

# Systems Engineering and Modeling at Start-Up Company

by *Gerrit Muller* Buskerud University College

e-mail: `gerrit.muller@embeddedsystems.nl`

`www.gaudisite.nl`

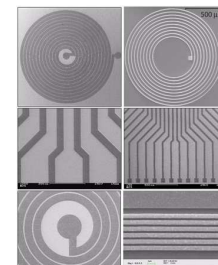
## Abstract

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.

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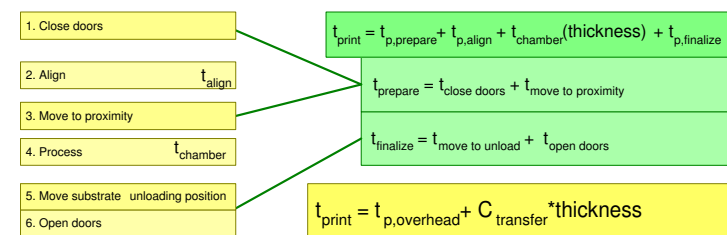
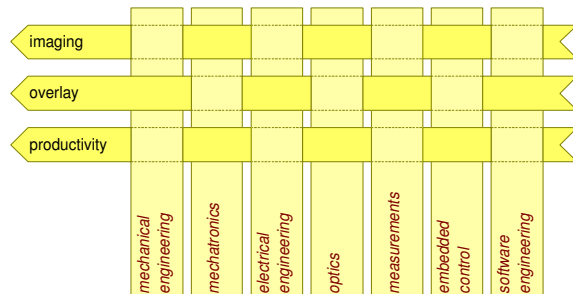
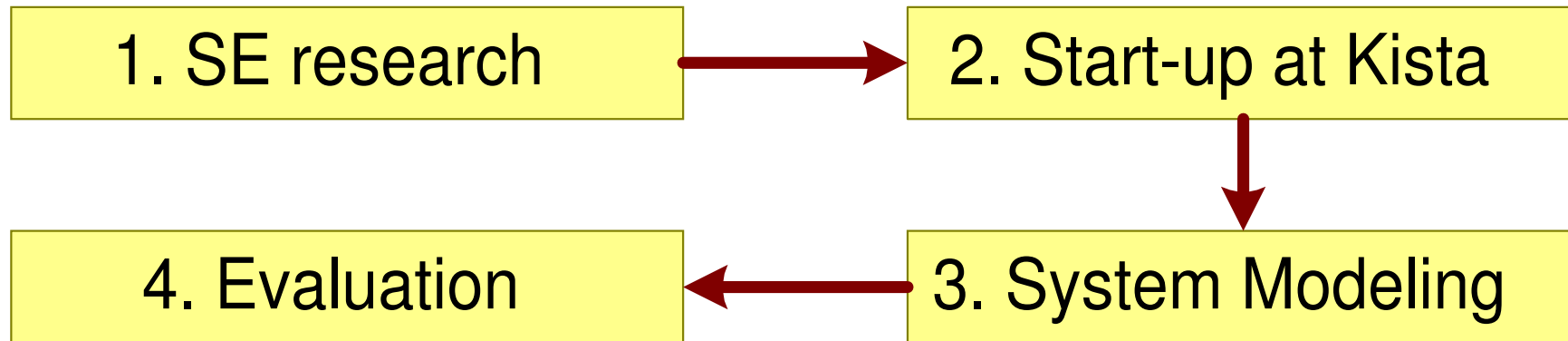
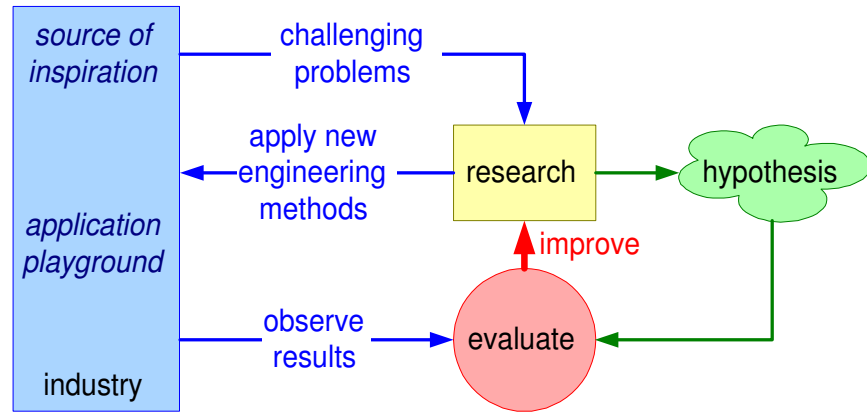
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July 1, 2011  
status: preliminary  
draft  
version: 0



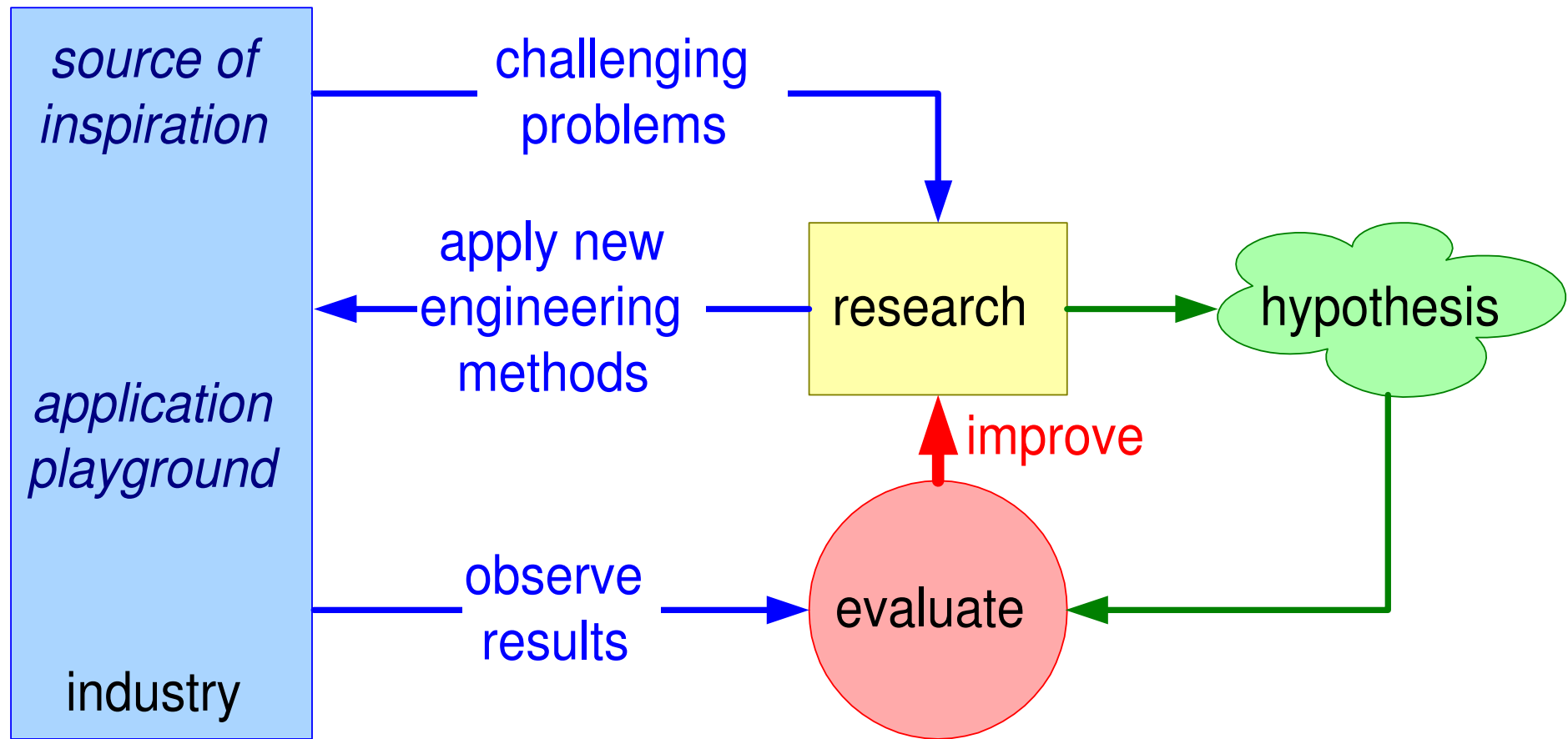
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# Figure Of Contents™

