Quiz: Making it autonomous

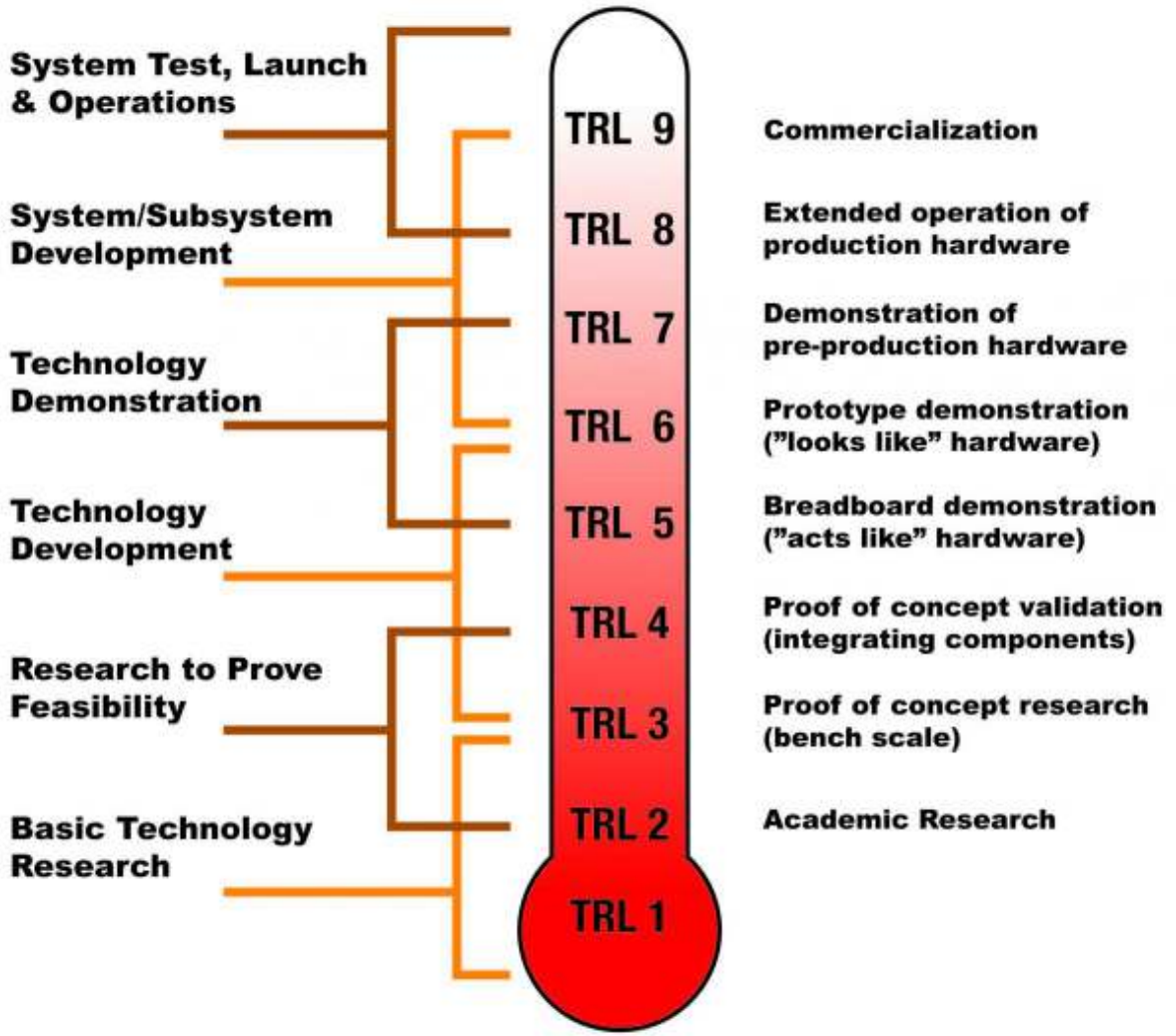
Sensors,
Algorithms,
Models

→

WHAT
IS
MISSING?

→

Where is academia's role?



