RESEARCH ON MODEL-BASED (CYBER-PHYSICAL) PRODUCT DEVELOPMENT @ Machine Design

Johan Ölvander
Division of Machine Design
Department of Management and Engineering

LINKÖPINGS UNIVERSITET

MODPROD Workshop 2019
5-6/2 2018, Linköping University

Agenda

- Who we are
- What we do
- Example of recent PhD-projects
- Ongoing research
- Future trends

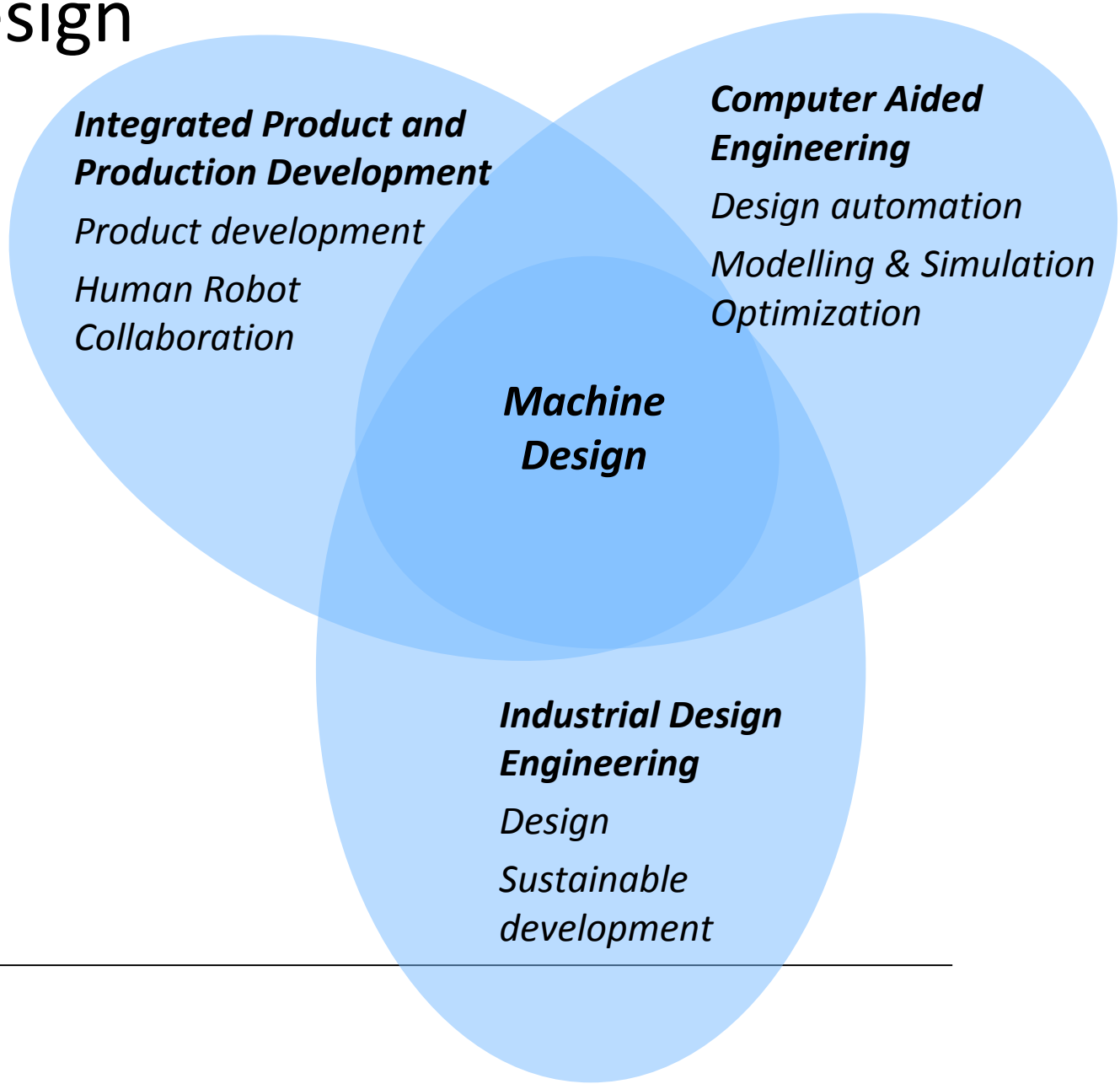
The Division of Machine Design

- 2 full professor
- 1 Adjoint professor
- 3 Associate professors
- 5 Senior Lecturers
- 7 Lecturers
- 3 Post docs
- 10 PhD students
- 2 Industrial PhD student
- 2 Technicians
- 1 administrator

In total >30 persons, 24 FTE + ind. PhD students

Budget: Education 26 MSEK

Research 9 MSEK



What we do!