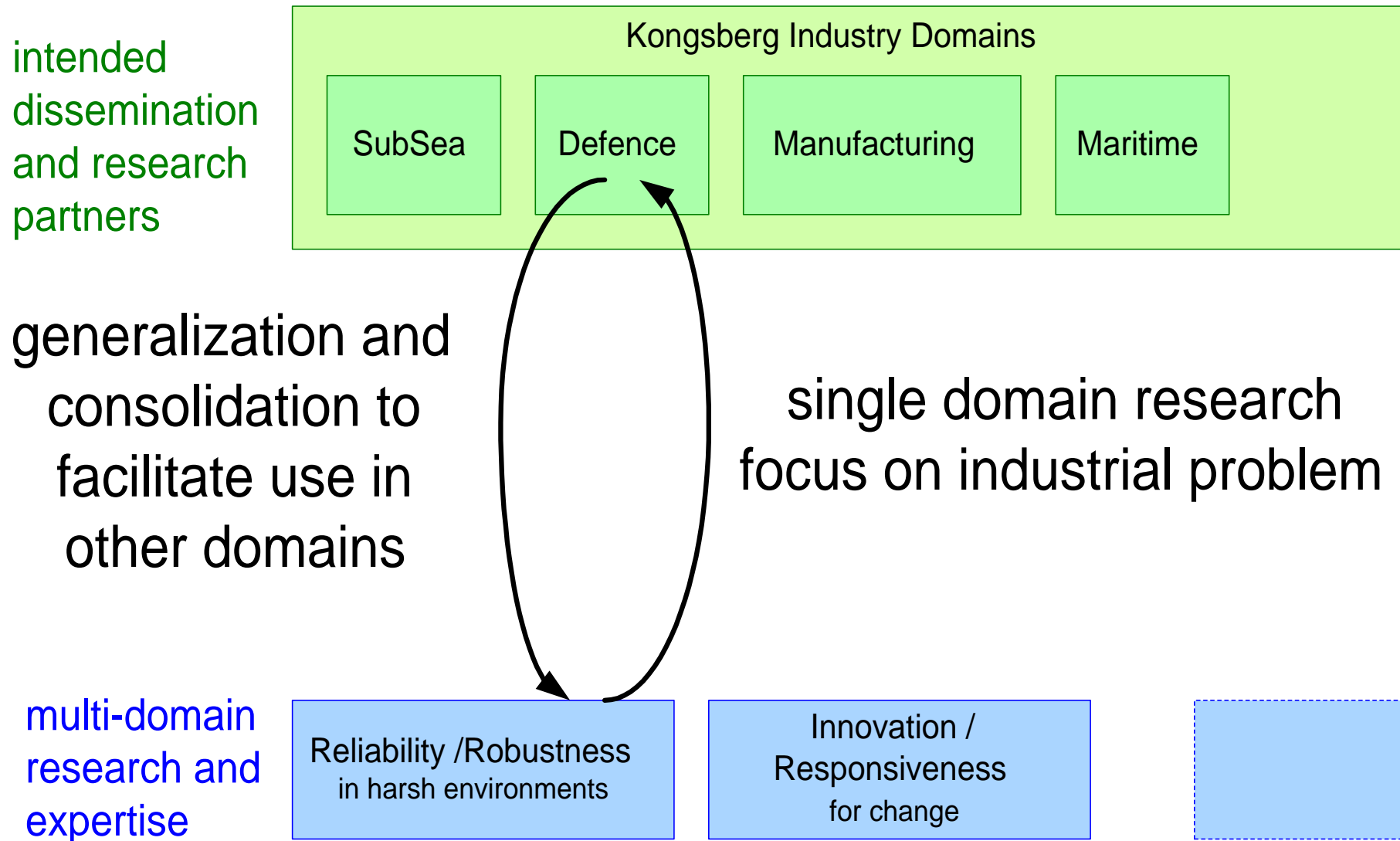


*note: original diagram was annotated with actual performance figures for confidentiality reasons these numbers have been removed*

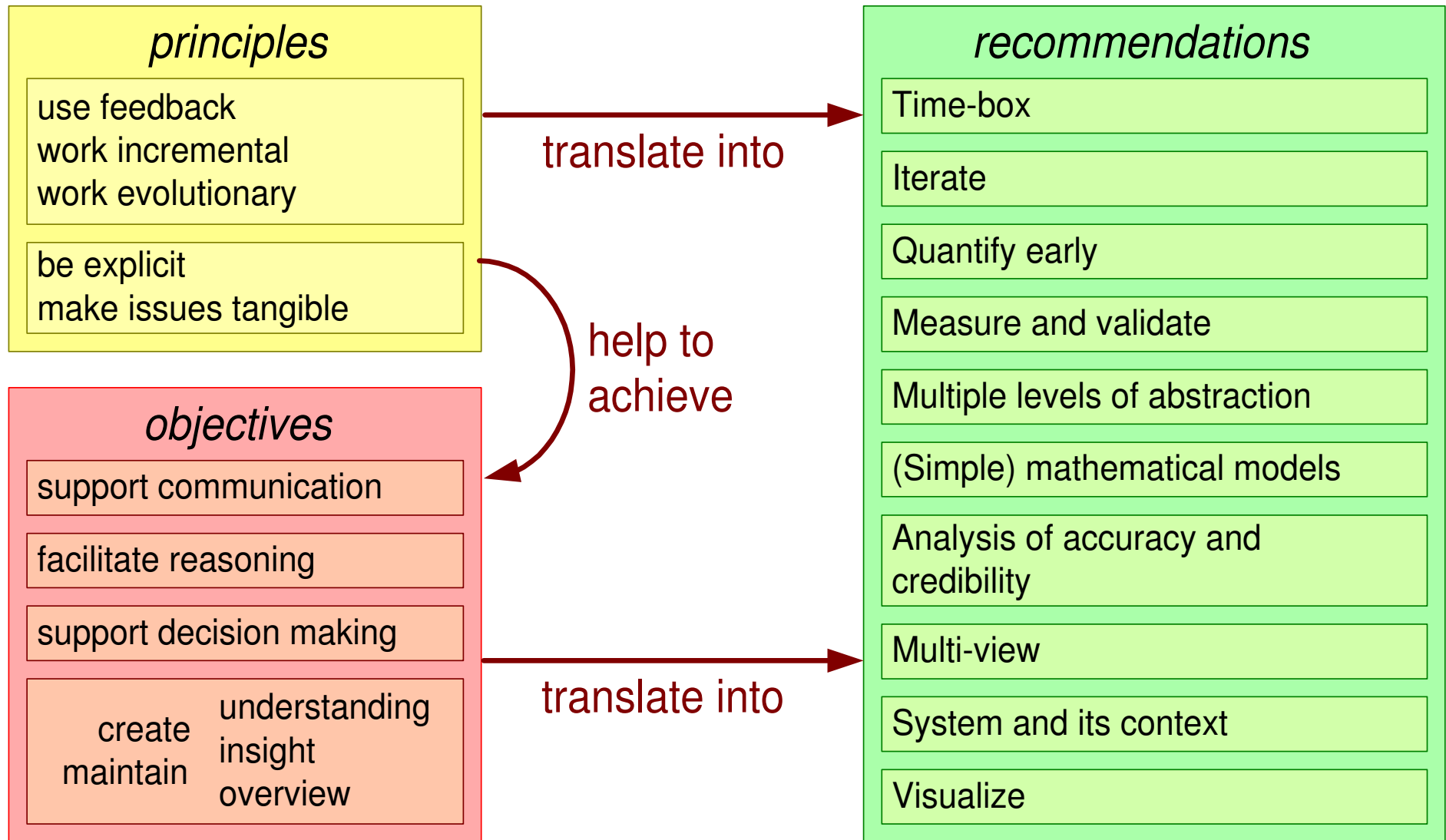
# Industry as Laboratory



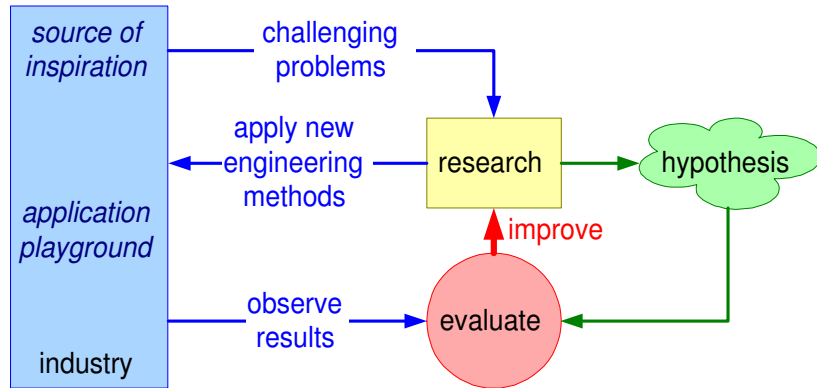
# Industry as Laboratory (2)



# Modeling Recommendations as Applied



# Start-Up Company Replisaurus in Kista (Sweden)

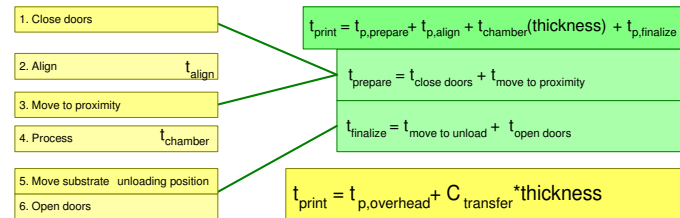
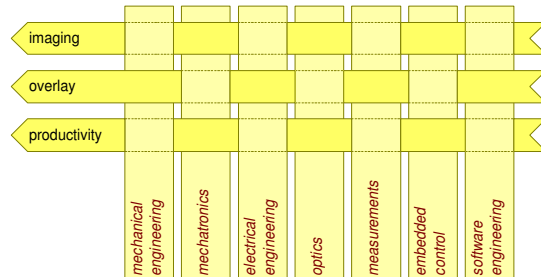


