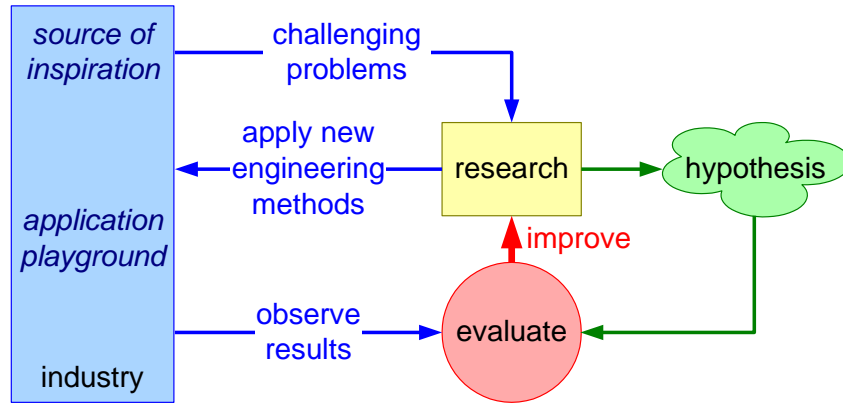
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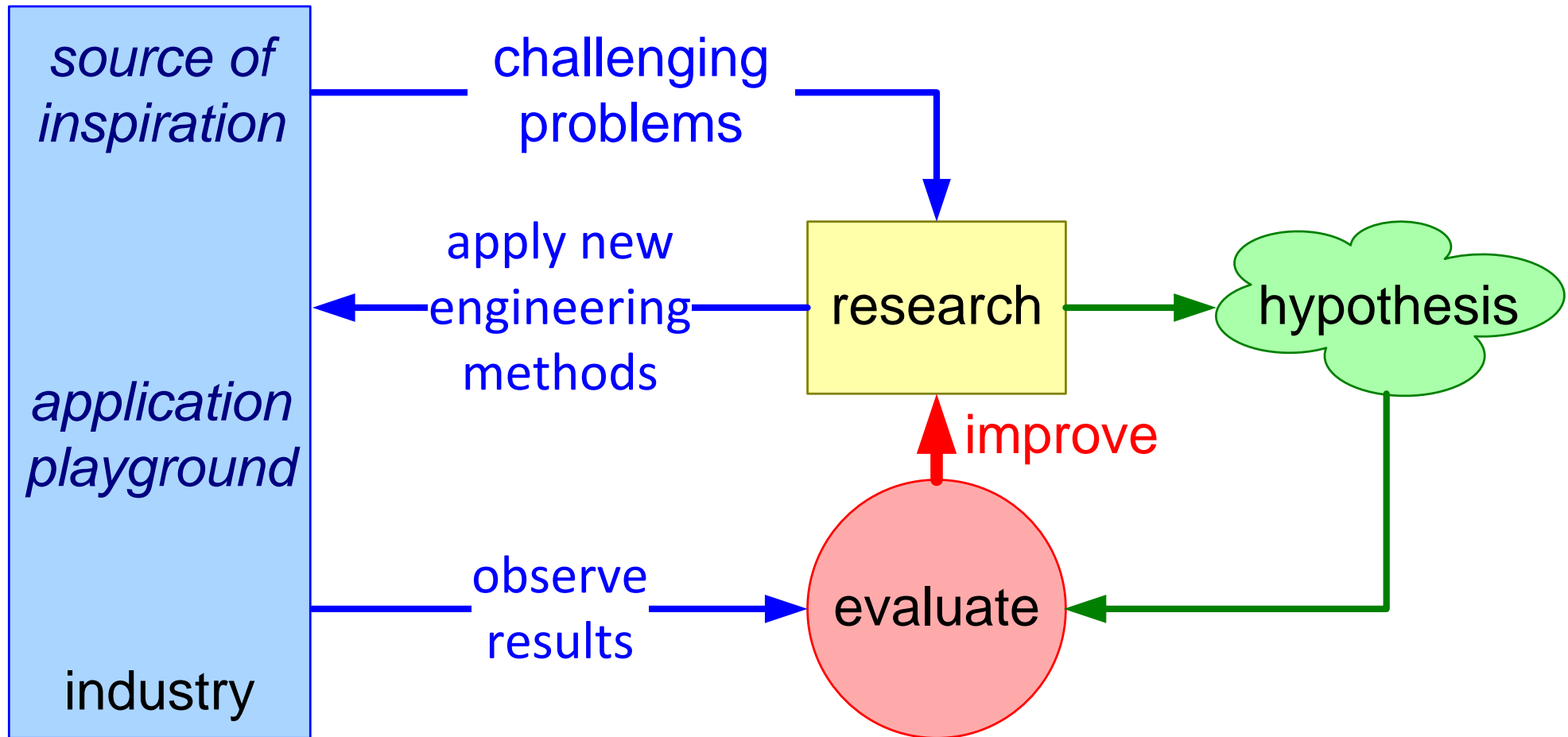
courtesy Replisaurus
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Figure Of Contents™



note: original diagram was annotated with actual performance figures for confidentiality reasons these numbers have been removed

Industry as Laboratory



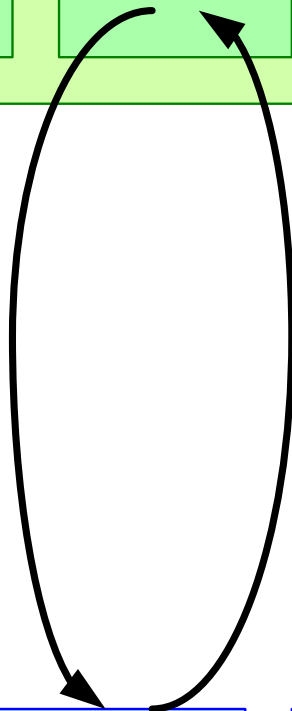
Industry as Laboratory (2)

intended dissemination and research partners

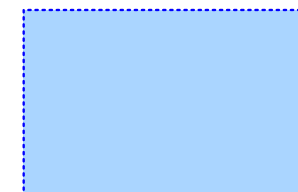
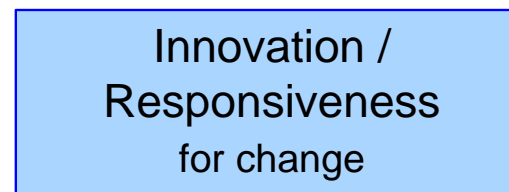
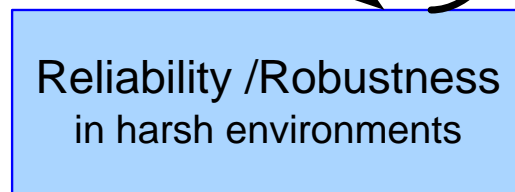