- Our aim is to make the product development process more efficient by using modelling, simulation and optimization.
- We consider physical products (cyber-physical systems) like aeroplanes, industrial robots, vehicles etc.
- We consider geometrical- as well as functional models of the product and the production system.
- We consider real-world problems meaning that they are vaguely formulated and include uncertainties
- We focus on computational efficiency using for example surrogate models.
- Most problem are addressed by multi-disciplinary and/or multi-objective optimization problems.

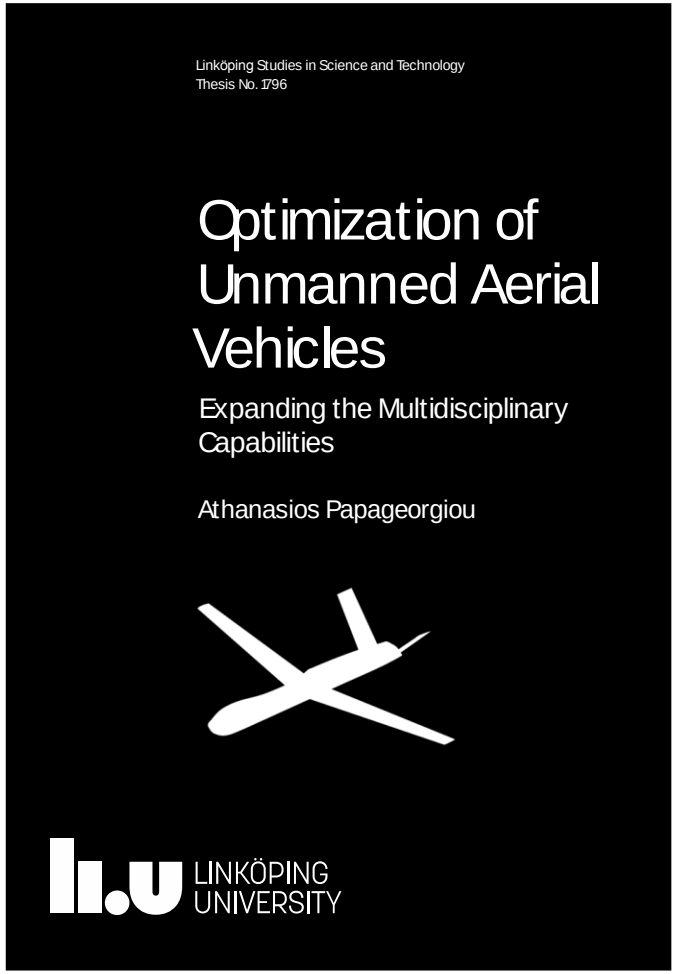
Recent PhD-projects

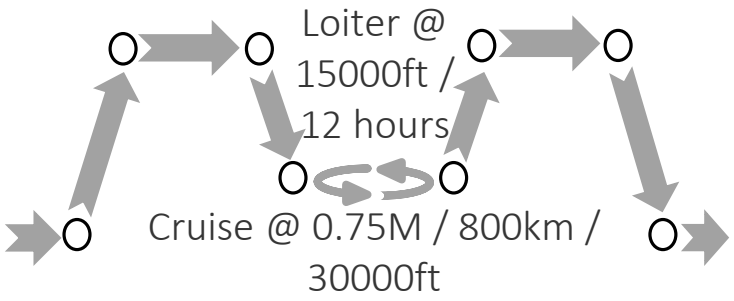
Multi-disciplinary optimization of UAV

Multi-objective optimization of system safety

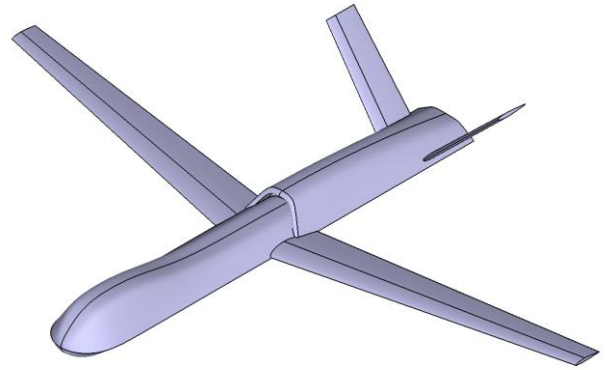
Design automation for industrial robot grippers