1. SE research

2. Start-up at Kista

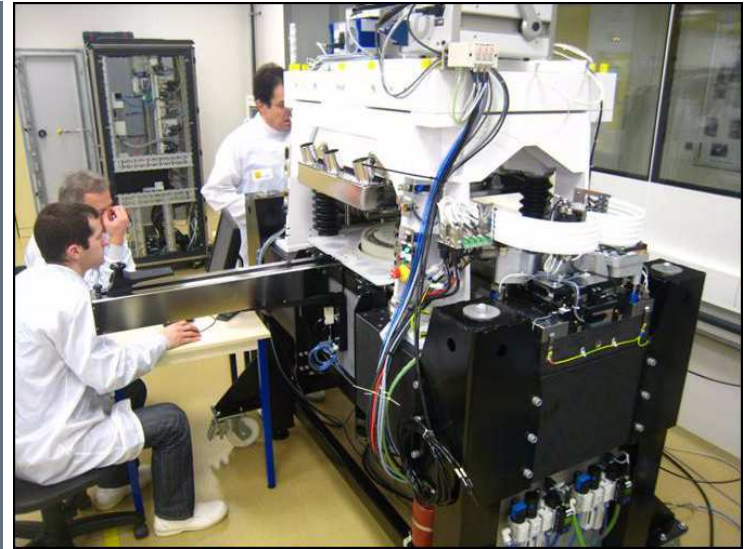
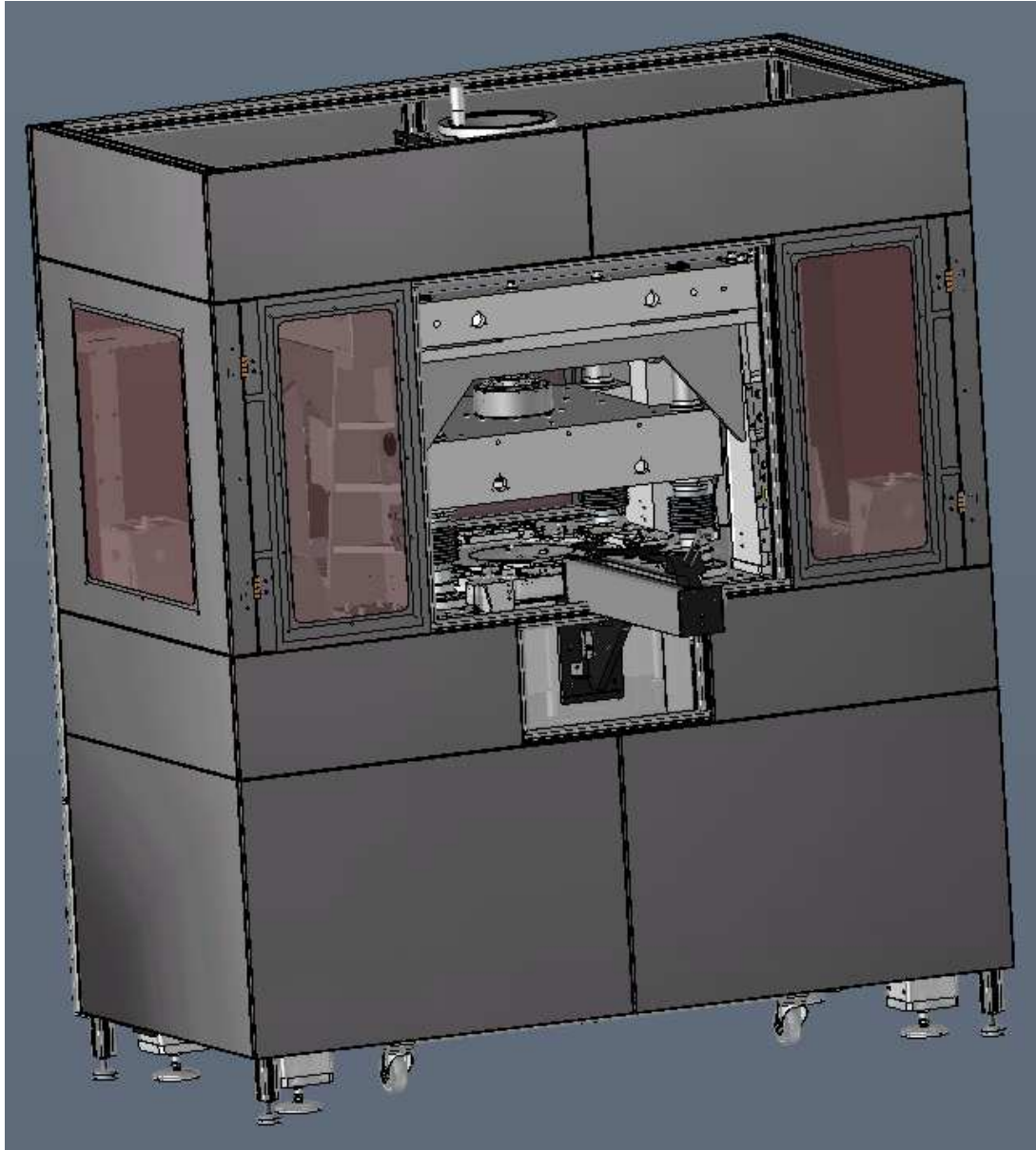
4. Evaluation

3. System Modeling

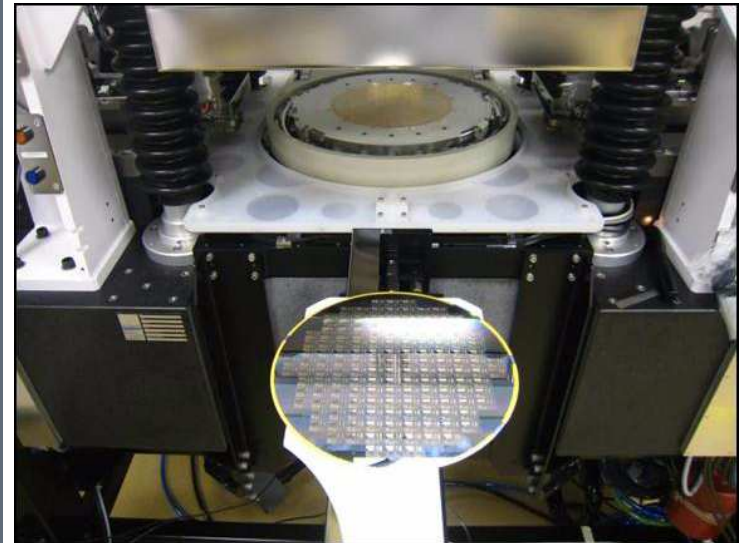


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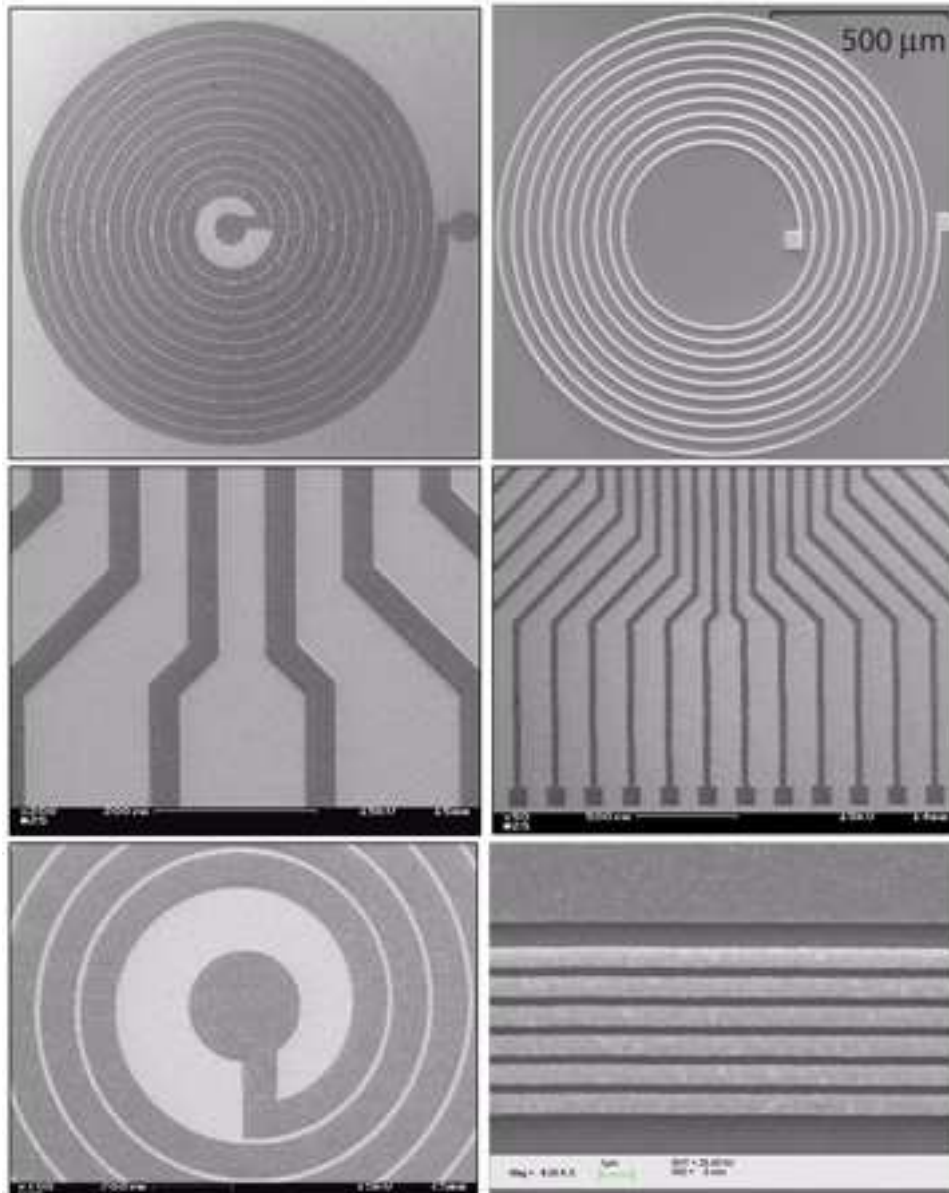
# The Copper Printer