generalization and consolidation to facilitate use in other domains

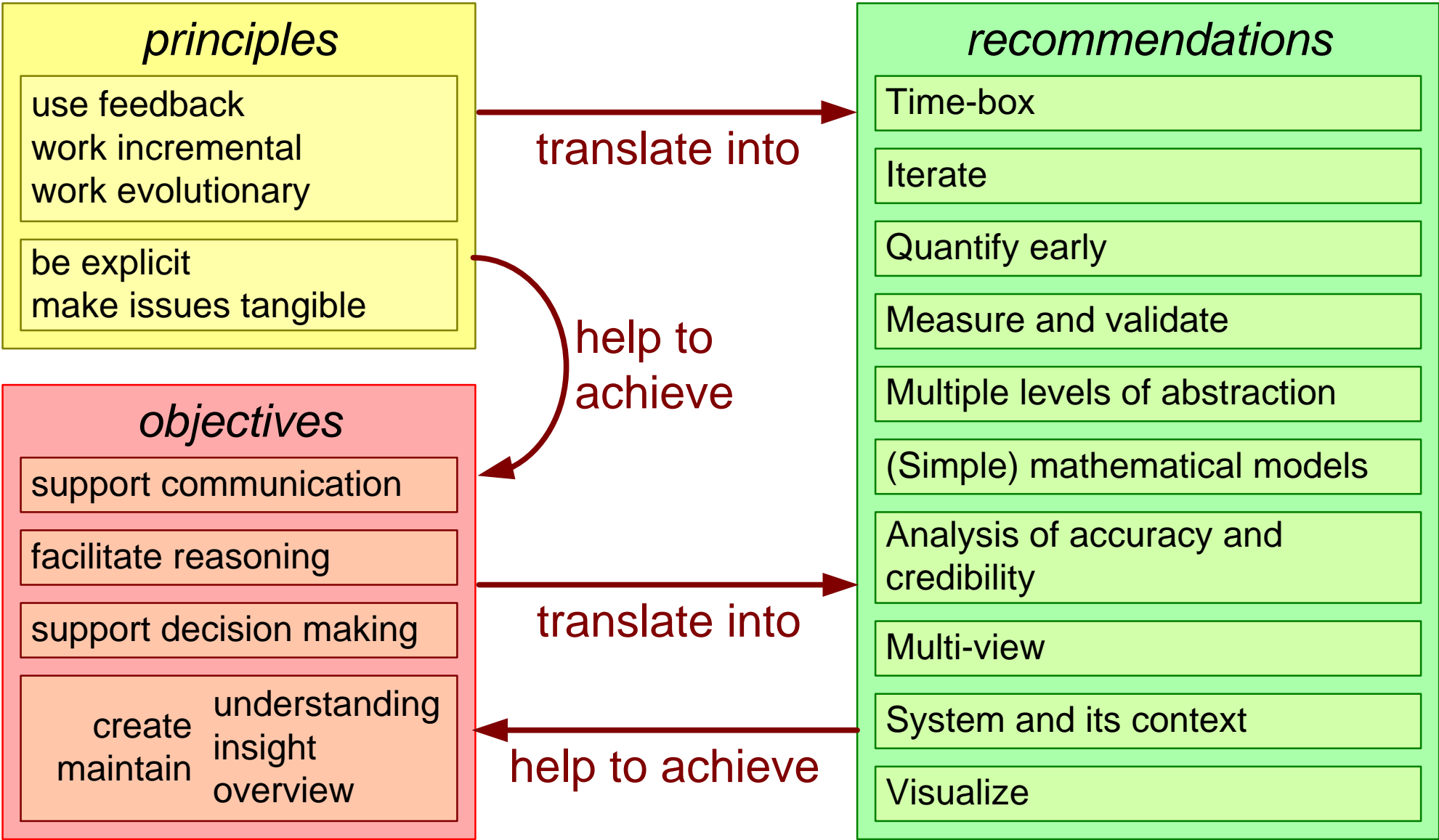
single domain research focus on industrial problem



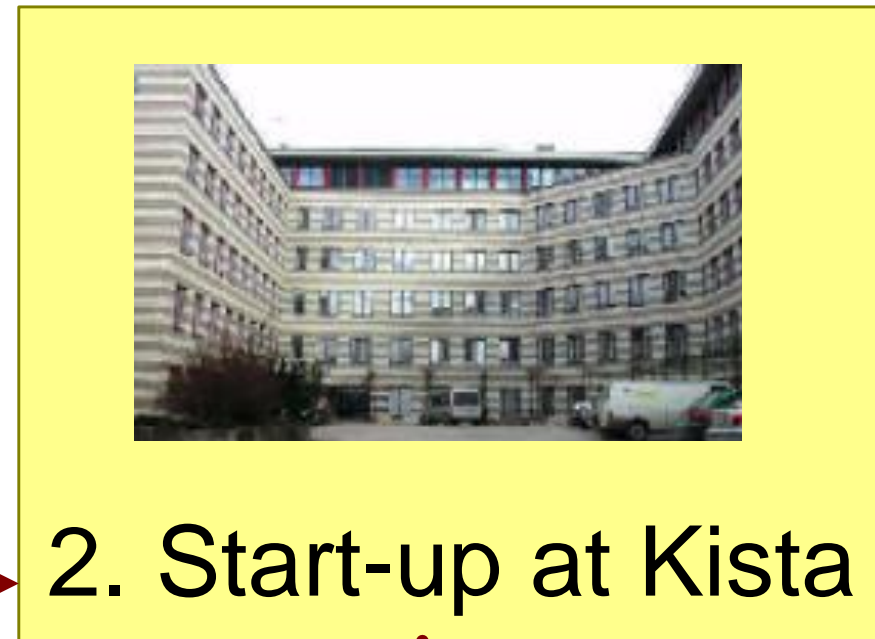
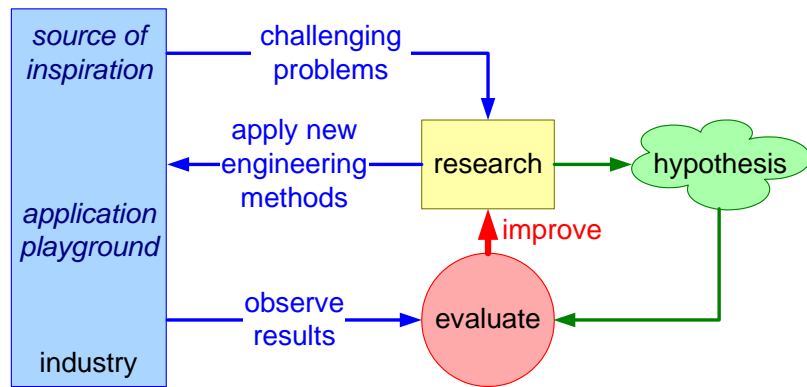
multi-domain research and expertise



Modeling Recommendations as Applied



Start-Up Company Replisaurus in Kista (Sweden)

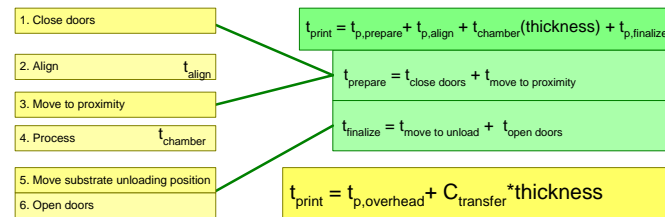
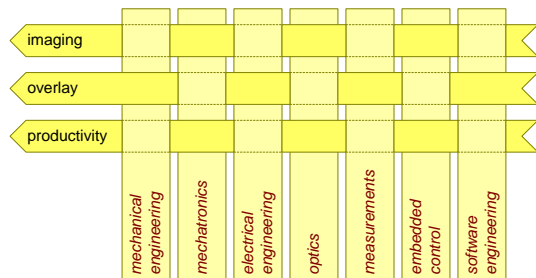