Takeaway

Research in 'bits and pieces' $\rightarrow$ Certified autonomous product

- Outstanding challenge for complex, autonomous systems

A holistic approach to systems autonomy

For complex, intelligent, safety-critical systems

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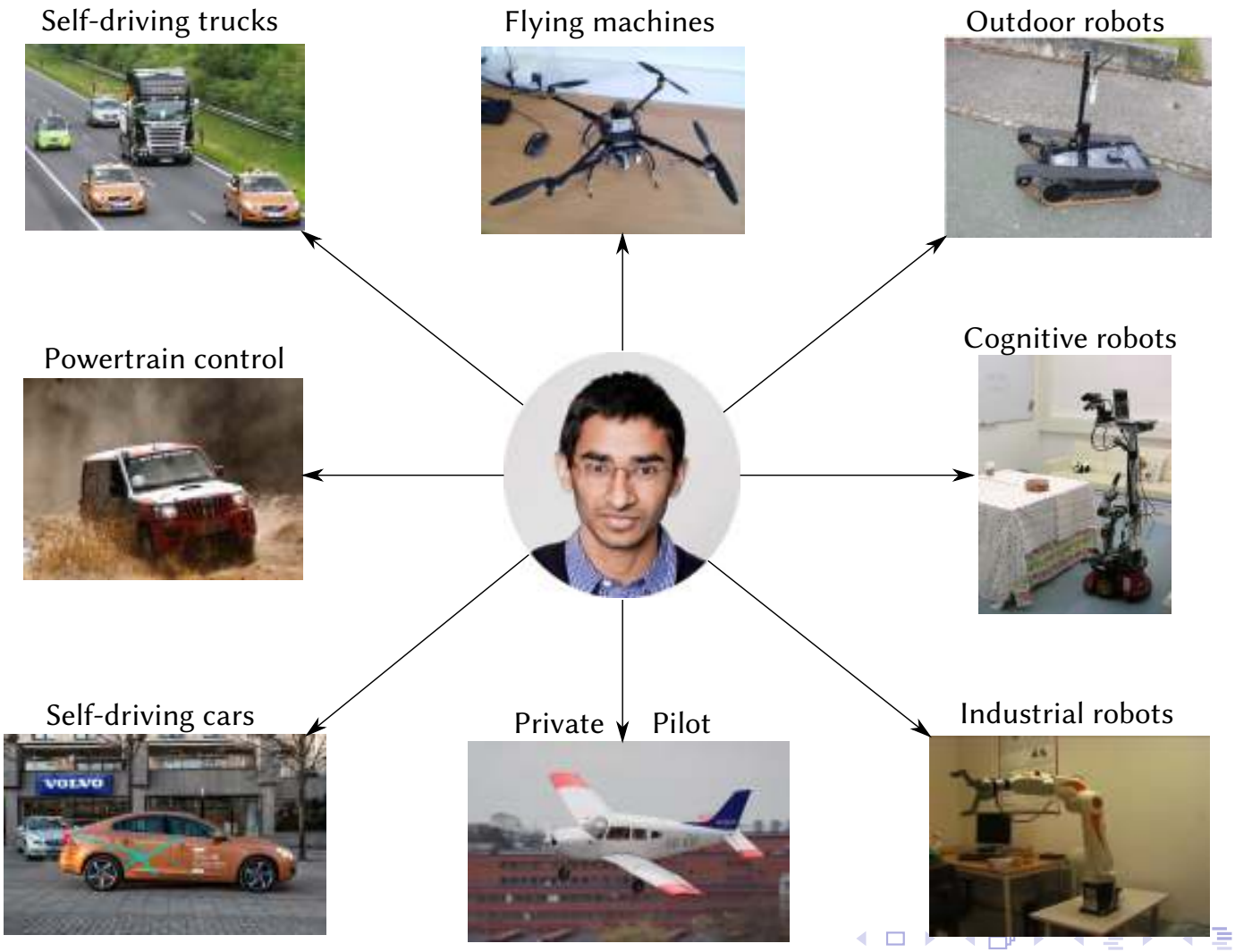
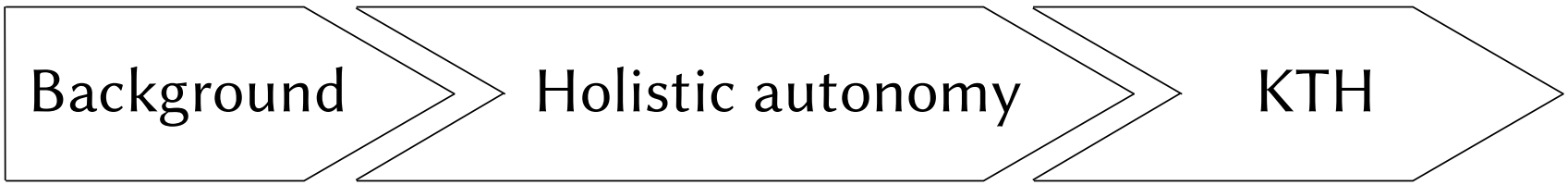
14 November 2014

ITA, São Jose dos Campos, Brazil

Who am I?


Self-driving trucks
Flying machines
Outdoor robots
Powertrain control
Cognitive robots
Self-driving cars
Private
Pilot
Industrial robots
VOLVO

Contents



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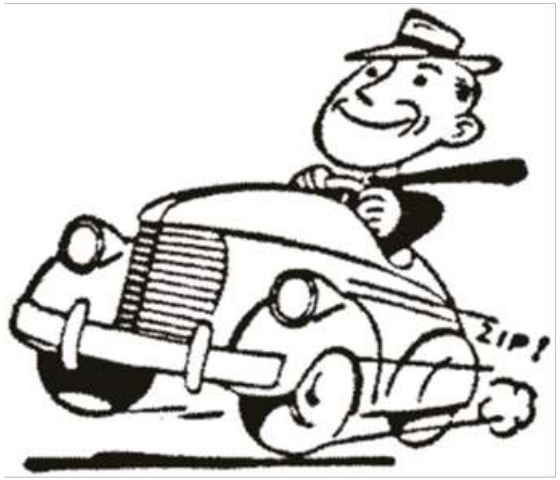
- The ability of a system to act appropriately in an uncertain environment
- Appropriate action is that which increases the probability of success
- Success is the achievement of behavioral sub-goals that support the system's ultimate goal
- The criteria of success and the system's ultimate goal may be defined external to the intelligent system