courtesy Replisaurus  
[www.replisaurus.com](http://www.replisaurus.com)



# Example of printed copper structures

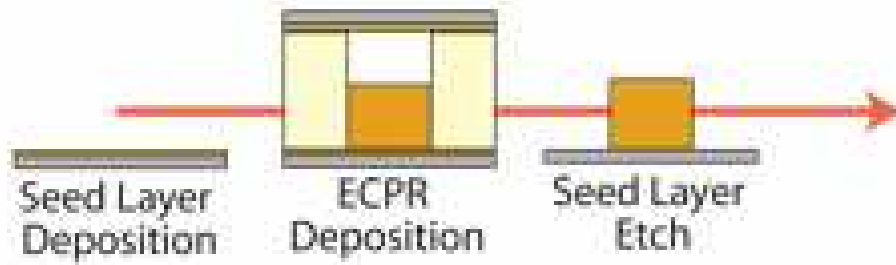


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# ECPR technology replaces 6 process steps by 1 step

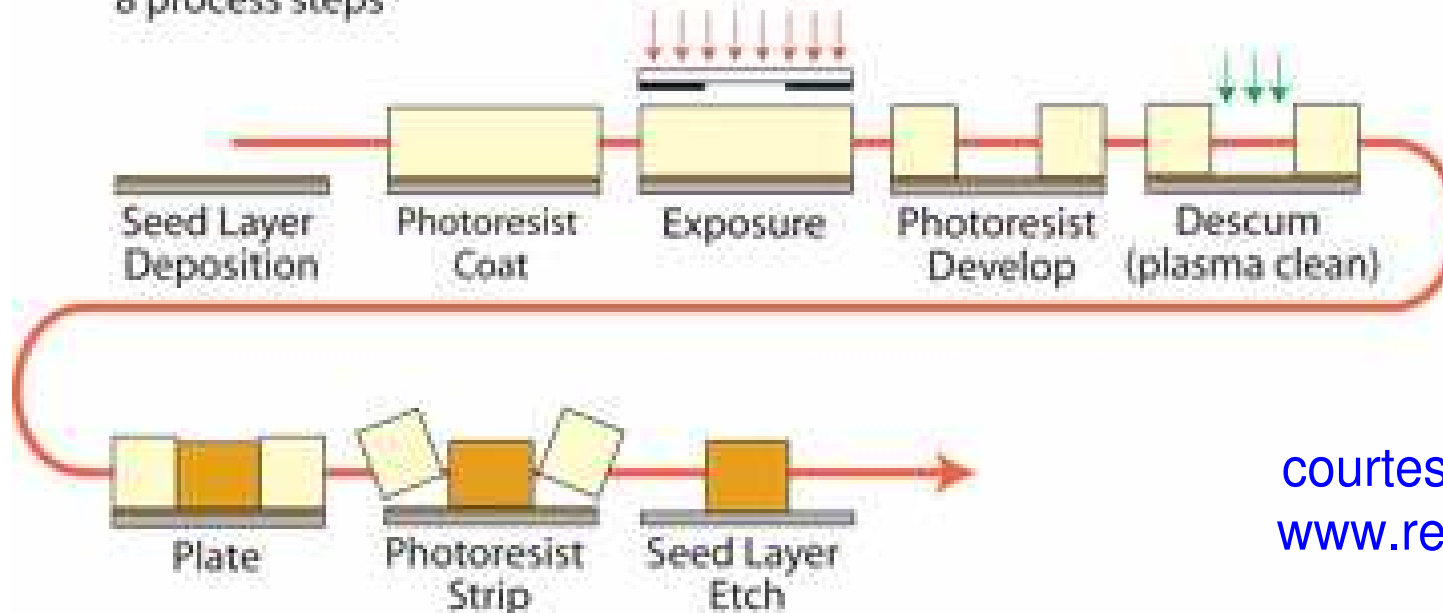
## ECPR - ElectroChemical Pattern Replication

3 process steps



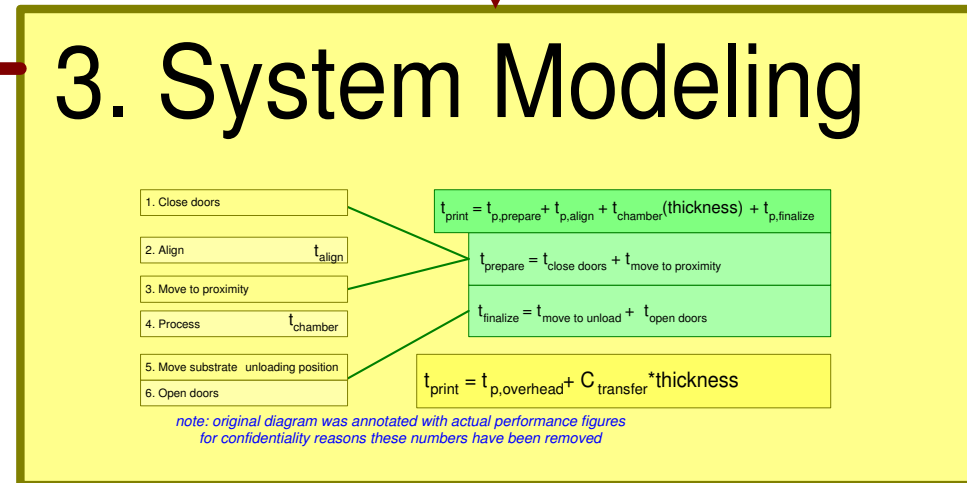
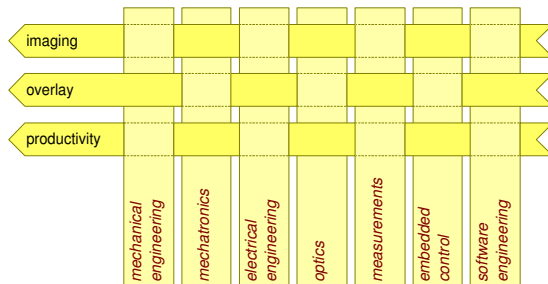
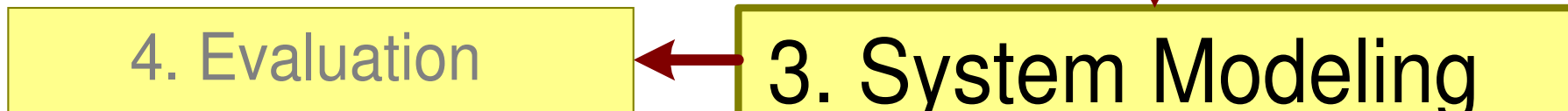
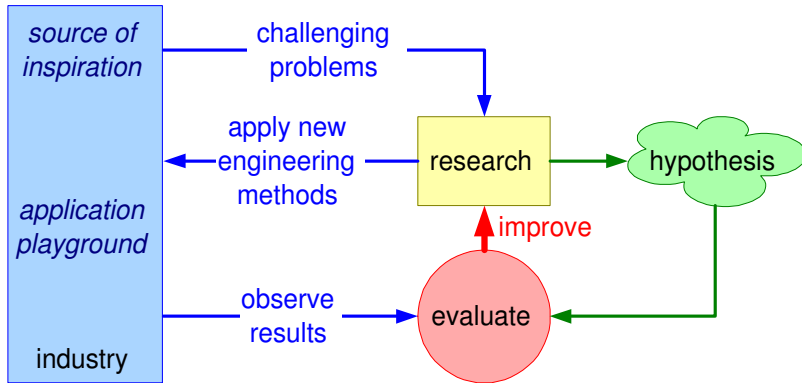
## Conventional lithography based metallization