Multi-disciplinary Optimization of UAV:s – *A. Papageorgiou*

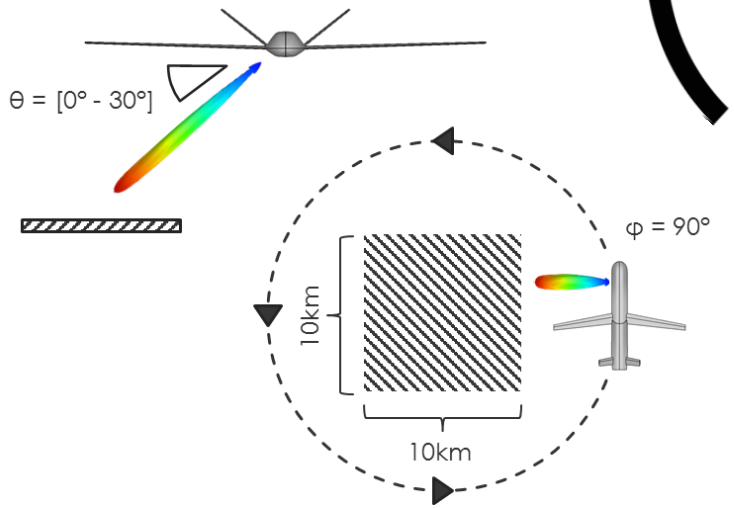




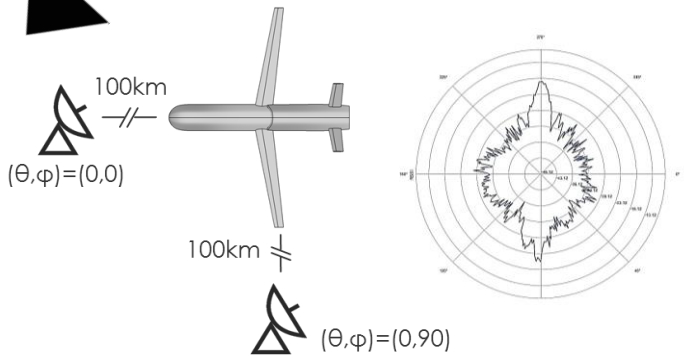
Flight mission



Geometry



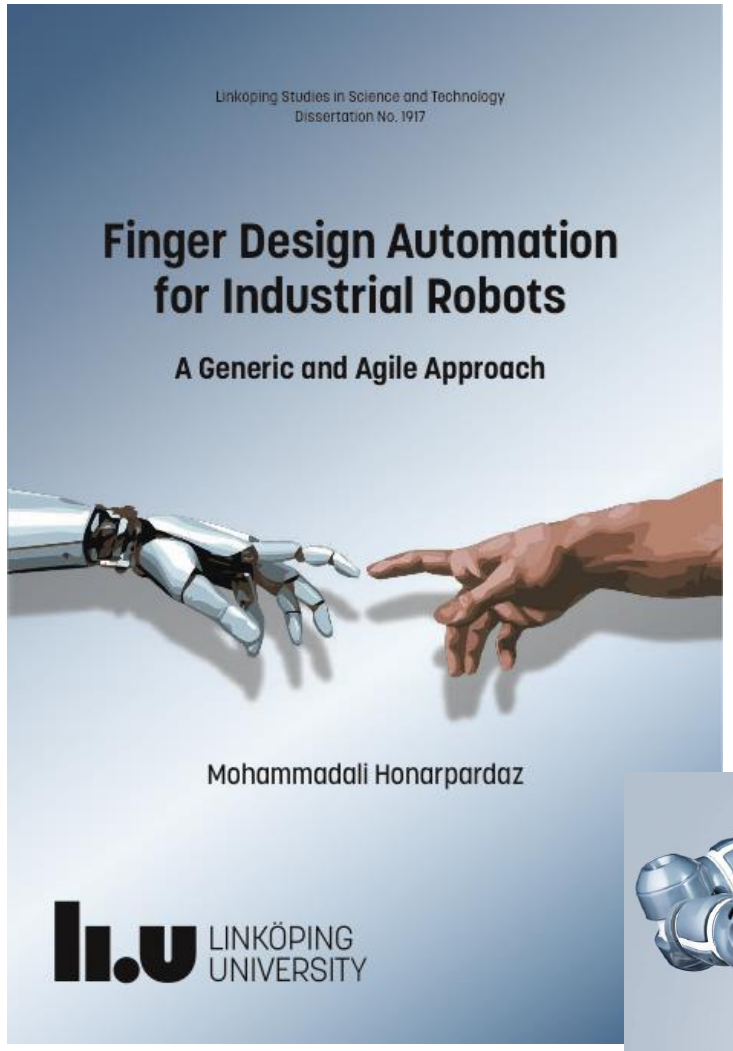
Sensor performance



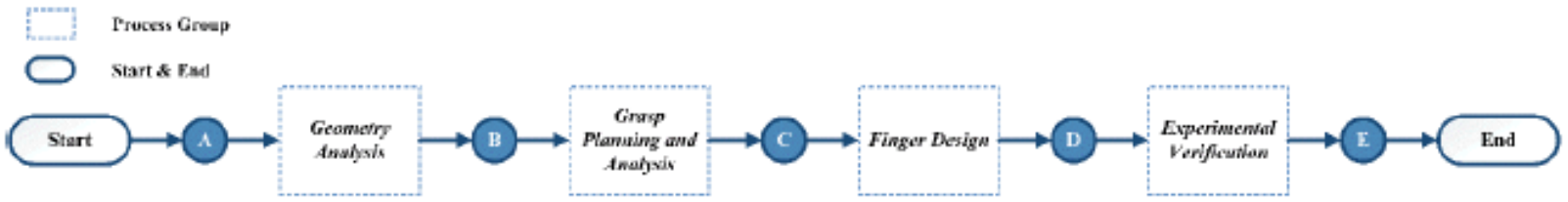
Radar Cross section

LINKÖPINGS UNIVERSITET

Design automation of robotic fingers: *M. Honarpardaz*



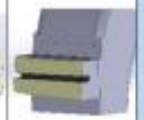
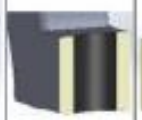
- High variety and short cycles in manufacturing
- The cost of robot integration is high

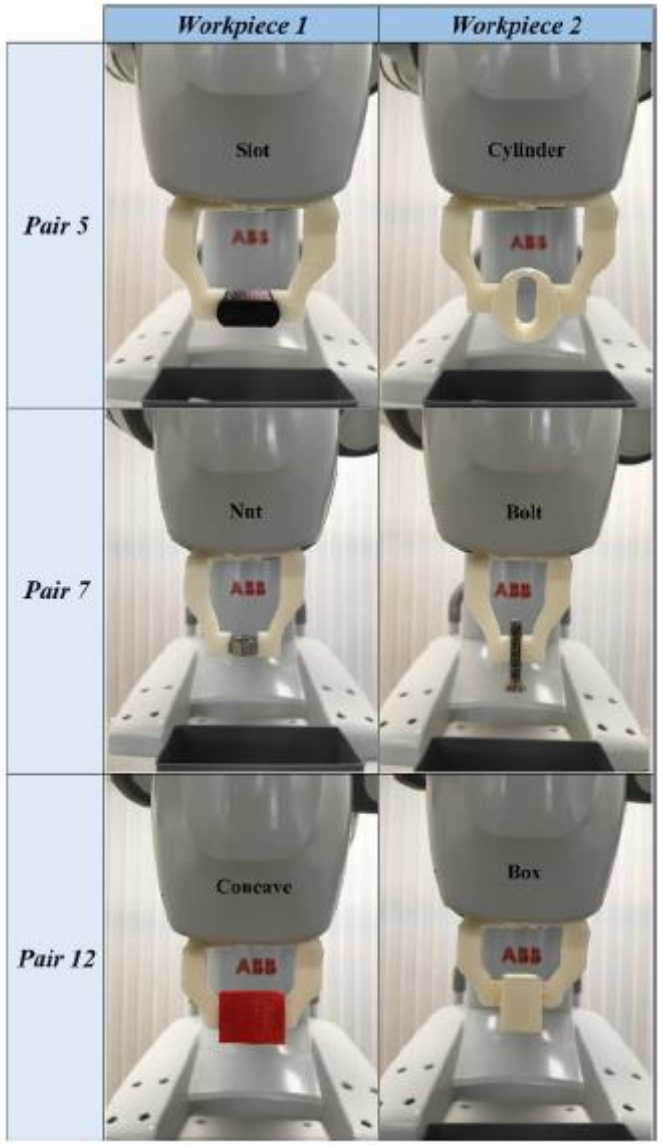


Pair No.	Workpiece Name	Workpiece CAD Model	Pair No.	Workpiece Name	Workpiece CAD Model	Pair No.	Workpiece Name	Workpiece CAD Model	Pair No.	Workpiece Name	Workpiece CAD Model
1	Phone PCB		4	AAA Battery		7	Hexnut		10	Nozzle Spanner	
	Phone Cover			Gasket			Bolt			Servo	
2	Clip		5	Slot		8	Gripper Platform		11	Conflat	
	Board			Cylinder			Minifit 600			USB	
3	Lamp Base		6	DSUB Female		9	Minifit Plug		12	Concave	
	Lamp Cap			DSUB-Male			Minifit 200			Box	

LINKÖPINGS UNIVERSITET

Design automation of robotic fingers: *M. Honarpardaz*

Pair No.	Workpiece Name	Left Finger	Right Finger	Left Fingertip	Right Fingertip	Pair No.	Workpiece Name	Left Finger	Right Finger	Left Fingertip	Right Fingertip
1	Phone PCB Phone Cover					7	Hexnut Bolt				
2	Clip Board					8	Gripper Platform Minifit 600				
3	Lamp Base Lamp Cap					9	Minifit Plug Minifit 200				
4	AAA Battery Gasket					10	Nozzle Spanner Servo				
5	Slot Cylinder					11	Conflat USB				
6	DSUB Female DSUB Male					12	Concave Box				