(source: J. Albus, Outline of a theory of intelligence)

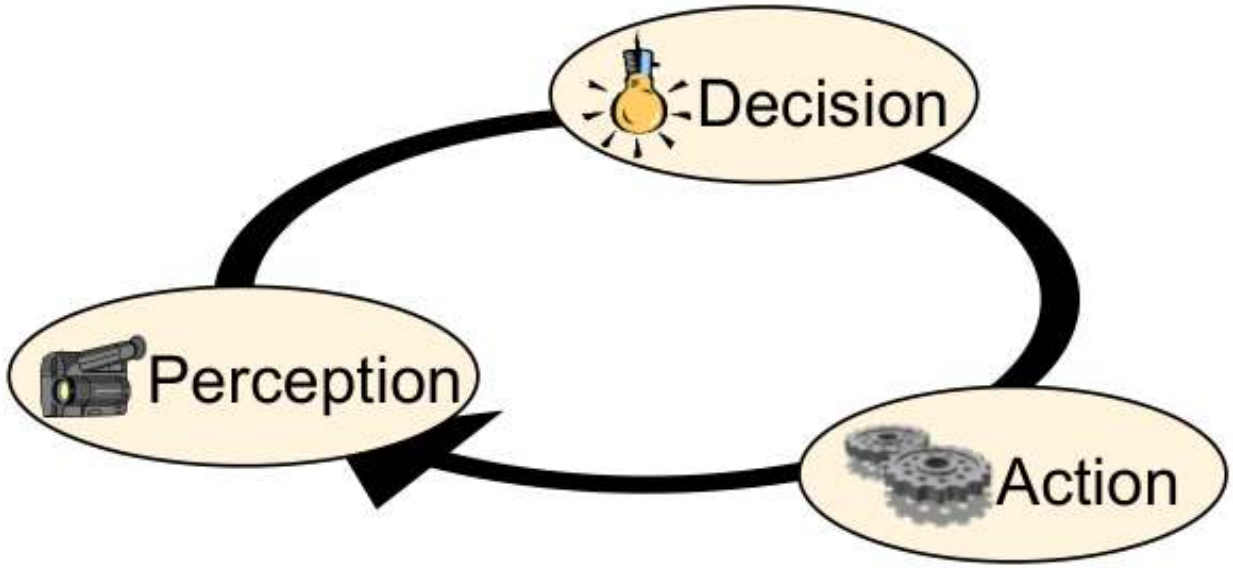
What is autonomy?

What is autonomy?

The ability to operate without human supervision/intervention



Summary: Intelligent autonomy



Intelligent autonomy requires decisional processes

Decision: notion of deliberation, planning, prediction and evaluation of the outcomes of an action

Holistic

ho·lis·tic /hō'listik/ [adj.]
parts → intimately connected, and
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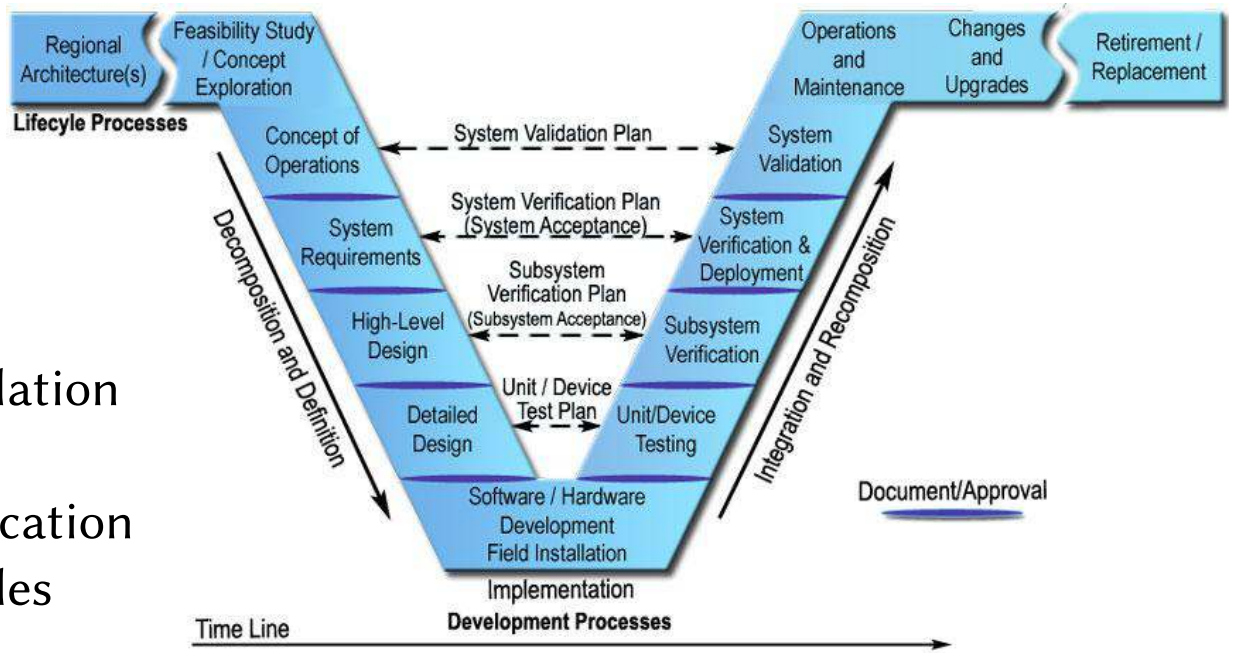
So what is necessary for a holistic approach to autonomy?