8 process steps

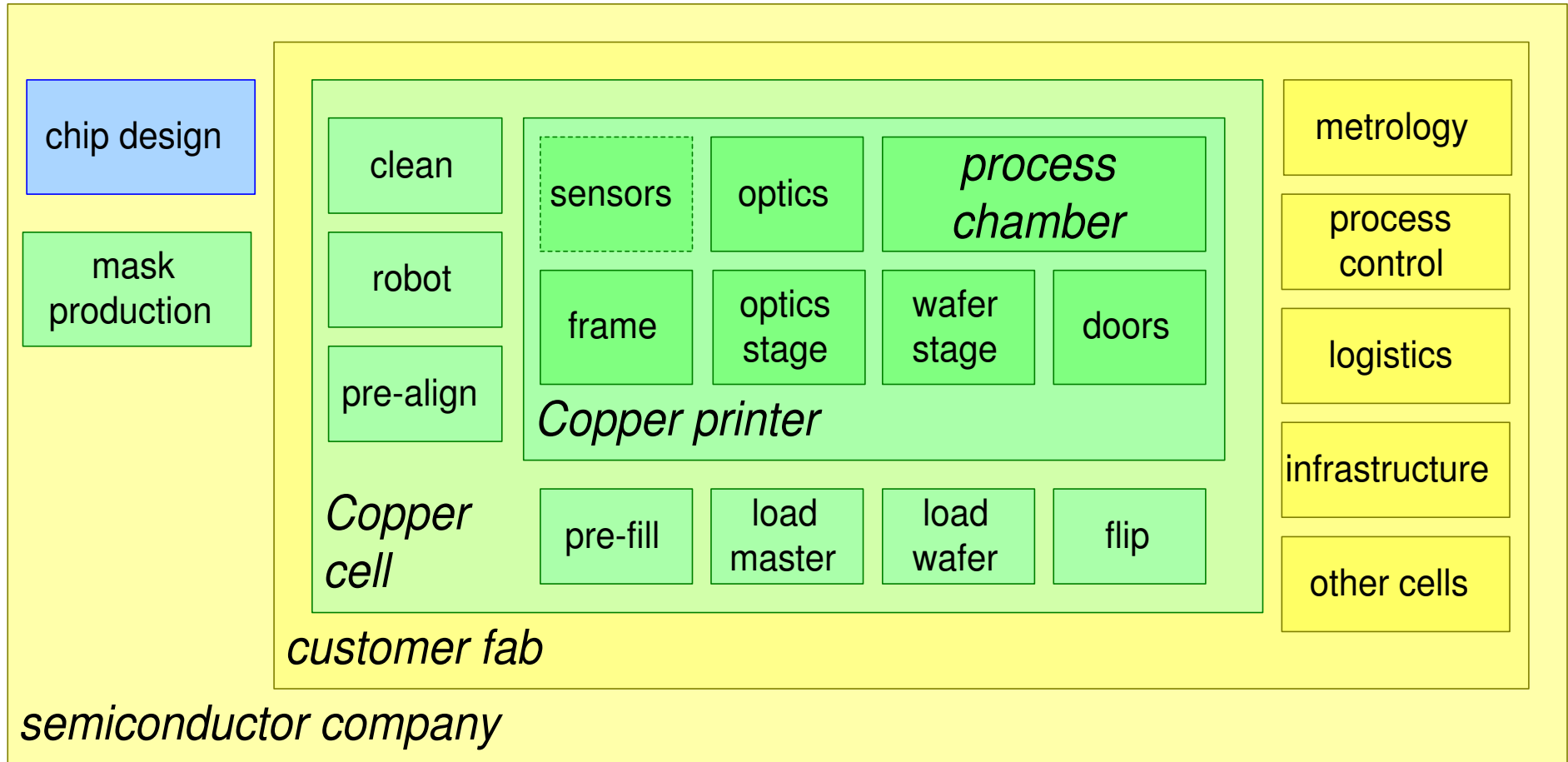


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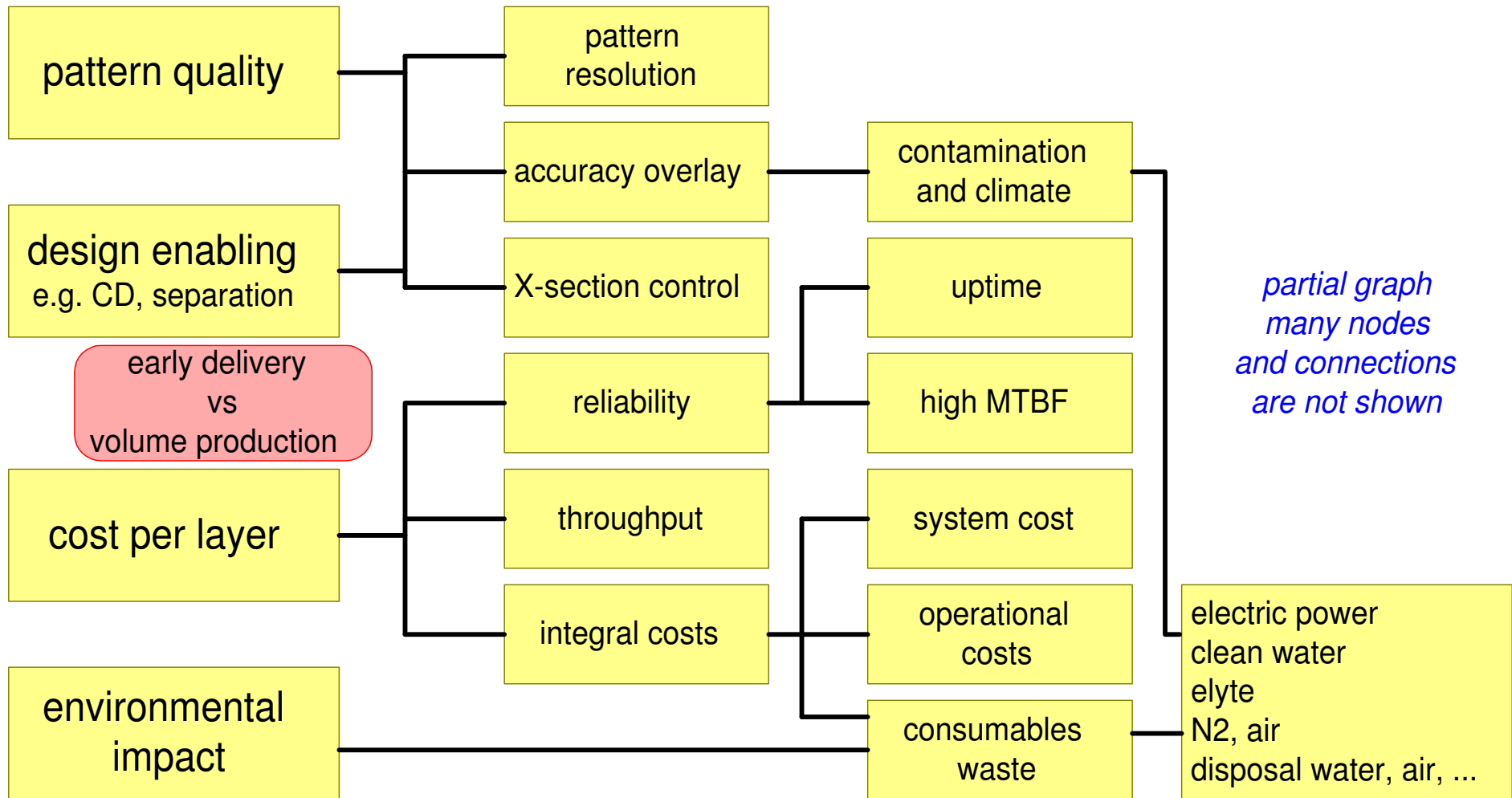
# System Modeling



