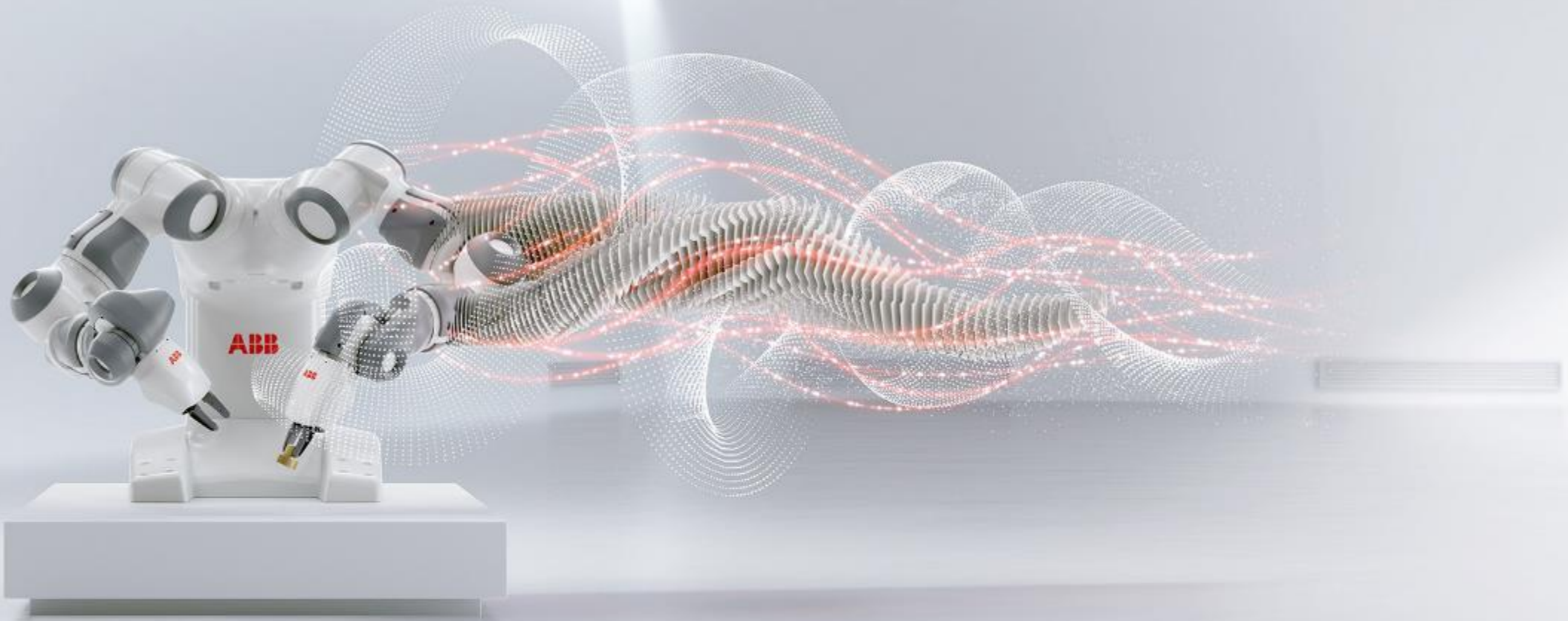


SEPTEMBER 2018, MARTIN NAEF – RESEARCH DEPARTMENT MANAGER - AUTOMATION

AI in industry – from automated to autonomous

ABB’s approach to Artificial Intelligence in the context of automation

Transformation in markets: energy and fourth industrial revolutions

The Energy Revolution

The Fourth Industrial Revolution

Utilities | **Industry** | **Transport & Infrastructure**

Source: Economist, WEF

ABB’s value propositions

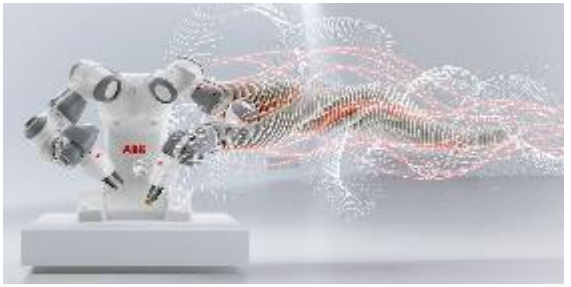
Bringing electricity from any power plant to any plug