→ A systems engineering perspective

Systems engineering concerns

Requirements
Specification
Design
Implementation
Testing
Verification and validation
Safety engineering
Standards and certification
Maintenance, upgrades



From algorithms to systems

Requirements
Specification
Design
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Safety engineering
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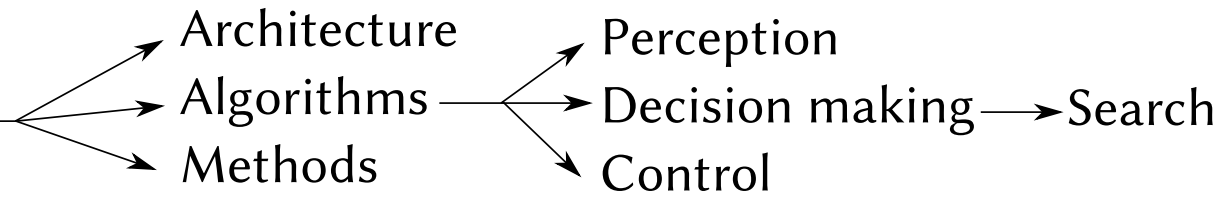
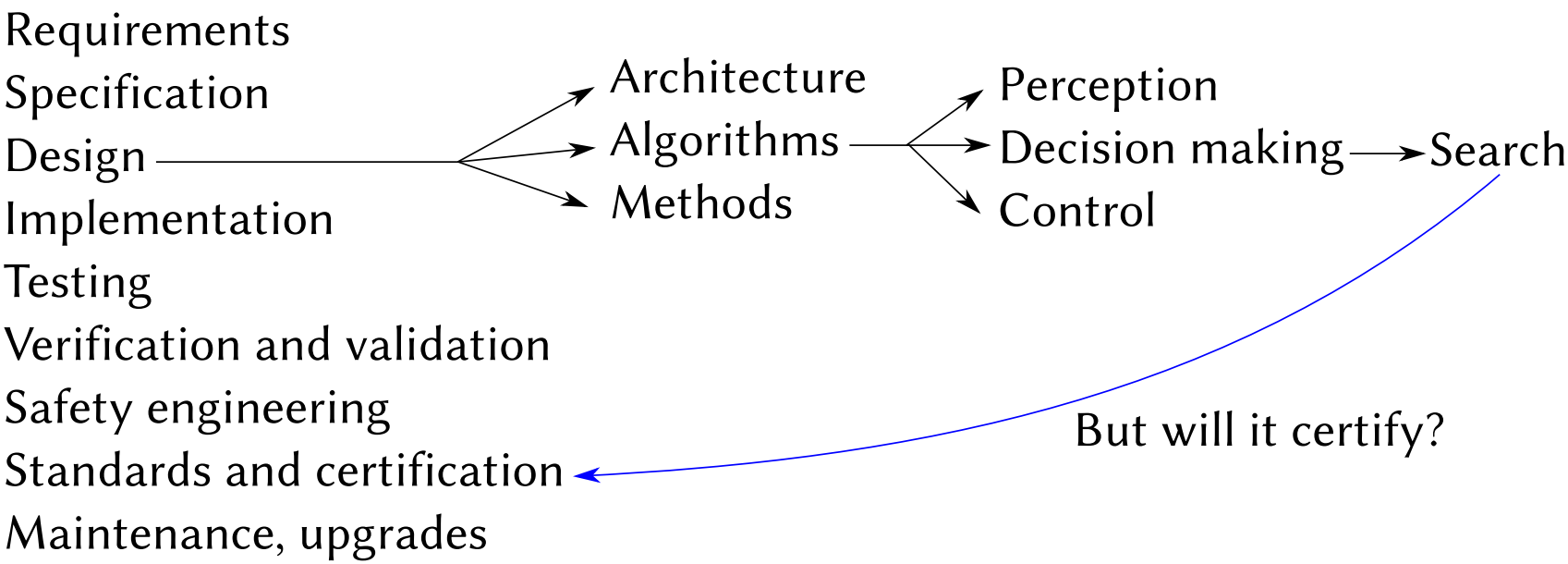
Maintenance, upgrades