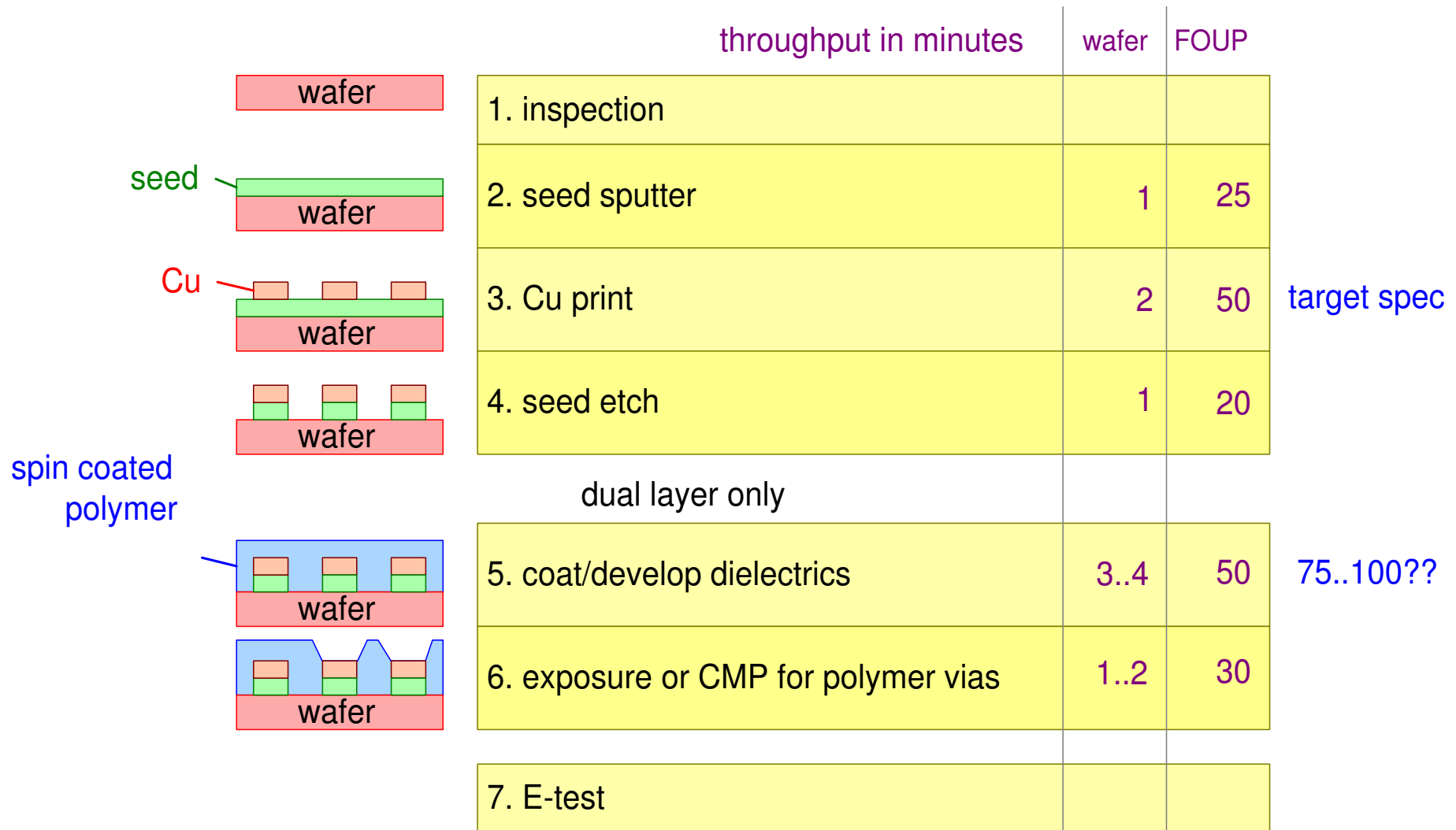
# Overview of the different scopes



# Customer key driver graph



# Process flow at fab level, from inspection until testing



# Work flow in the Copper Printer

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0. Loading Master&substrate

1. Close doors

2. Align

3. Move to proximity

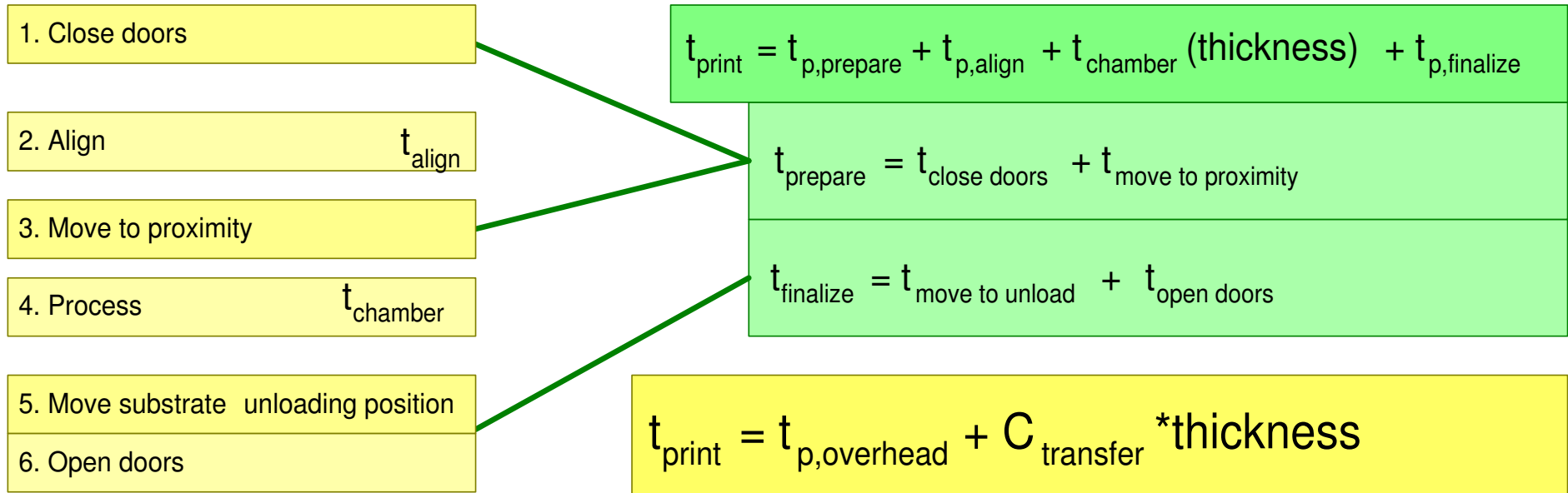
4. Process incl. rinse&dry

5. Move substrate unloading position

6. Open doors

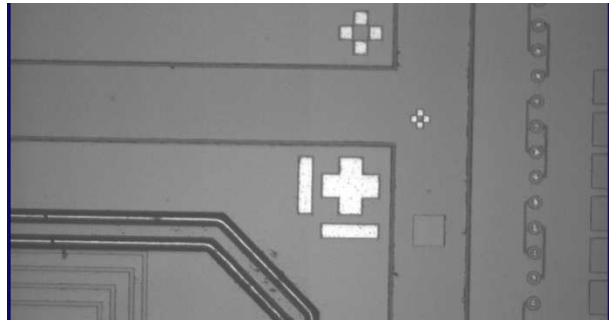
7. Unloading Master&substrate

# Formula of printer throughput time



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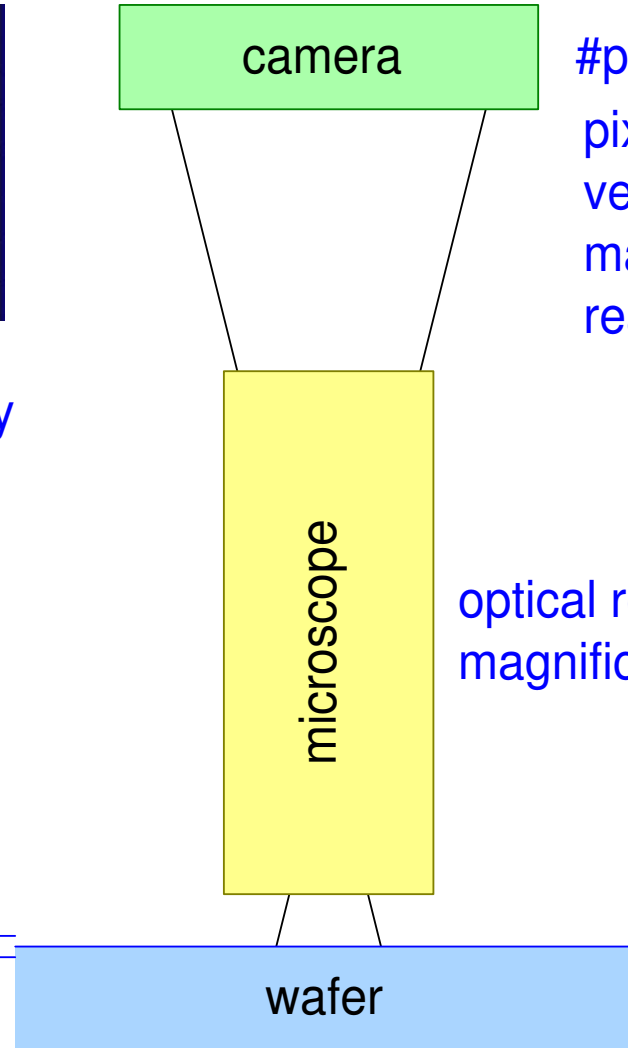
# Optical path to measure marker position