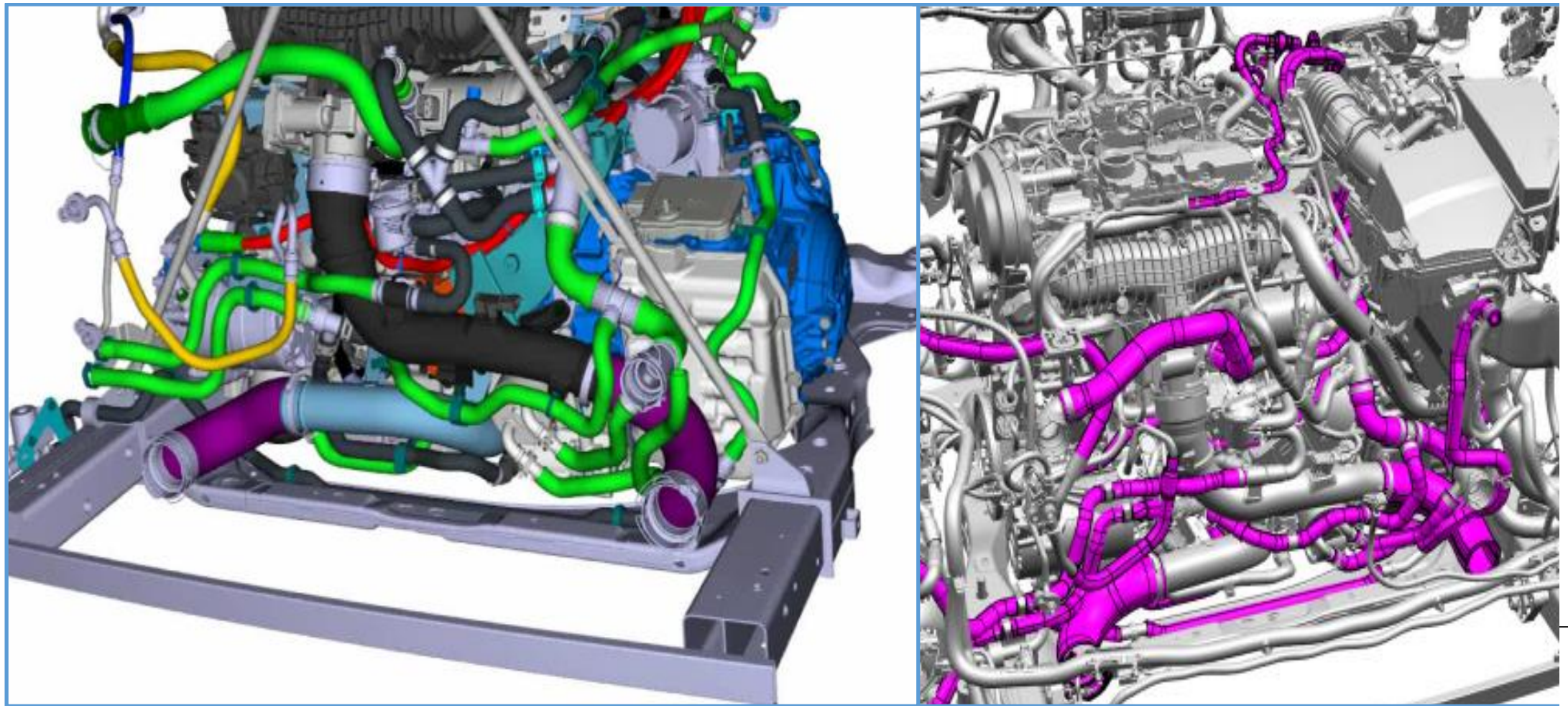
On-going research projects

Design for Additive Manufacturing

AR/VR Support in Product Development

Multi-Disciplinary Optimization and Machine learning

Automatic packaging of pipes and hoses based on optimization and machine learning