1. SE research

2. Start-up at Kista

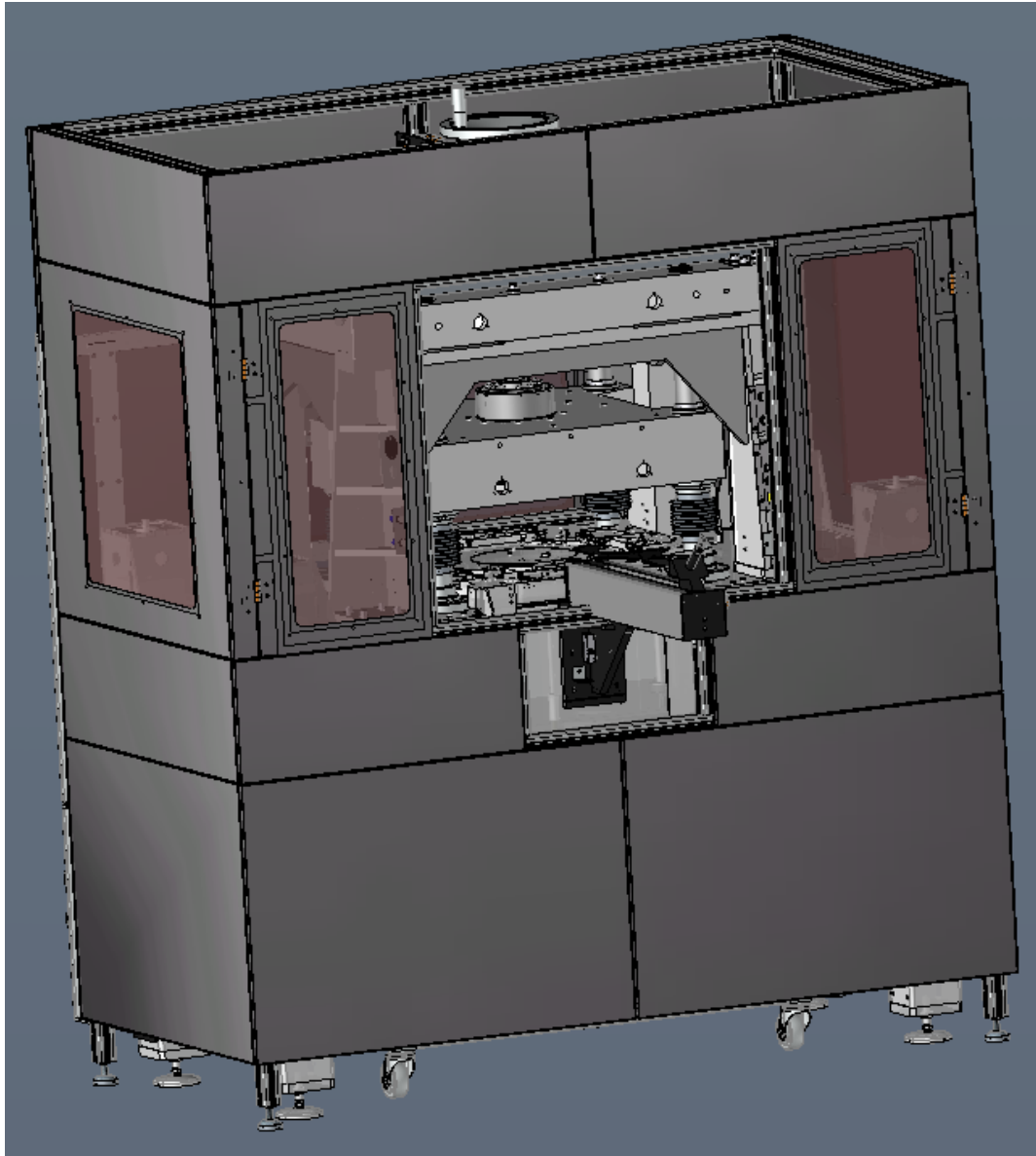
4. Evaluation

3. System Modeling

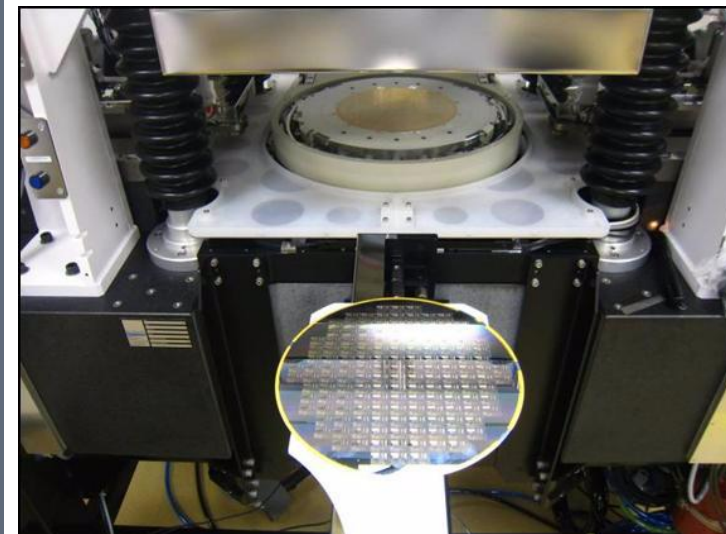


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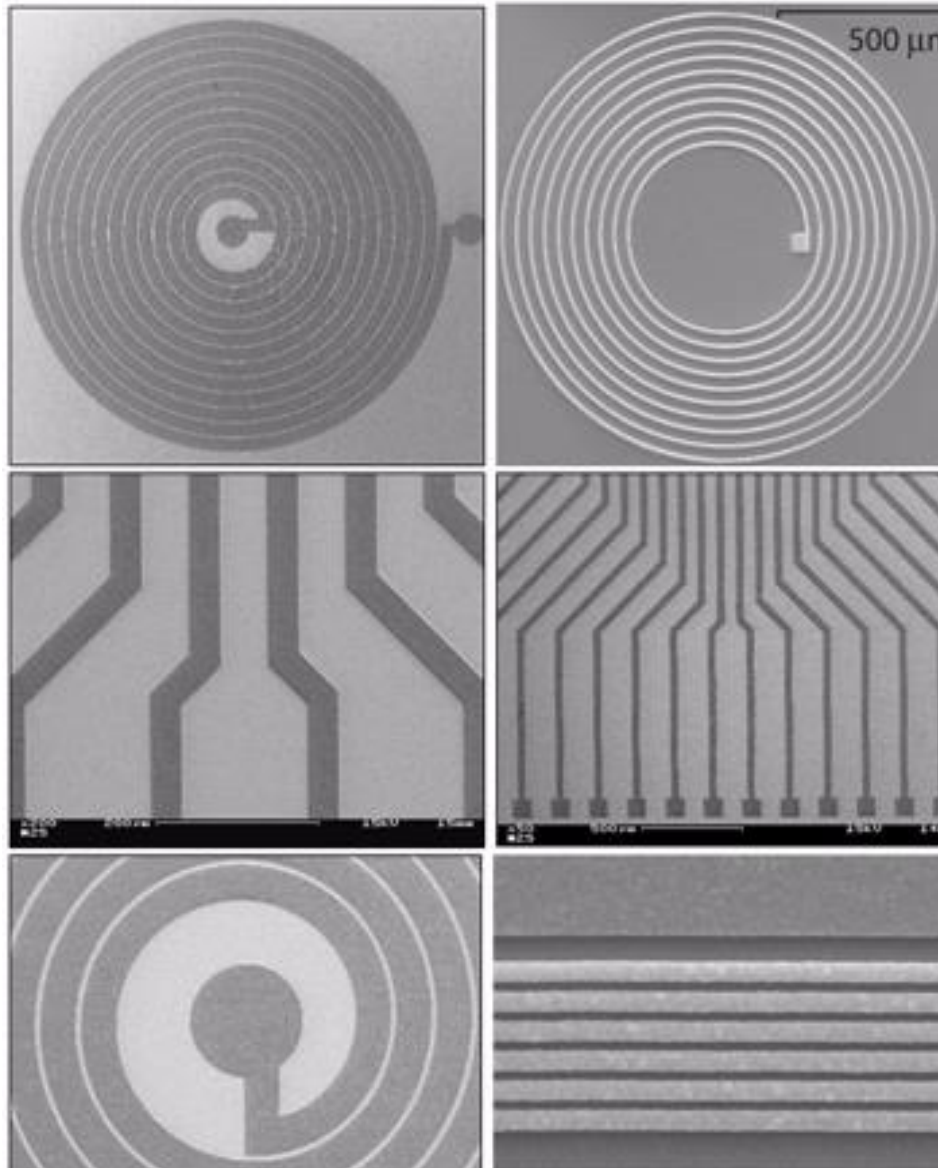
The Copper Printer



courtesy Replisaurus
www.replisaurus.com



Example of printed copper structures

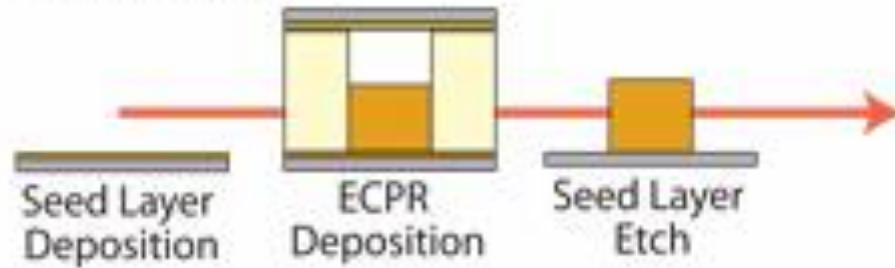


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ECPR technology replaces 6 process steps by 1 step