measurement accuracy  
determines  
required resolution



DoF

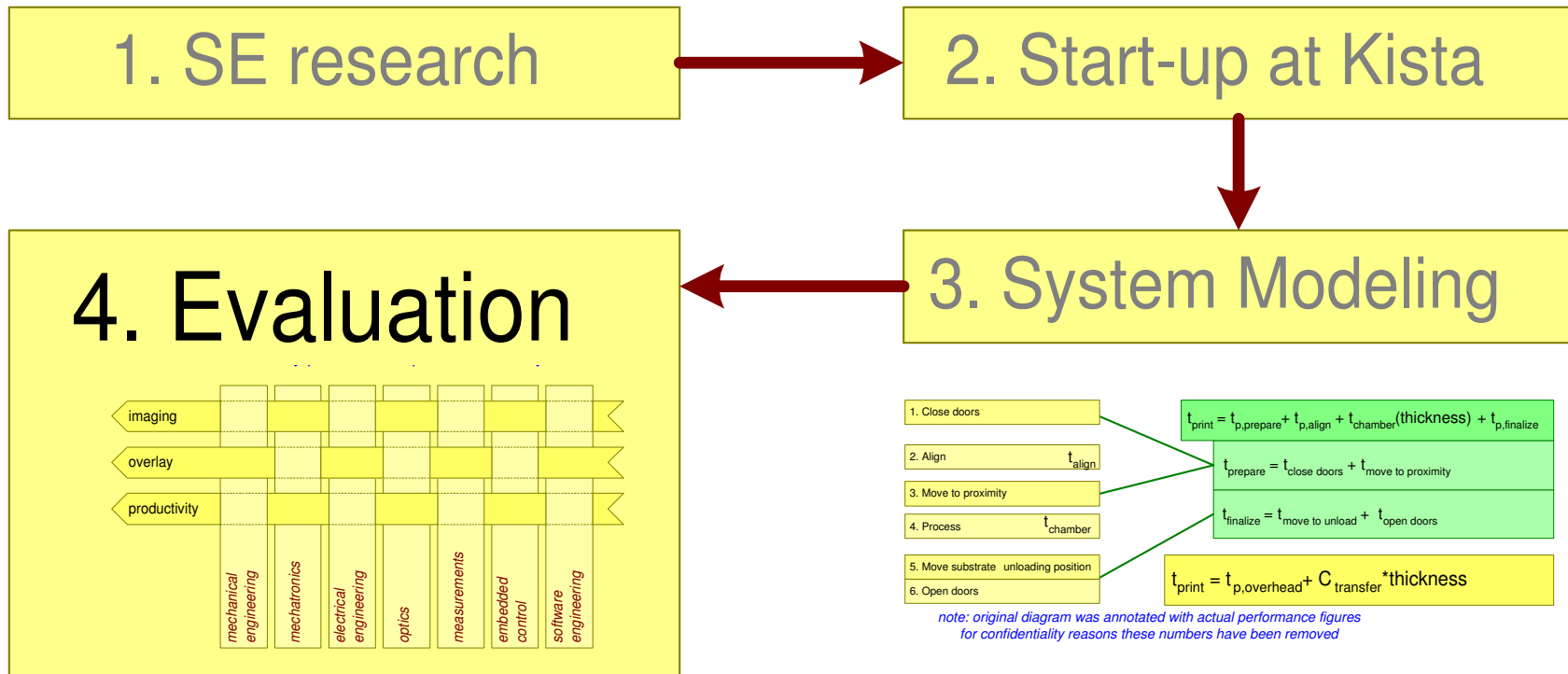
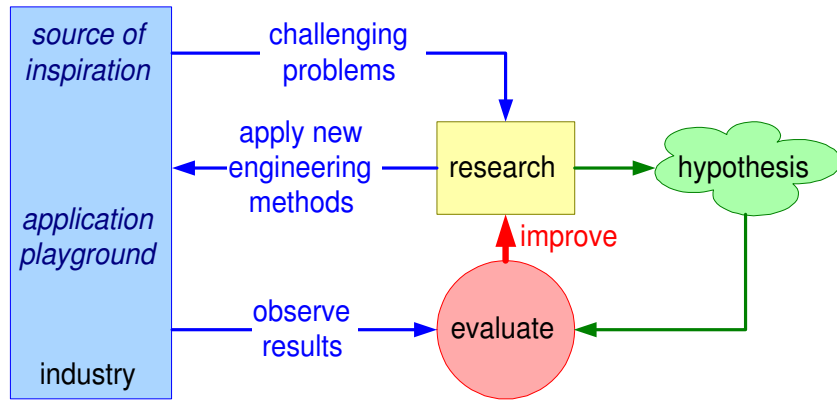


#pixels  $\approx$  5M  
pixel resolution  
versus  
maximum Field of View  
read-out and processing time

optical resolution  
magnification

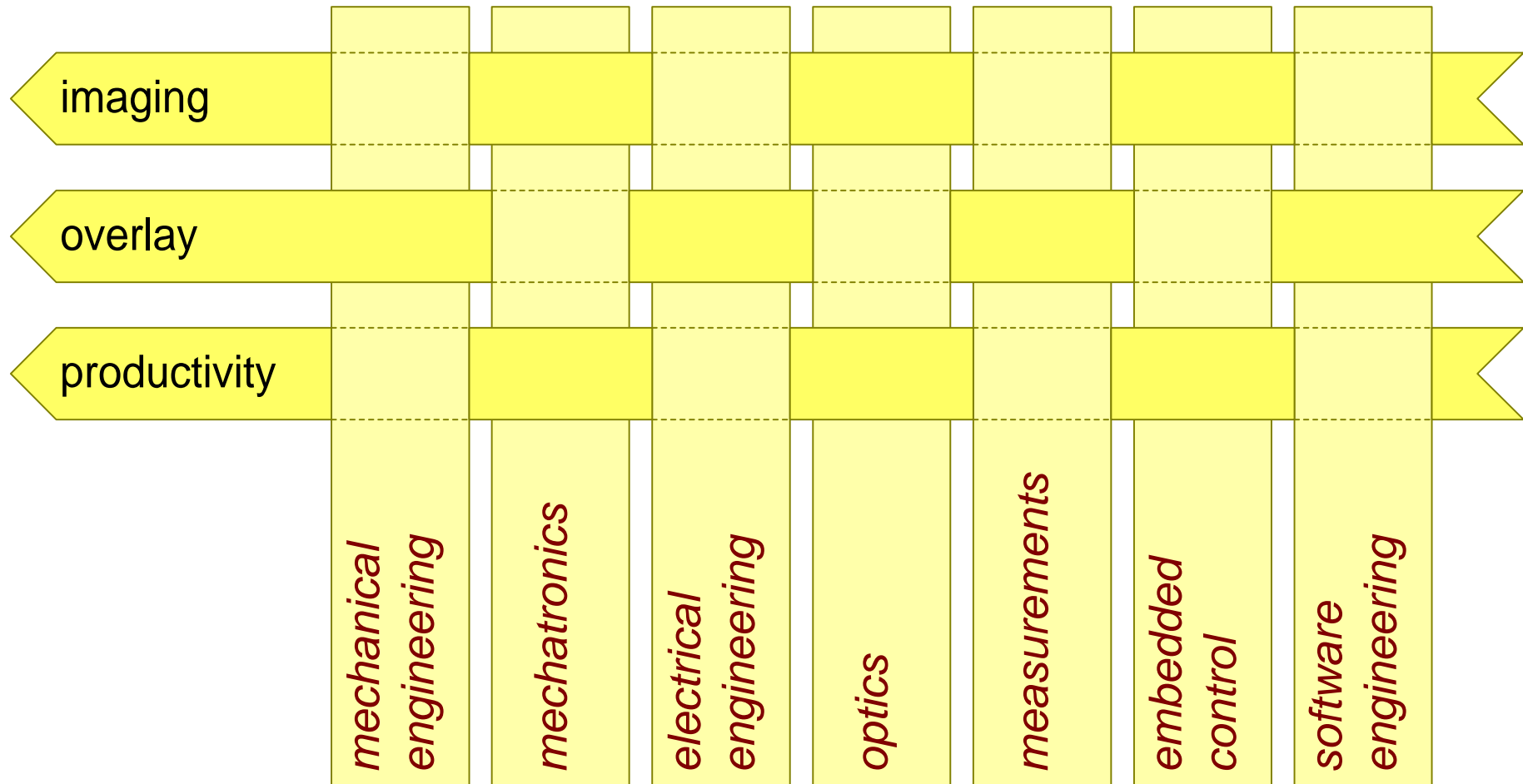
displacement  
determines  
required Field of View