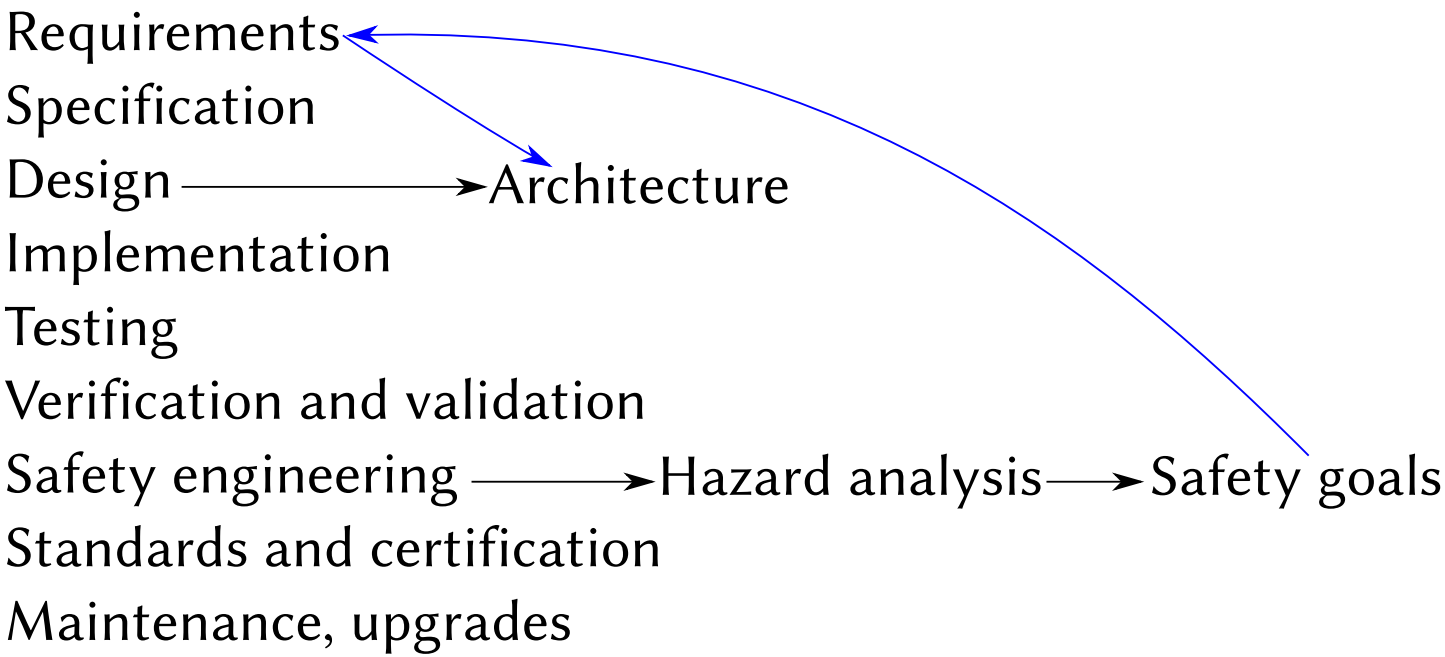
From algorithms to systems



Development process support

Requirements
Specification
Design
Implementation
Testing
Verification and validation
Safety engineering $\longrightarrow$ Hazard analysis $\longrightarrow$ Safety goals
Standards and certification
Maintenance, upgrades