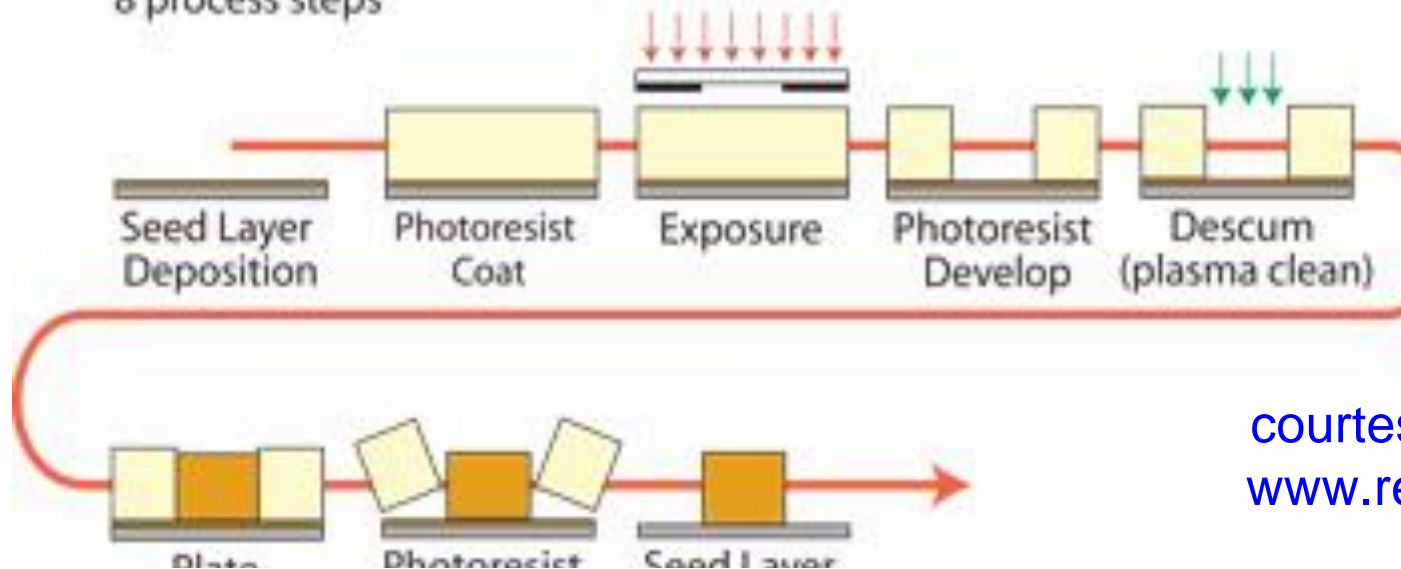
ECPR - ElectroChemical Pattern Replication

3 process steps



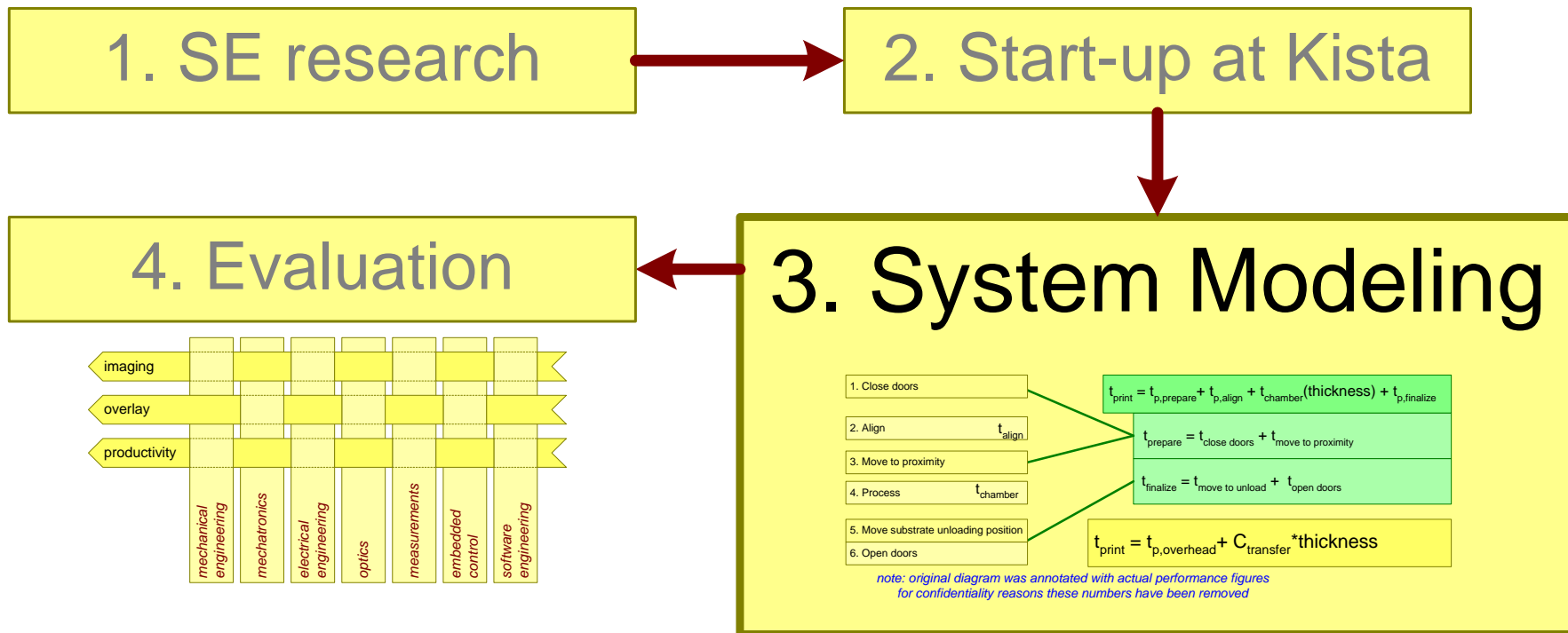
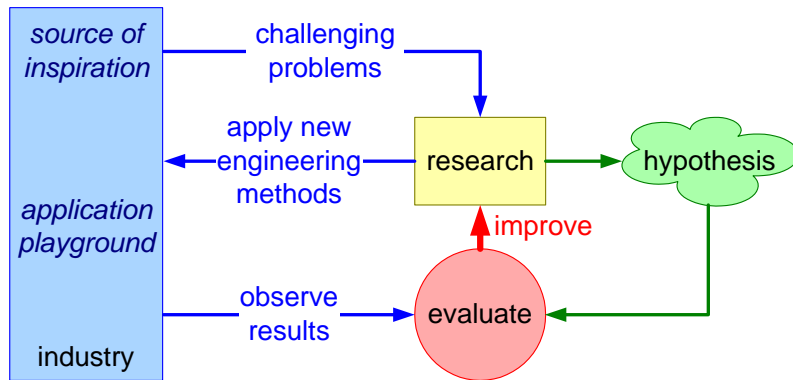
Conventional lithography based metallization