# Evaluation

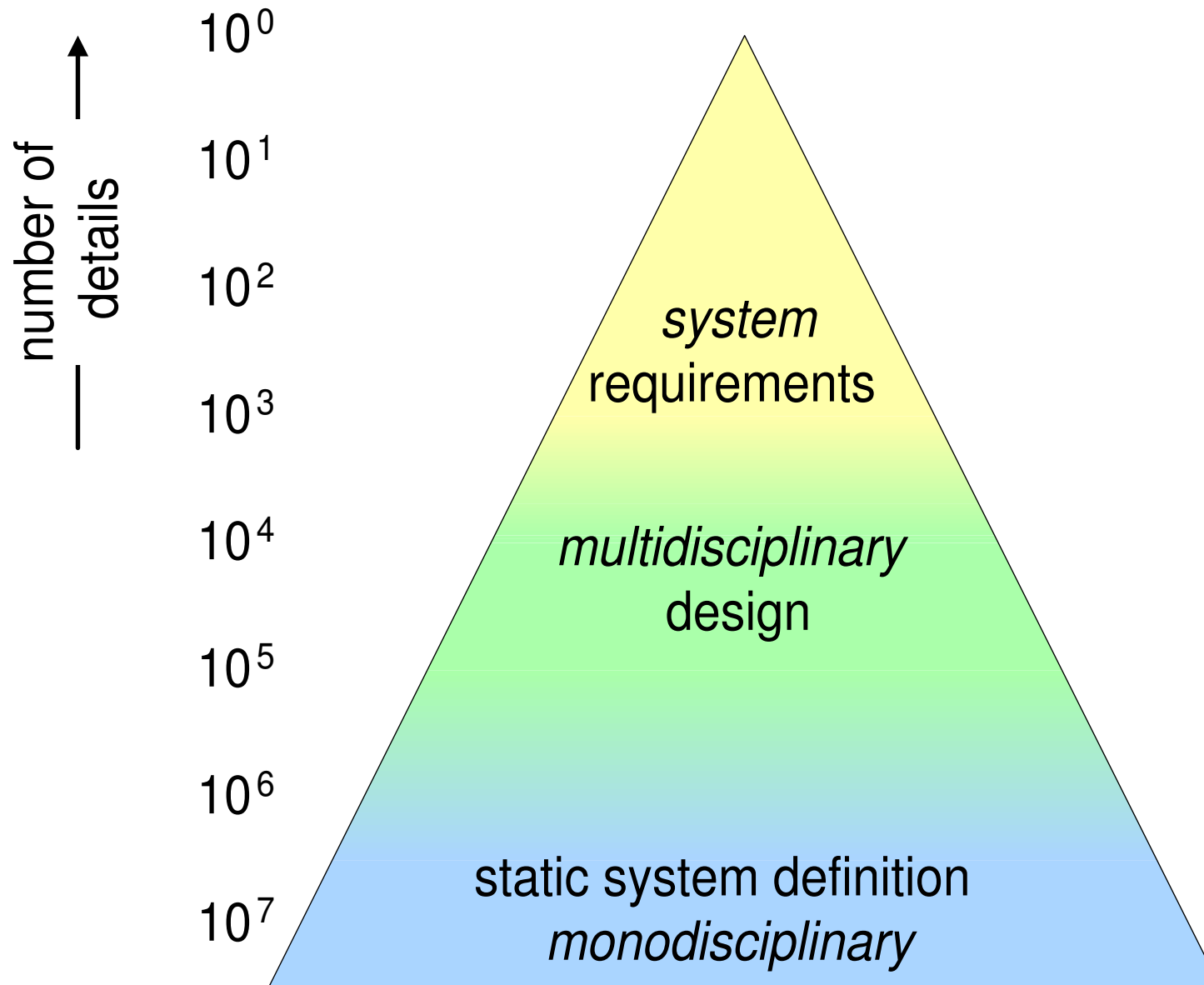


# From Engineering Disciplines to System Qualities

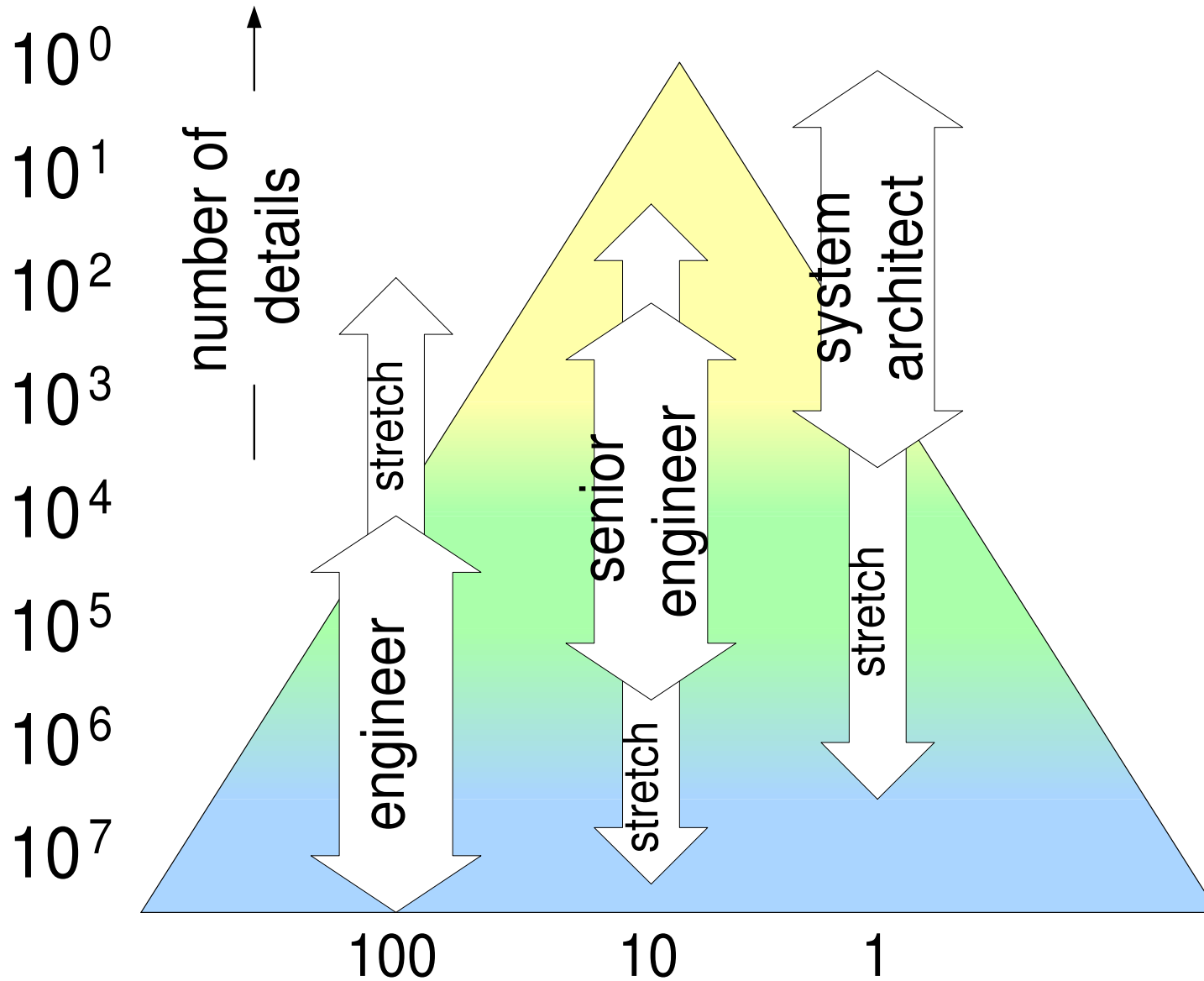
Systems Engineering: responsible for customer key drivers and key performance parameters of system



# Levels of Abstraction



# Lifting Engineers to System Concerns



Systems Engineering at Start-Up companies is applicable

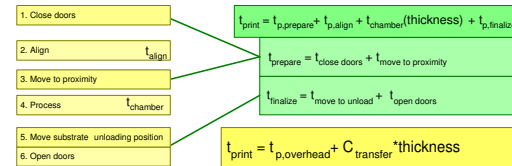
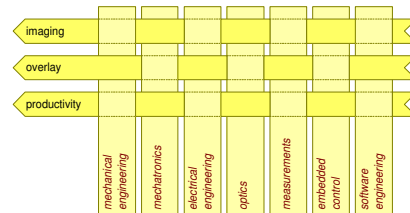
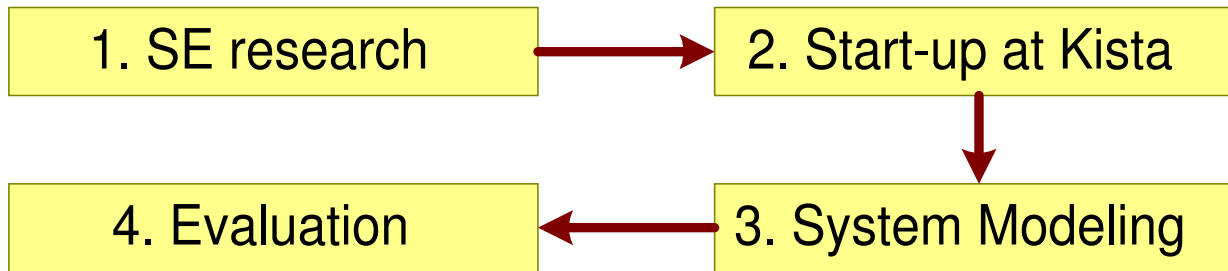
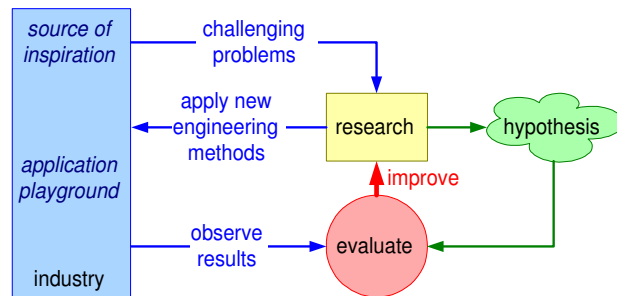
customization is required to adapt to:

- 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**