Automating industries from natural resources to finished products

Power Grids

Electrification Products

Industrial Automation



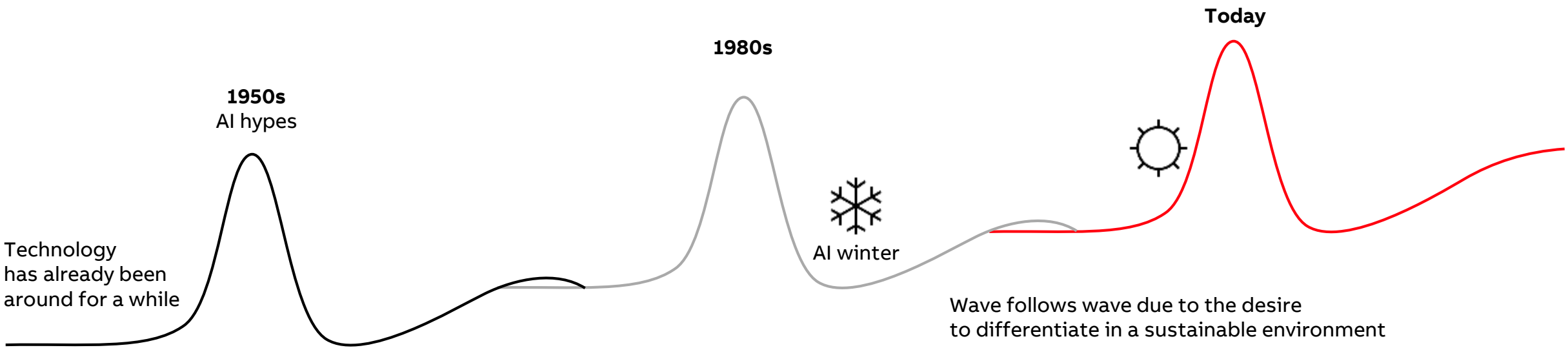
Robotics and Motion

Partner of choice for…

… a stronger, smarter and greener grid	… electrification of all consumption points	… perfection in automation	… robotics and intelligent motion solutions
#1	#2	#2	#1 motion #2 robotics

Innovation cycles

Waves of hype cycles

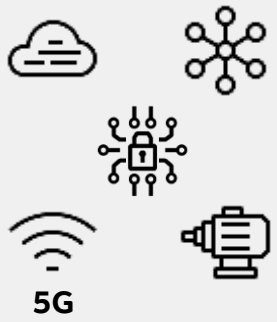


What is different today?

Digital technologies are reviving AI advances

Processing power lifts big data and algorithms to the next level

Big Data



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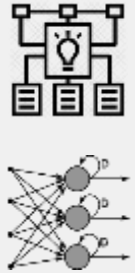
Algorithms



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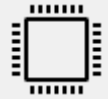
Processing power



›

Artificial Intelligence

Artificial Intelligence is a long term game changer

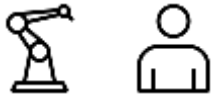
AI – a paradigm shift in ease of installation and use of robots

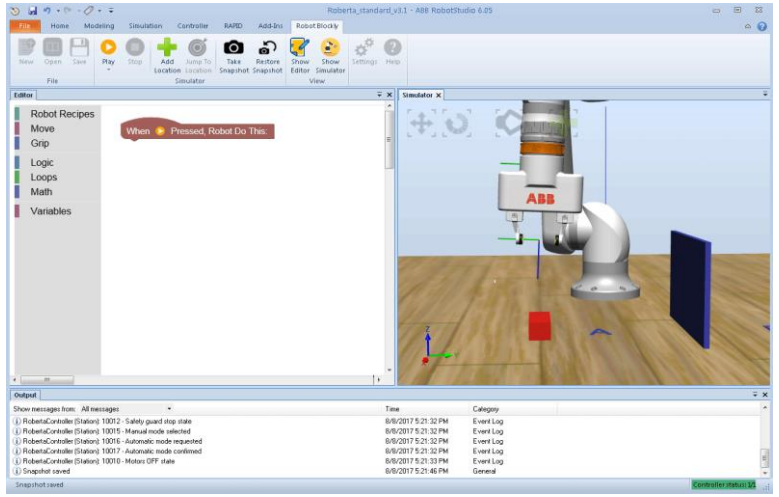
From programming to teaching and learning

Yesterday: programming

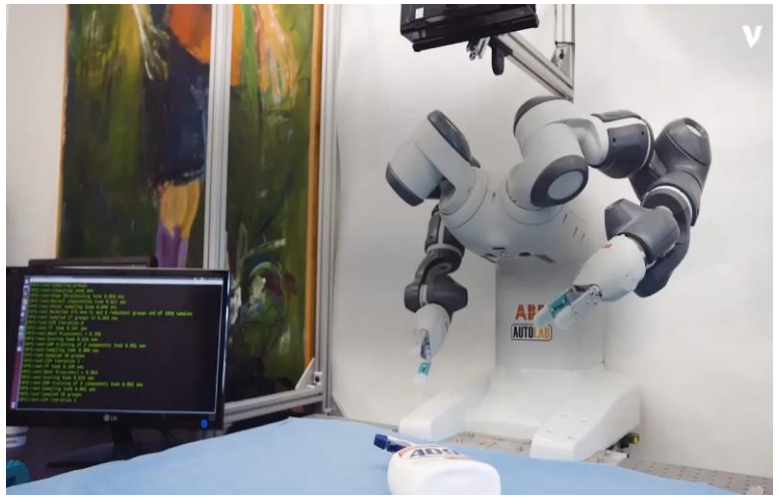
```
//Defining single location in RAPID

CONST robtarget
rb_Location1:=[[471.90028601, -
160.550088443, 259.855061587],
[0.0196845700059949, 0.999779442304461, -
0.00713127900217168, 0.00165206200050307],
[-1, -1, 1, 0], [9000000000, 9000000000,
9000000000, 9000000000, 9000000000,
9000000000]];
```