8 process steps

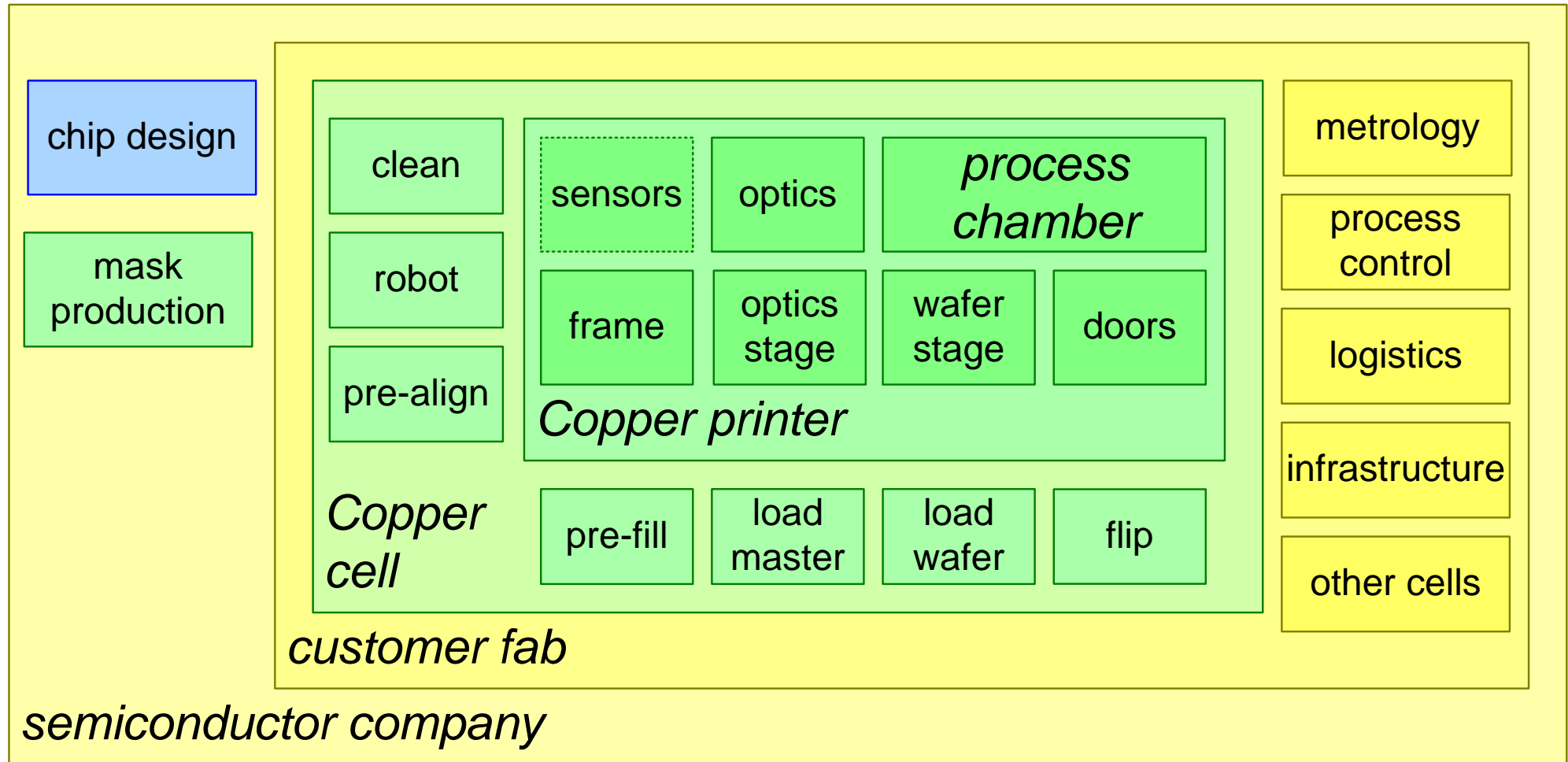


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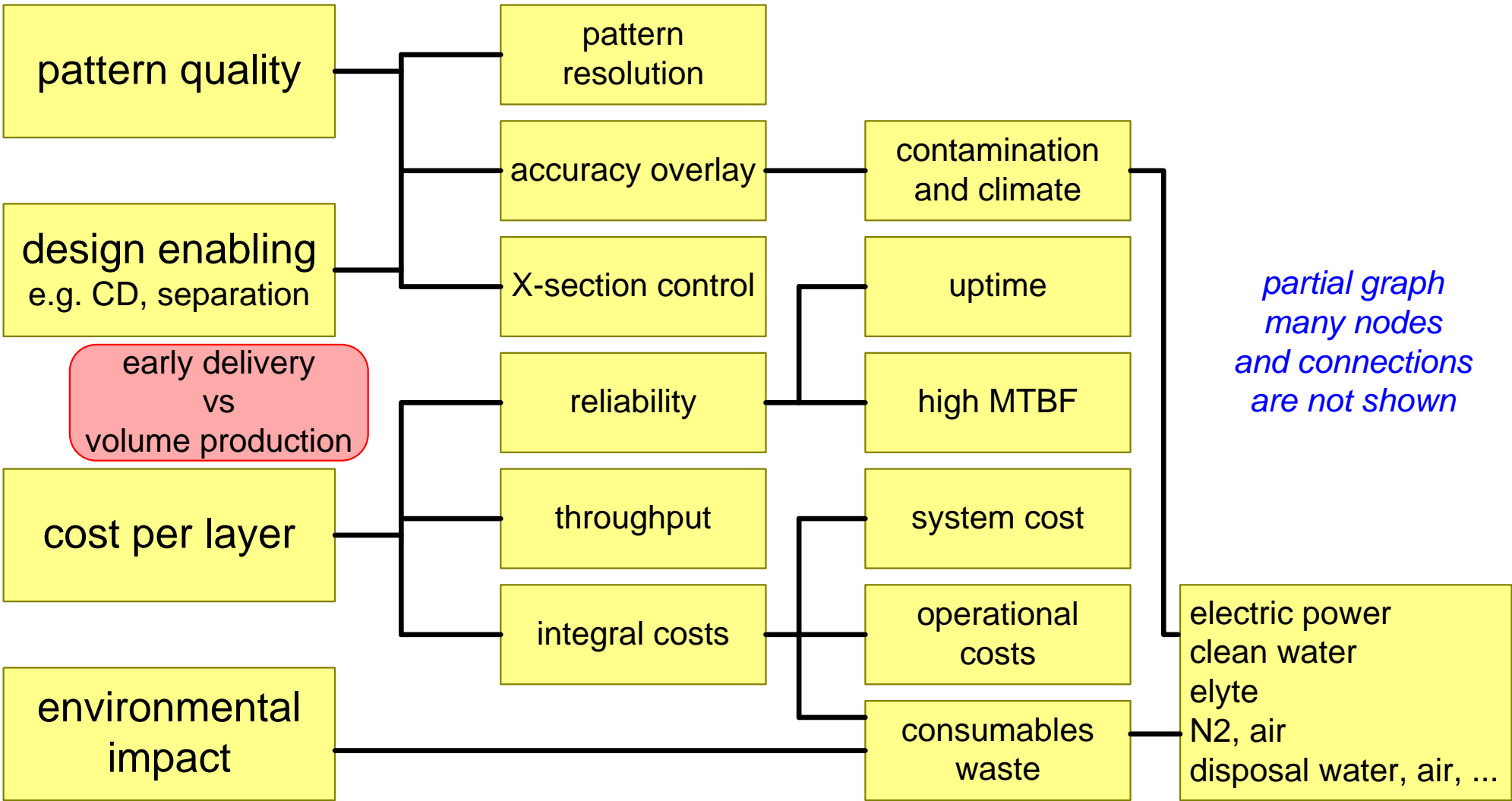
System Modeling