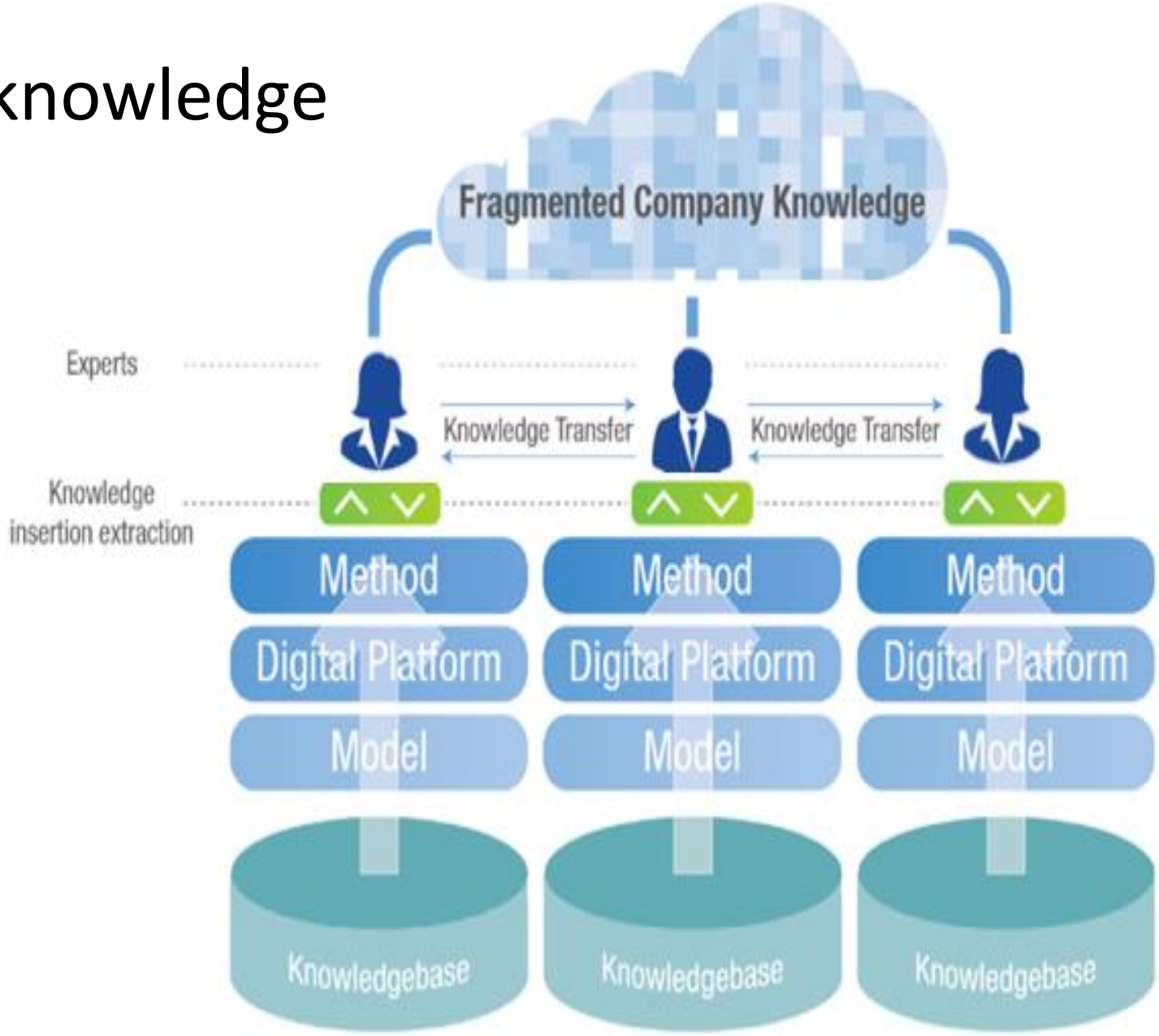
Future research directions

Increase the ability to leverage on digitalization

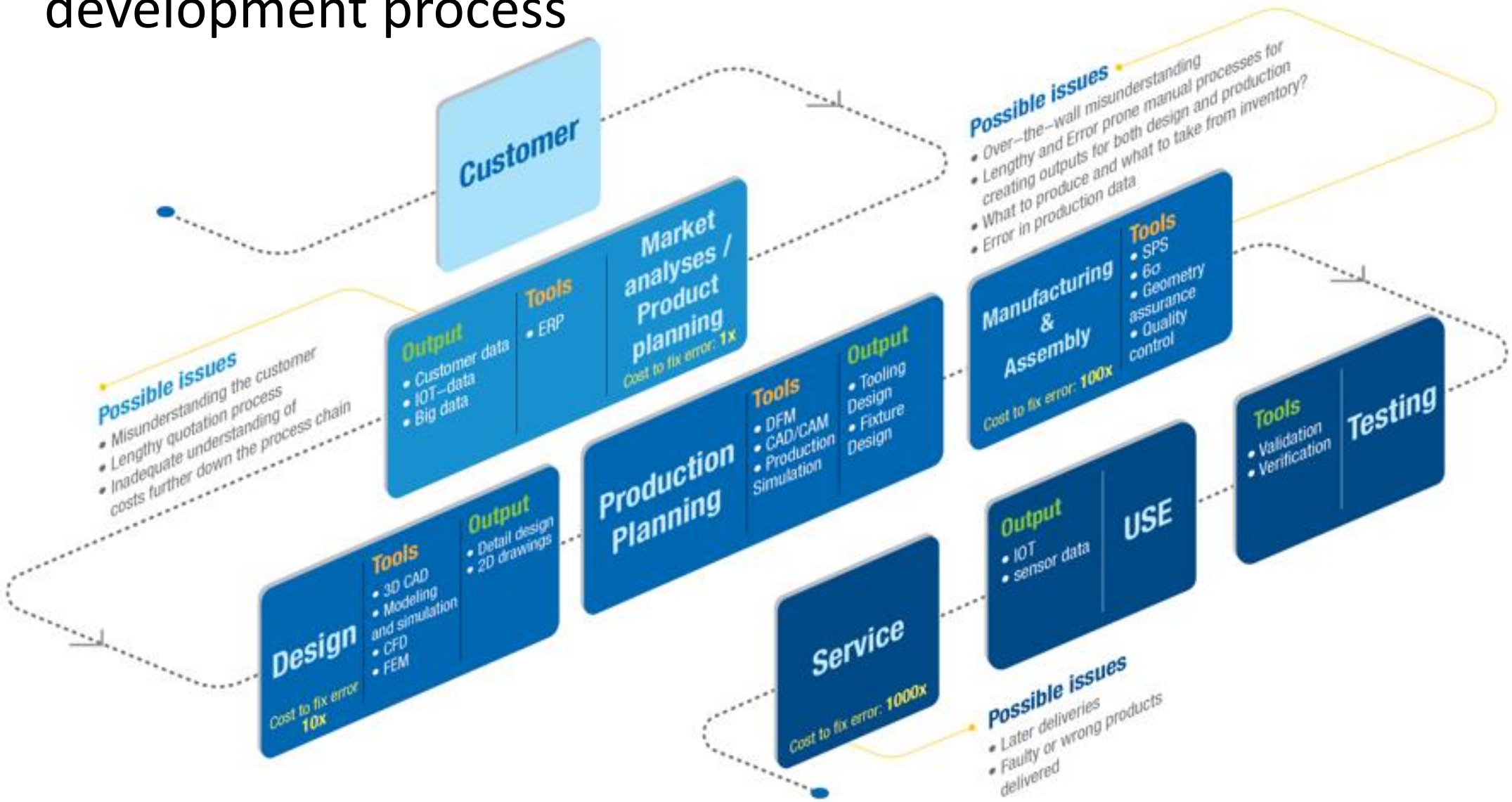
Some challenges from the companies we work with