Development process support



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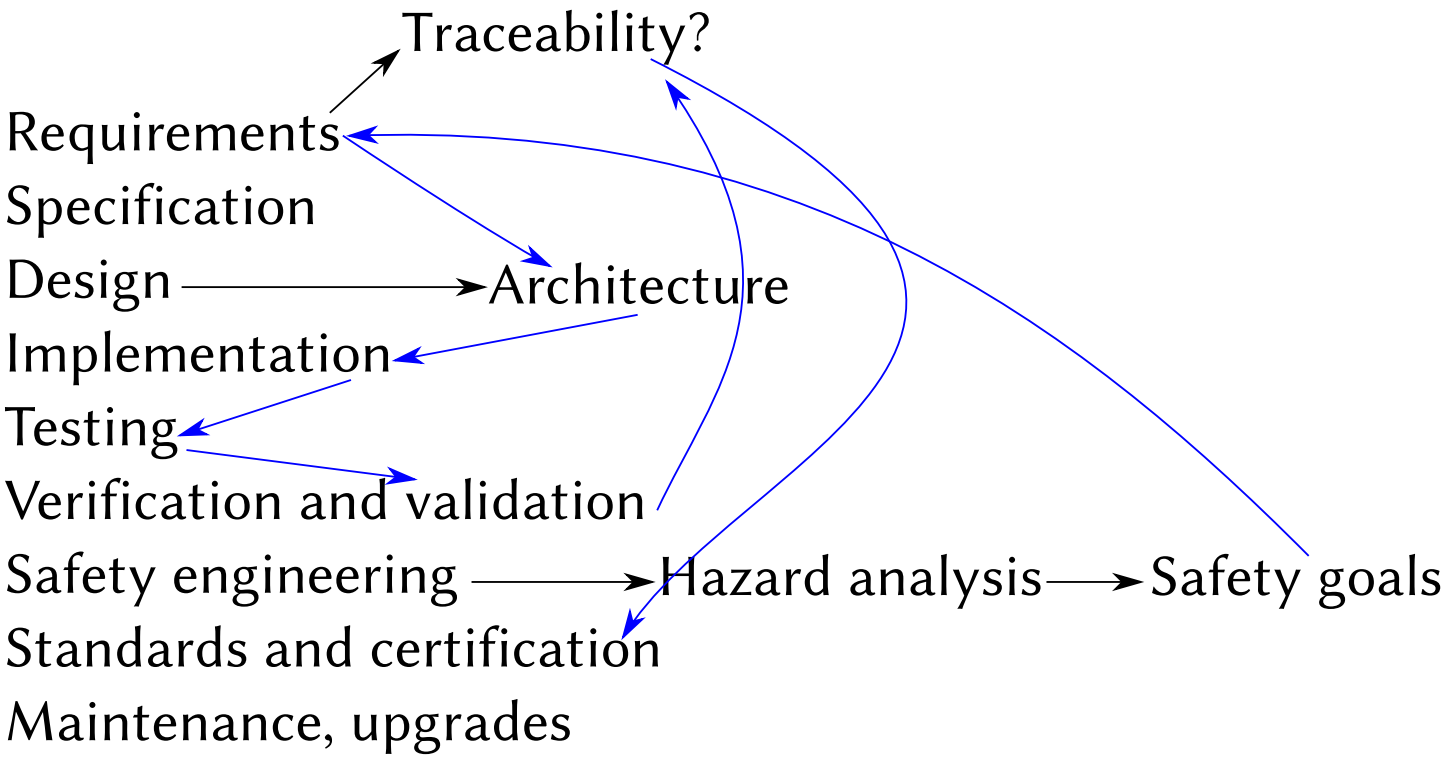


Product complexity

	Sus/C	Brake	Steer	Wheel	Diff	Trans	Clutch	Eng	Driver
Susp				X					X
Brake				X					X
Steer				X					X
Wheel	X	X	X		X				
Diff				X		X			
Trans					X		X		
Clutch						X		X	
Eng							X		X
Driver		X	X				X	X	

X - Mechanical relations

Product complexity

	Sus/C	Brake	Steer	Wheel	Diff	Trans	Clutch	Eng	Driver
Susp		P	P	X+P	P	P	P	P	X+P
Brake	P		P	*X*+P	P	P	P	P	*X*+P
Steer	P	P		*X*+P	P	P	P	P	*X*+P
Wheel	X	X	*X*+P		*X*				
Diff	P	P	P	*X*+P		*X*+P	P	P	
Trans	P	P	P	P	*X*+P		*X*+P	P	P
Clutch		P	P		P	*X*+P		*X*+P	P
Eng	P	P	P	P	P	P	*X*+P		P
Driver	P	*X*+P	*X*+P		P	P	*X*+P	P	

P - Programmable relations

Key message

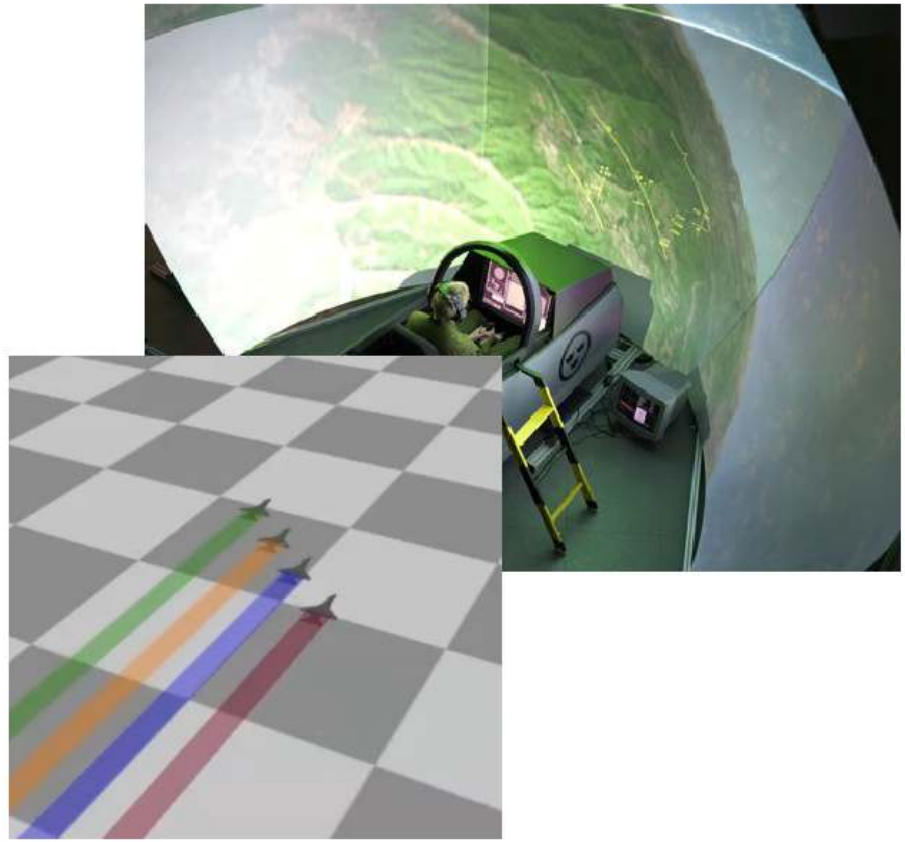
- 'Autonomy' is more than **just another requirement**
- Individual sensors, perception, control are all "getting there" but..
- ..problems of integrating them into a safe, total system are not even completely understood
  - Analysis methods are inadequate
  - Laws, regulations, standards are not up to speed
  - Exploding state space, difficulties guaranteeing behavior
  - ...