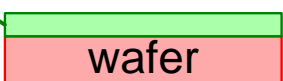
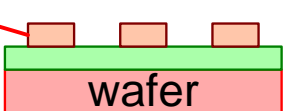
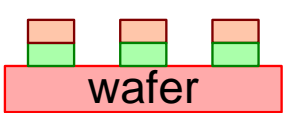
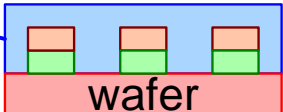
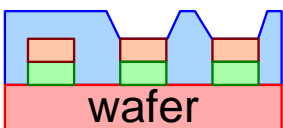
Overview of the different scopes



Customer key driver graph



Process flow at fab level, from inspection until testing

		throughput in minutes	wafer	FOUP	
		1. inspection			
seed		2. seed sputter	1	25	
Cu		3. Cu print	2	50	target spec
		4. seed etch	1	20	
<p>spin coated polymer</p> <p>dual layer only</p>					
		5. coat/develop dielectrics	3..4	50	75..100??
		6. exposure or CMP for polymer vias	1..2	30	
		7. E-test			

Work flow in the Copper Printer

0. Loading Master&substrate

1. Close doors

2. Align

3. Move to proximity

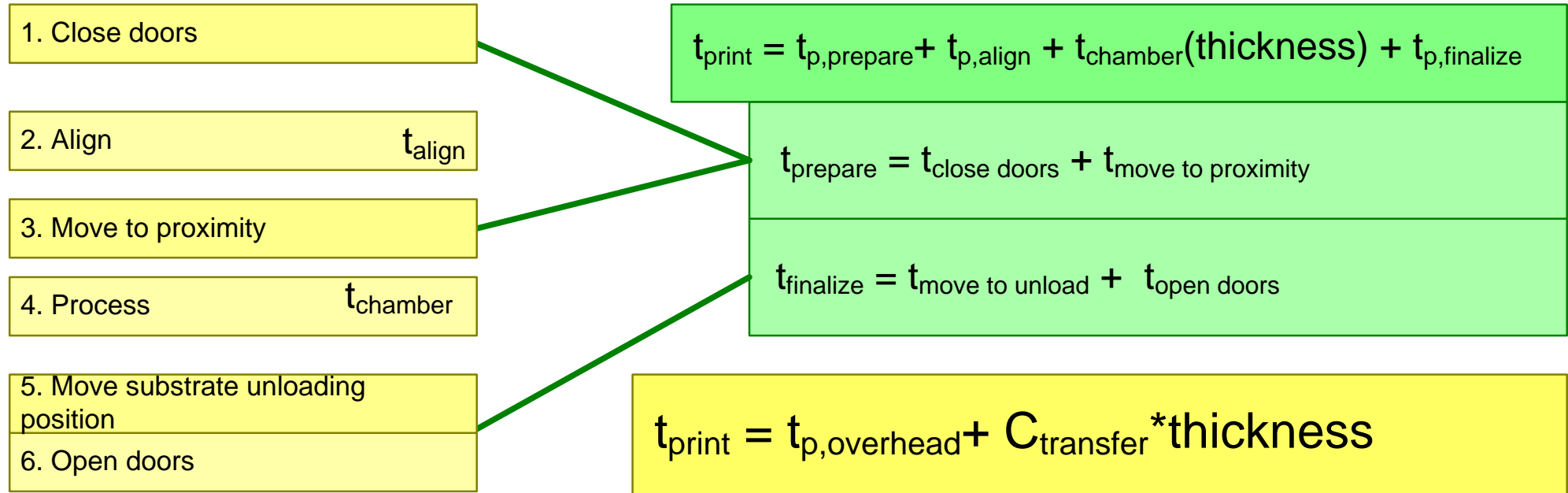
4. Process incl. rinse&dry

5. Move substrate unloading position

6. Open doors

7. Unloading Master&substrate

Formula of printer throughput time




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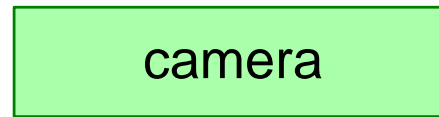
Optical path to measure marker position



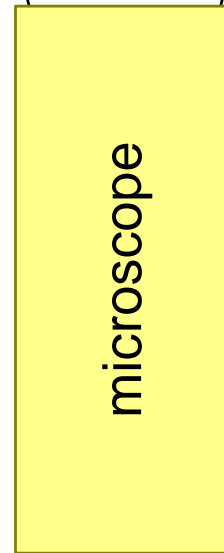
measurement accuracy
determines
required resolution



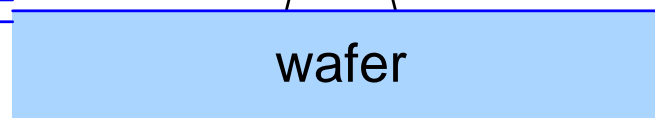
DoF 



#pixels \approx 5M
pixel resolution
versus
maximum Field of View
read-out and processing time

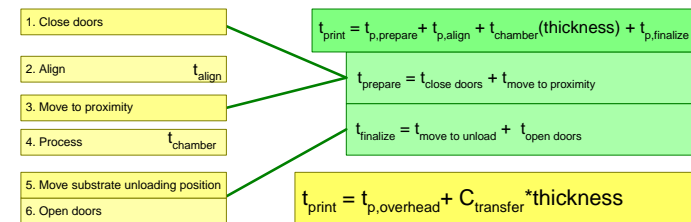
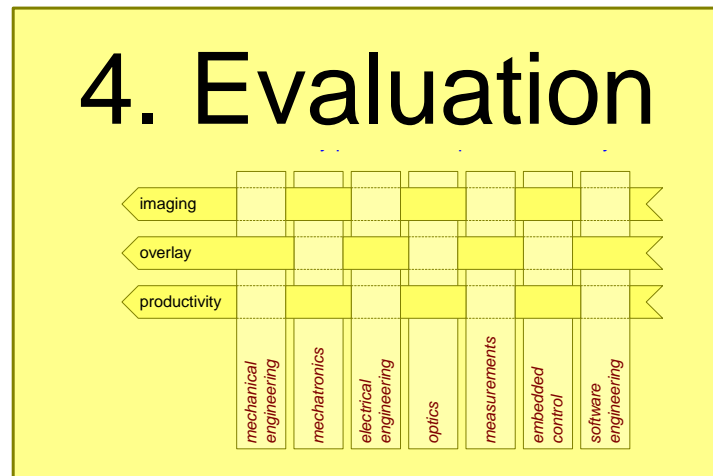
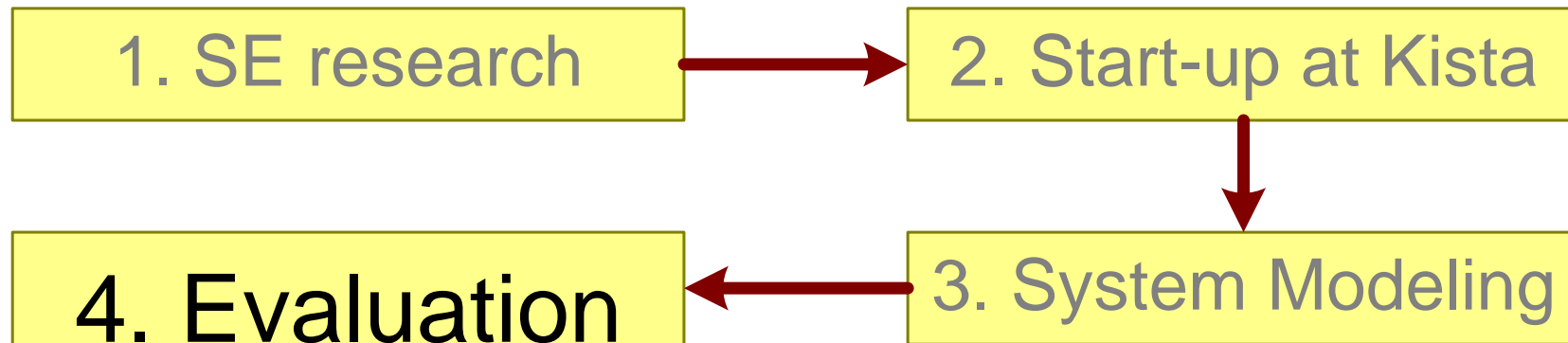
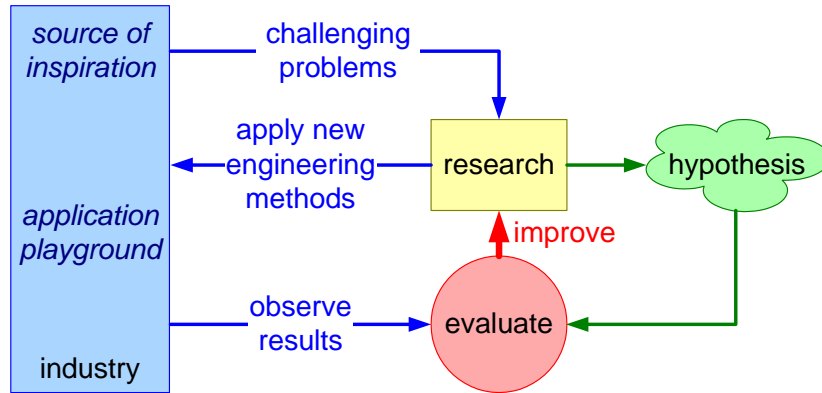