Fragmented company knowledge

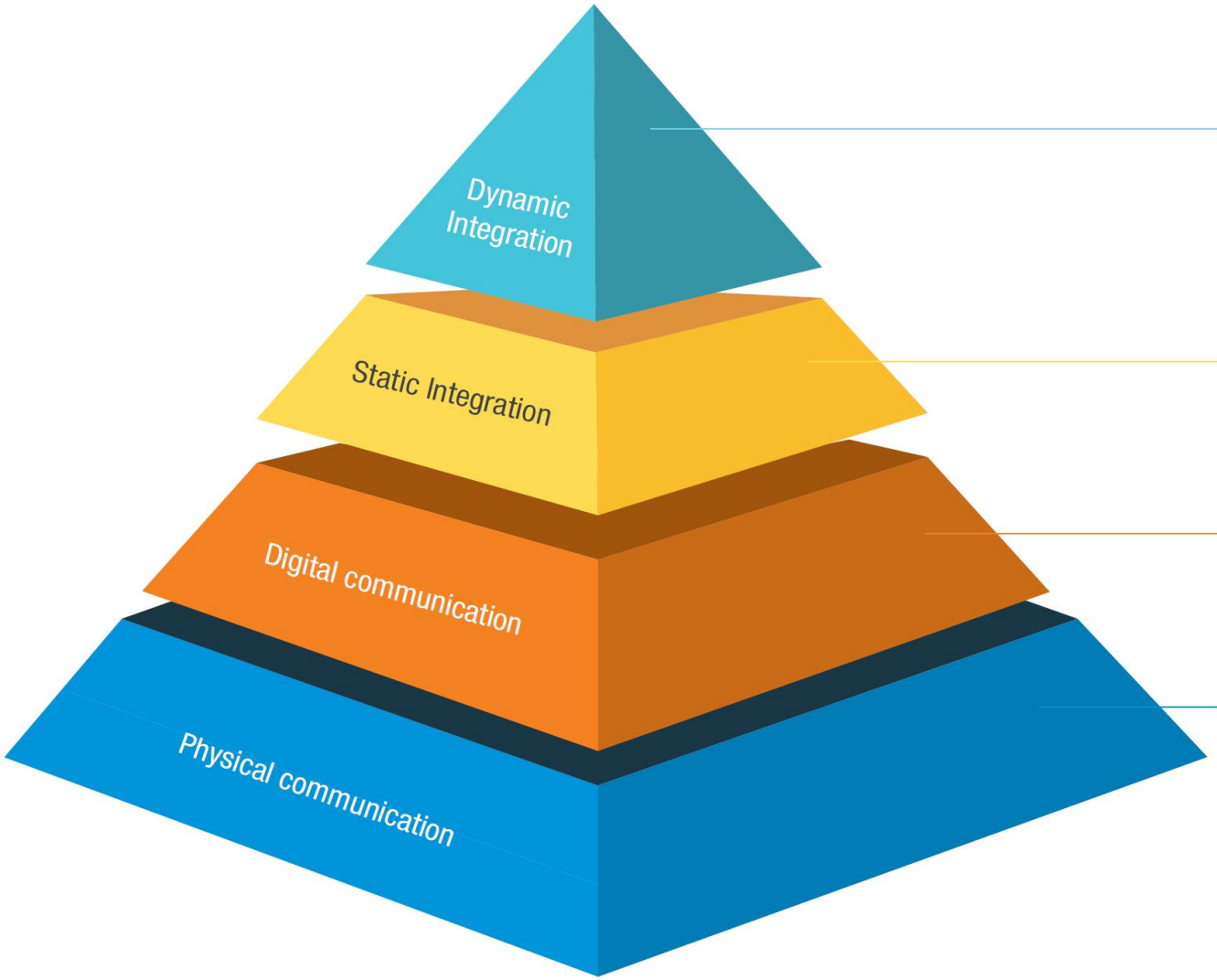
- There is a lot of data from digital models within the companies
- In many cases this data is embedded in different systems, c.f. knowledge silos
- How could e.g. AI and machine learning be used transform this data into knowledge?