Main research units

- Center for Autonomous Systems (CAS)
- Automatic Control
- Mechatronics
- KTH Transport Labs

CAS - Unmanned aerial vehicles

- Cooperation with Swedish Air Force Air Combat Simulation Centre
- Pilot-UAV-Interaction
- Cooperative UAV control
- Search, Tracking, Formations Control, Task Assignment



CAS - Unmanned ground vehicles

- Autonomous trucks: iQmatic
- Darpa Urban Challenge (part of MIT team)
- Intelligent Teleoperation for Search and Rescue

CAS - Underwater vehicles

- Autonomous Underwater Vehicles (AUVs) for seabed mapping and navigation

CAS - Indoor robotics

- Grasping
- Manipulation
- Robotic Assembly
- Navigation
- Understanding the environment
- Cooperation
- Intuitive robot programming
- Computer Vision

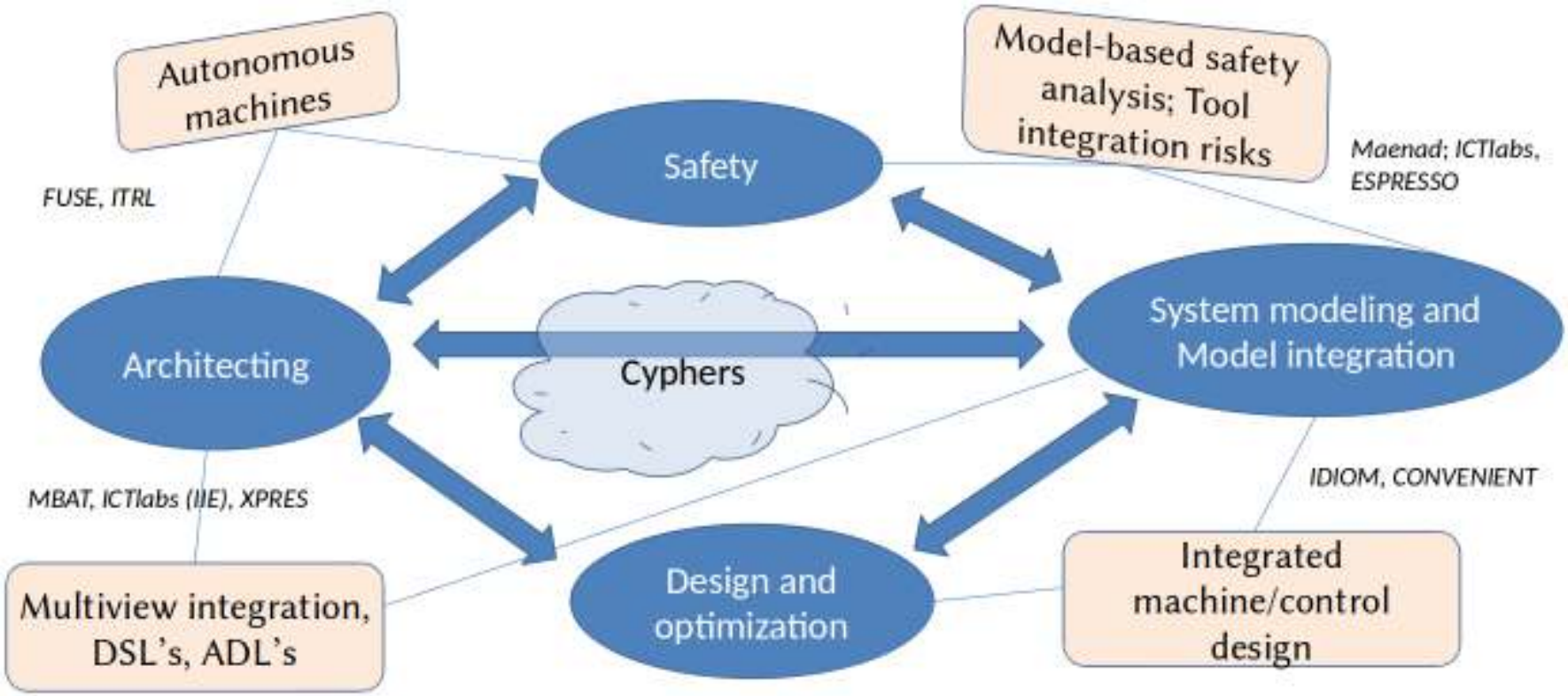




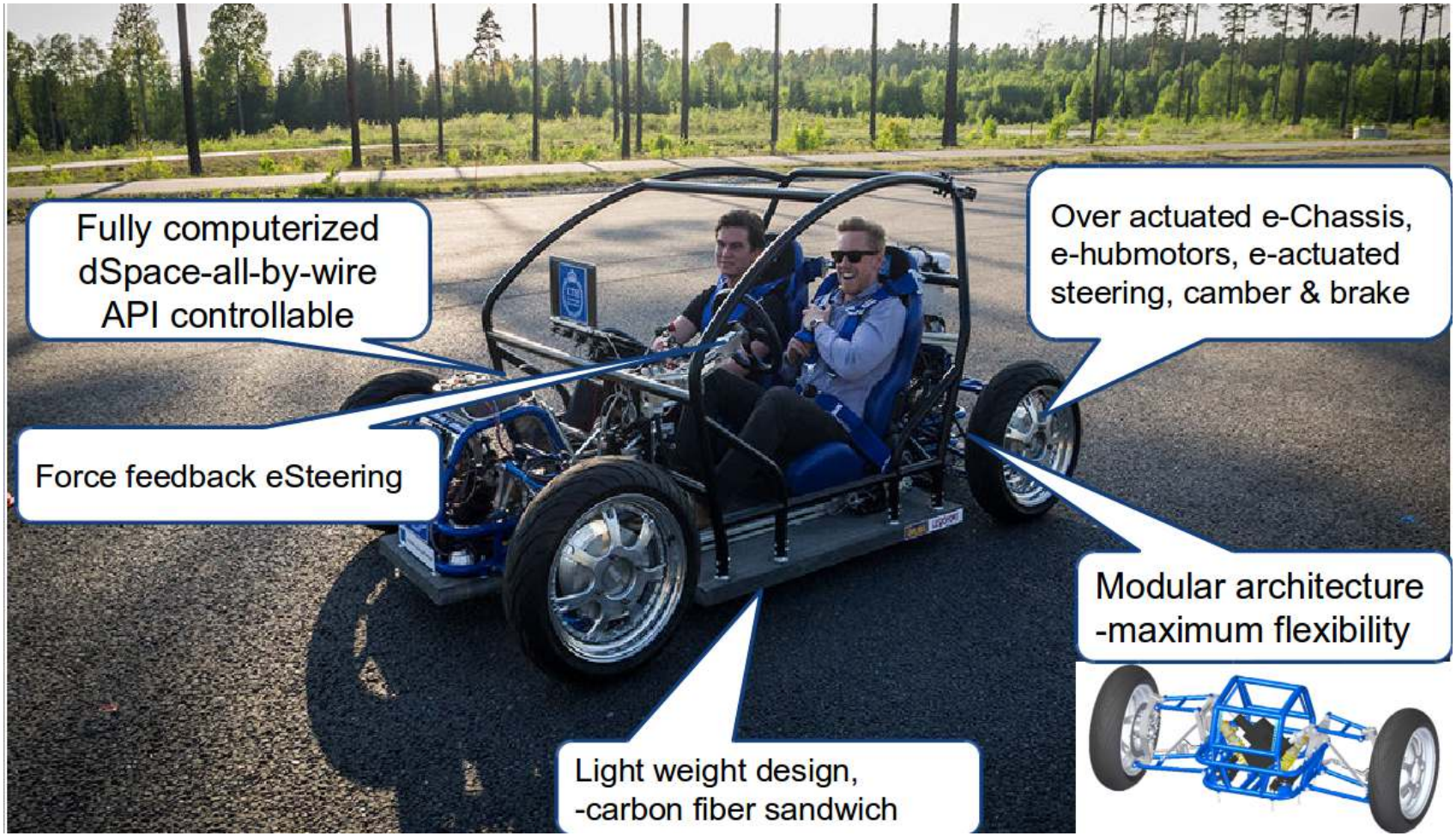

Automatic control

- Situation awareness
- Task/Mission (re)planning
- Predictive control under constraints
- Model identification
- Path planning

Mechatronics



Research Concept Vehicle



Collaboration opportunities

- Exchange
  - Master students, interns, thesis workers
  - PhD students (typically one semester)
  - Individual researchers
- Brazilian Industry
  - Joint projects
  - Assignments
  - Case studies

Takeaway

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