optical resolution
magnification



displacement
determines
required Field of View

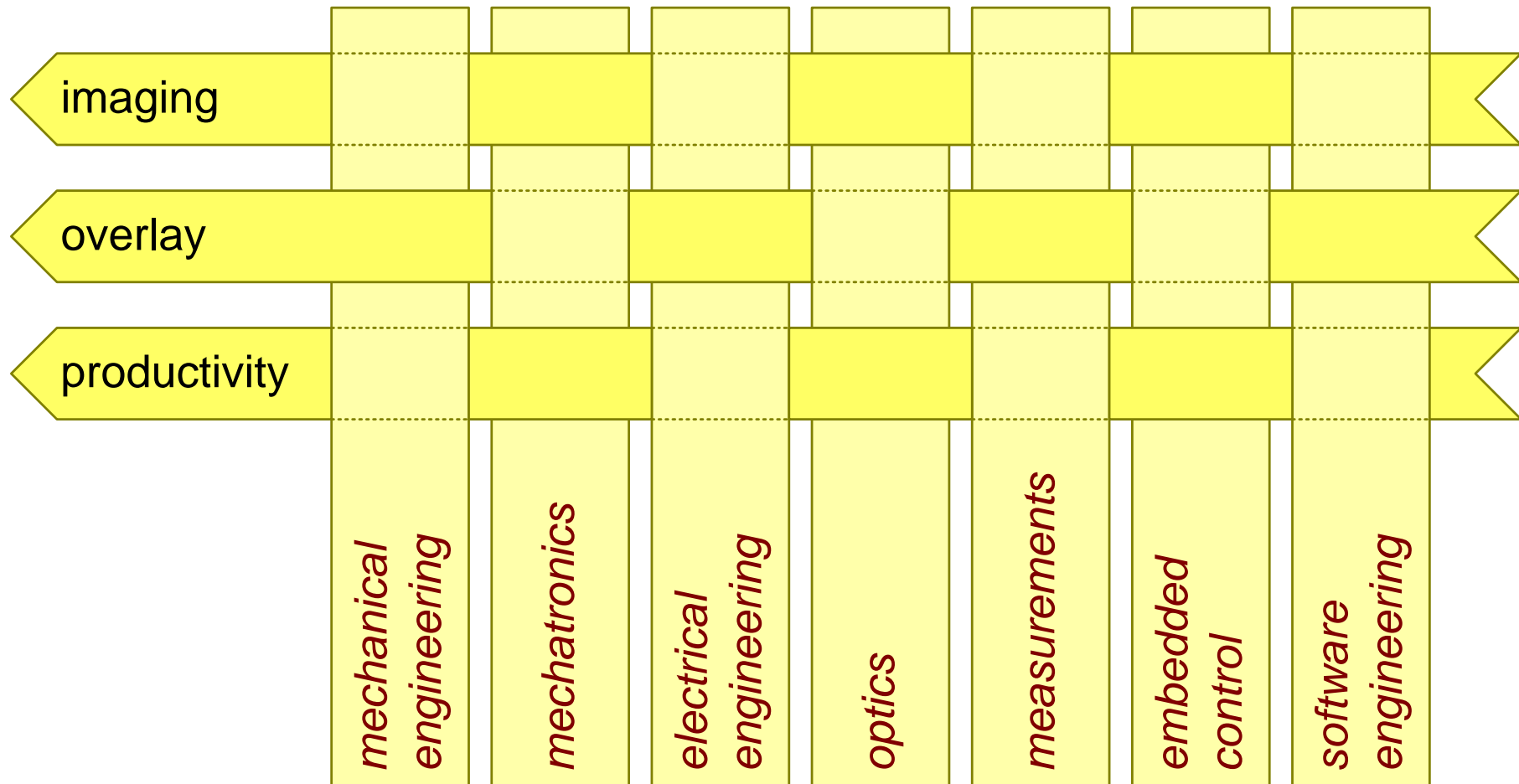
Evaluation



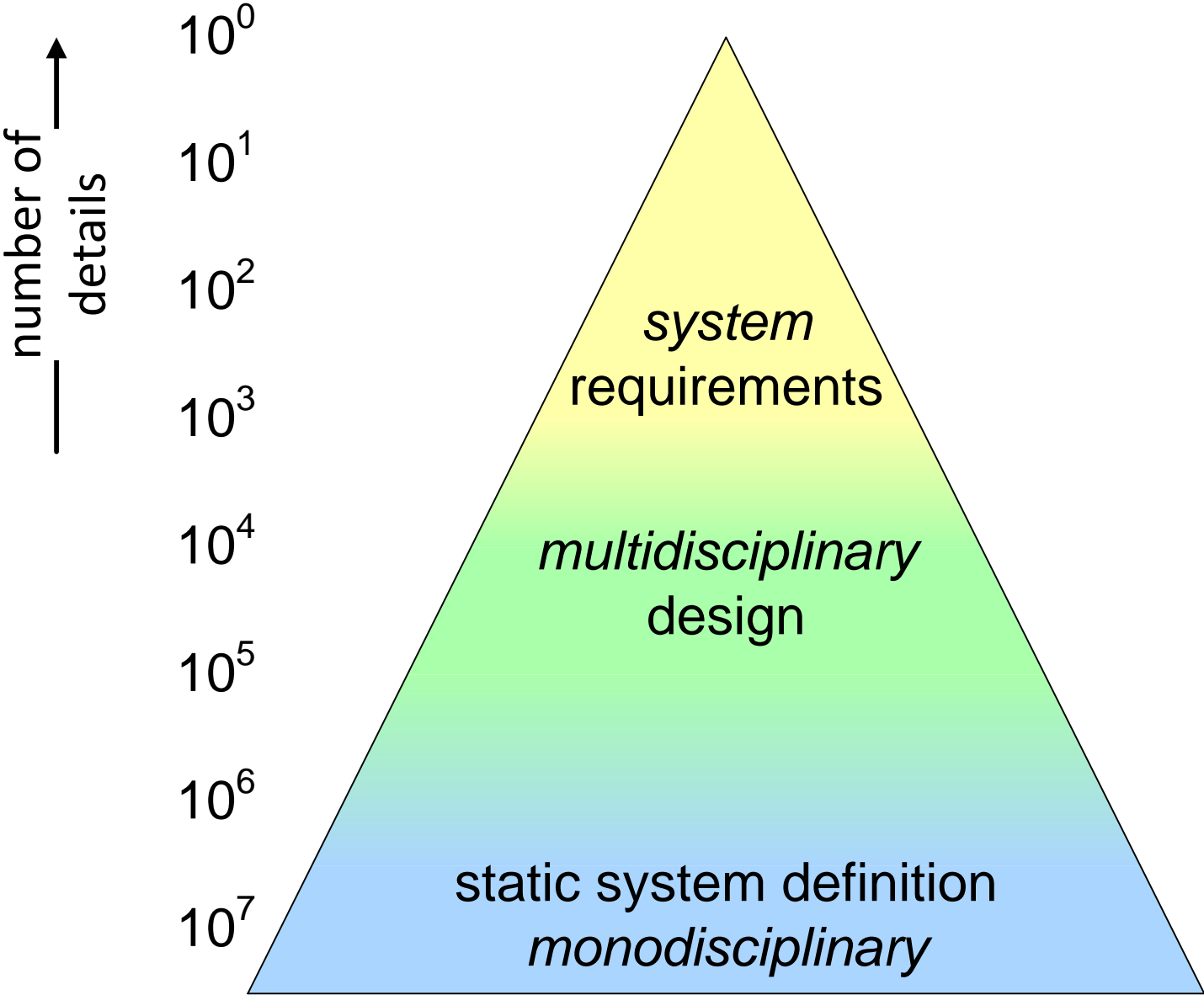
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From Engineering Disciplines to System Qualities