Information flow and digital models in the product development process



Evolution of knowledge transformation and integration



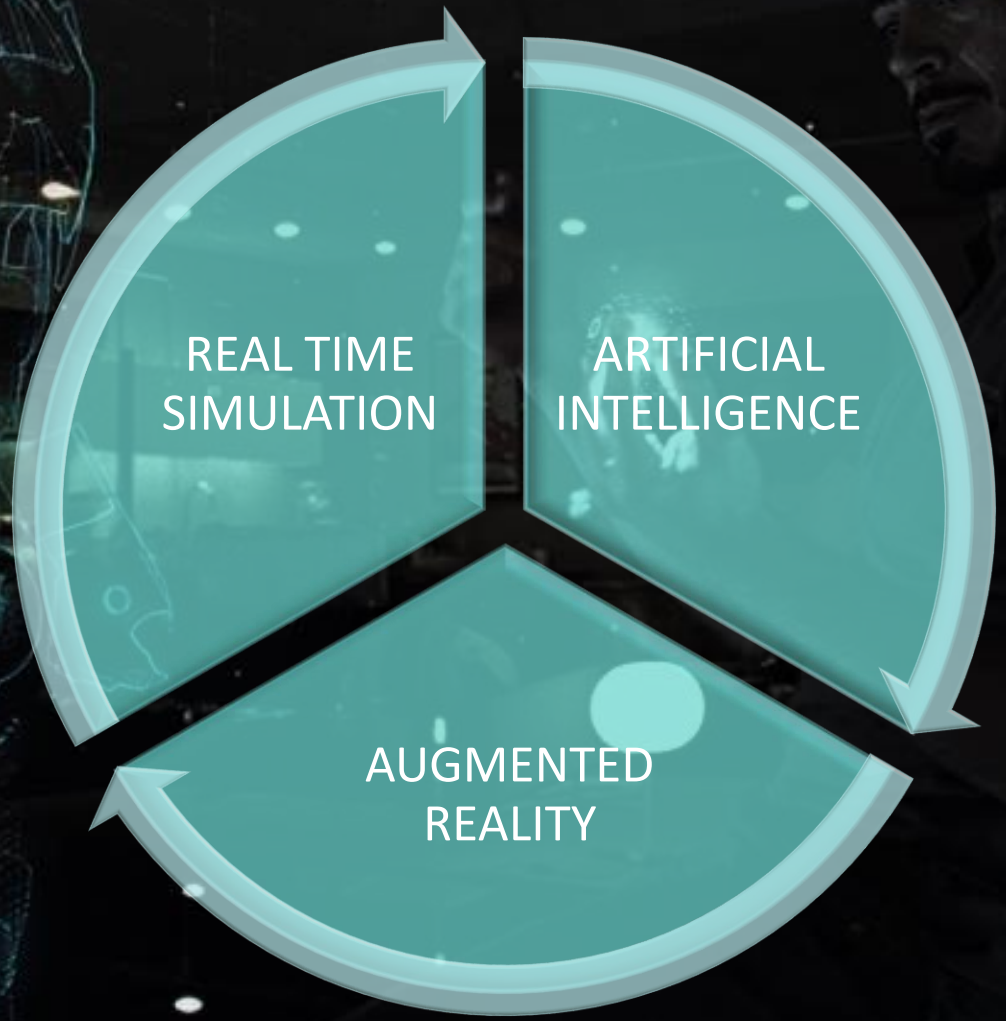
- Adaptable Integration by AI

- Integrated platforms
- Platform integrators
- Multidisciplinary Design Optimizers

- Phone, Mail, Chat
- File and data management, VPM, PLM, PDM, ERP

- Formal and planned activities such as meetings and workshops
- Sporadic discussions at the coffee machine and after work
- 2D paper communication such as drawings, bill of material etc

Disruptive technology



Johan Ölvander
Division of Machine design
Department of Management and Engineering

www.liu.se

LINKÖPINGS UNIVERSITET