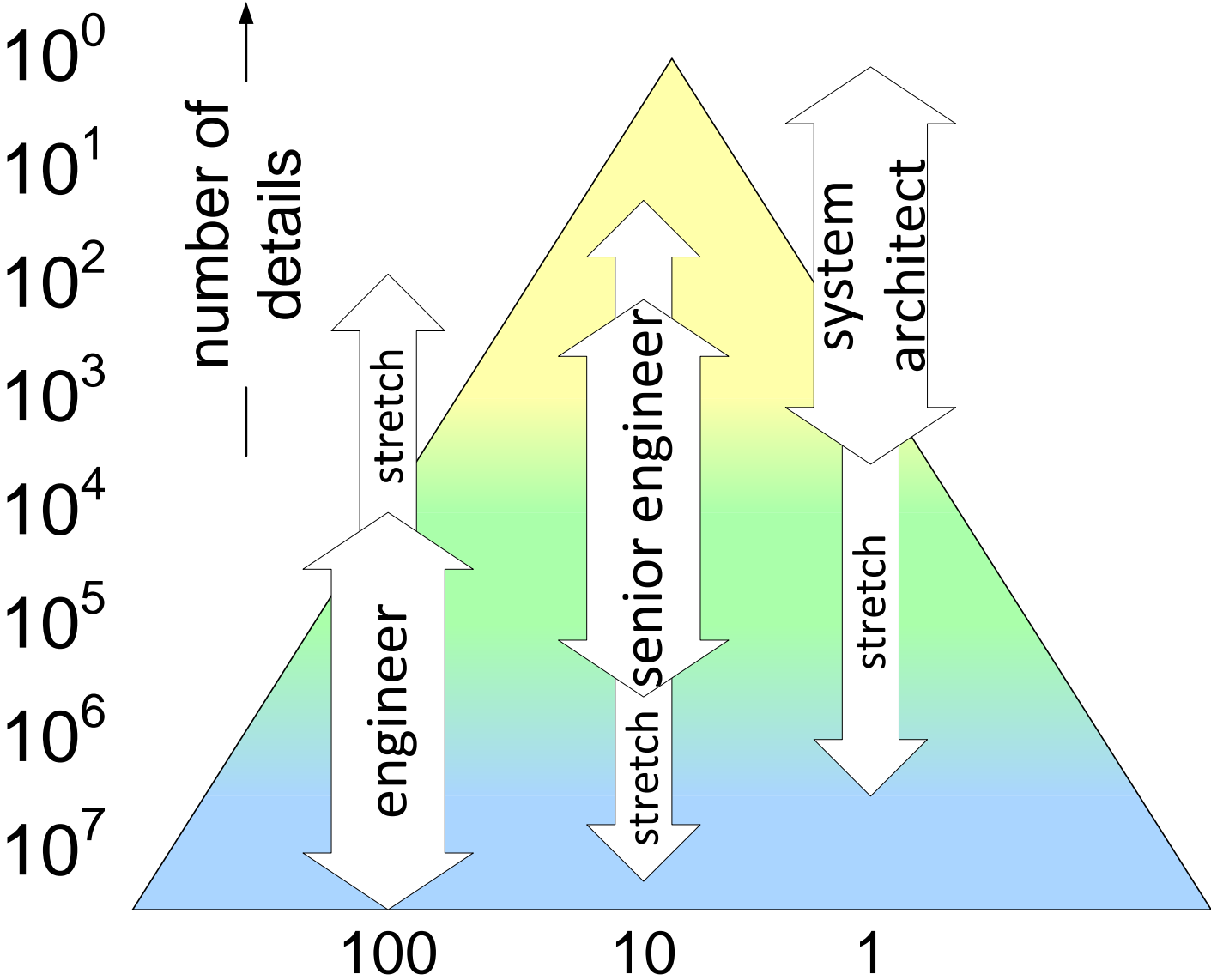
Systems Engineering: responsible for customer key drivers and key performance parameters of system



Levels of Abstraction



Lifting Engineers to System Concerns



Systems Engineering at Start-Up companies is applicable

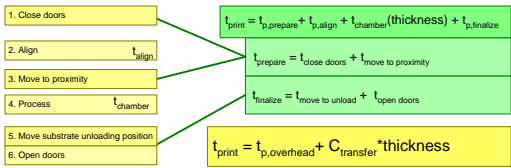
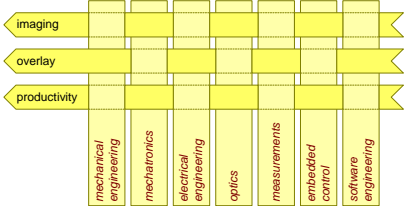
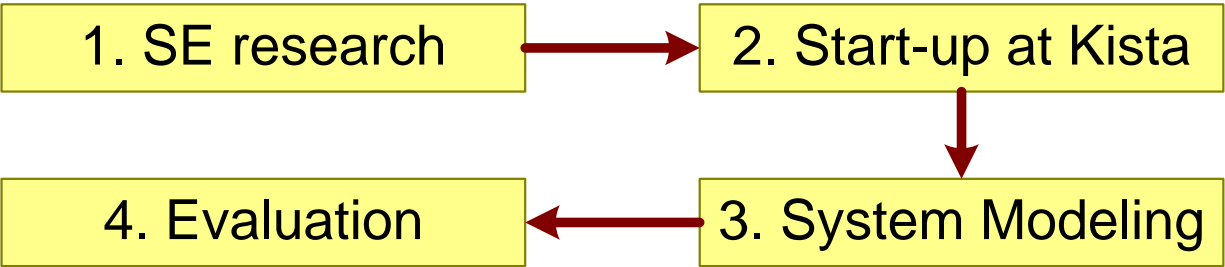
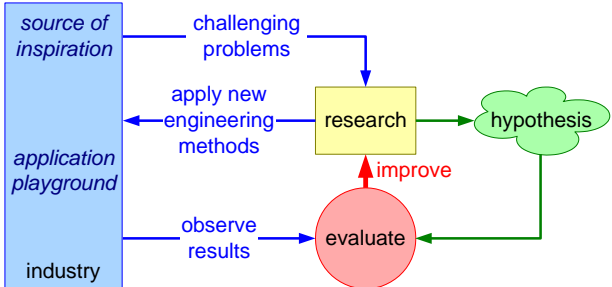
customization is required to adapt to:

company size

market and technology maturity

system models help to "lift" engineers to system level concerns

Application of theory in practice



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is required for **learning and validation**