Today: teaching



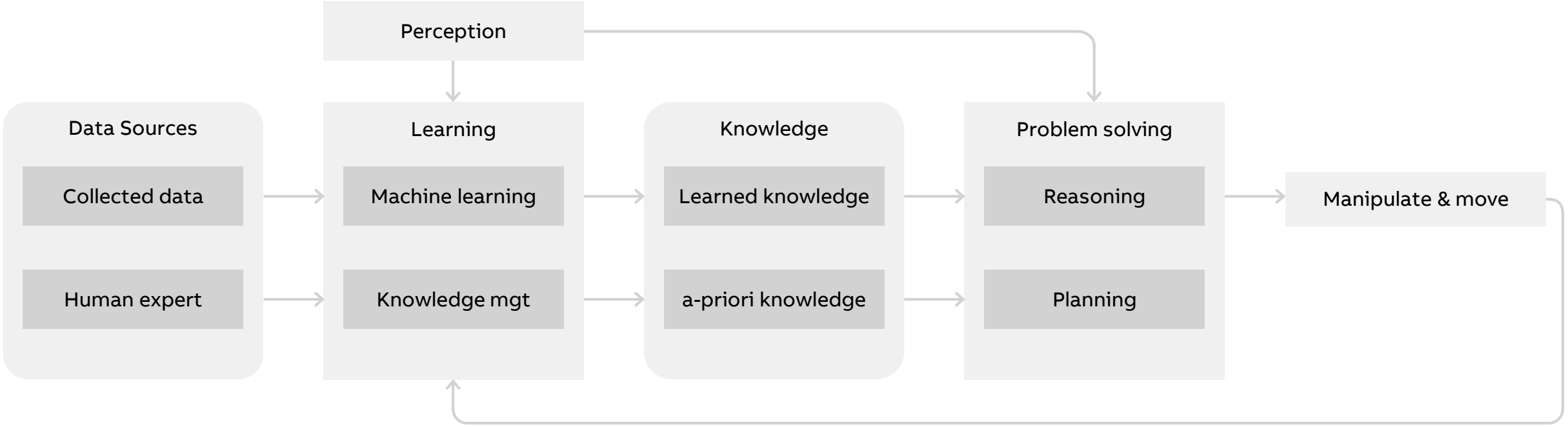


Tomorrow: learning



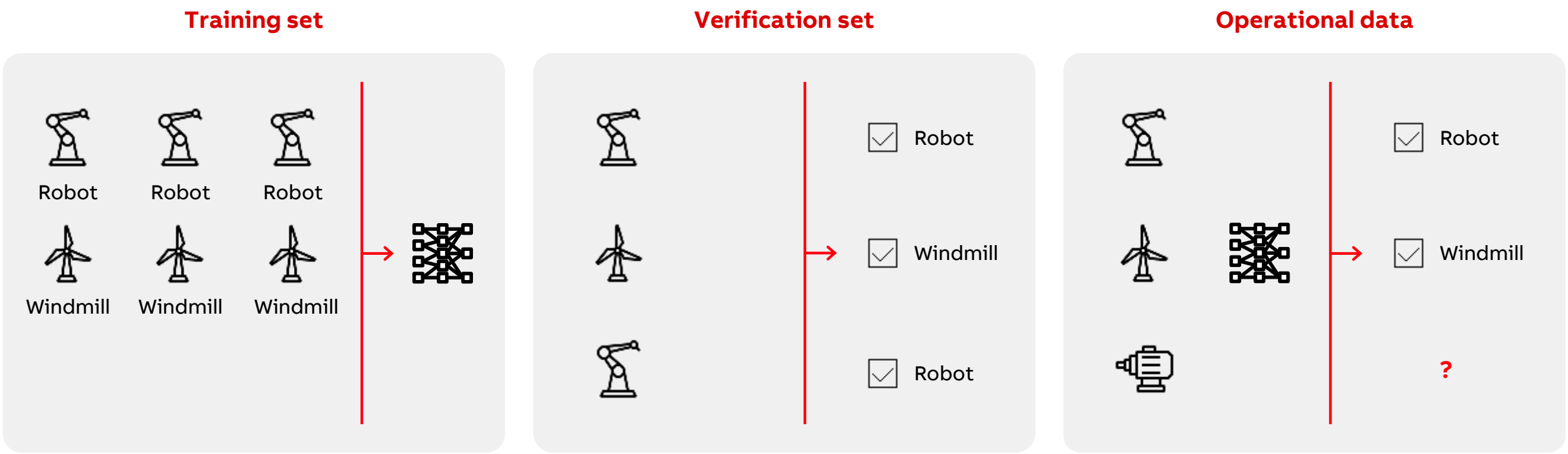
Artificial intelligence

Key components – more than machine learning



Data is key

Training an AI system with “rich” data



Data quality has a huge impact on AI solutions → Garbage in – garbage out

Extending automation towards autonomy

Amplifying human capabilities

Automated

Design – plan for what we know

React to expected, frequent situations:

- Steady state, normal operation
- Safety shutdown

Instructions: How

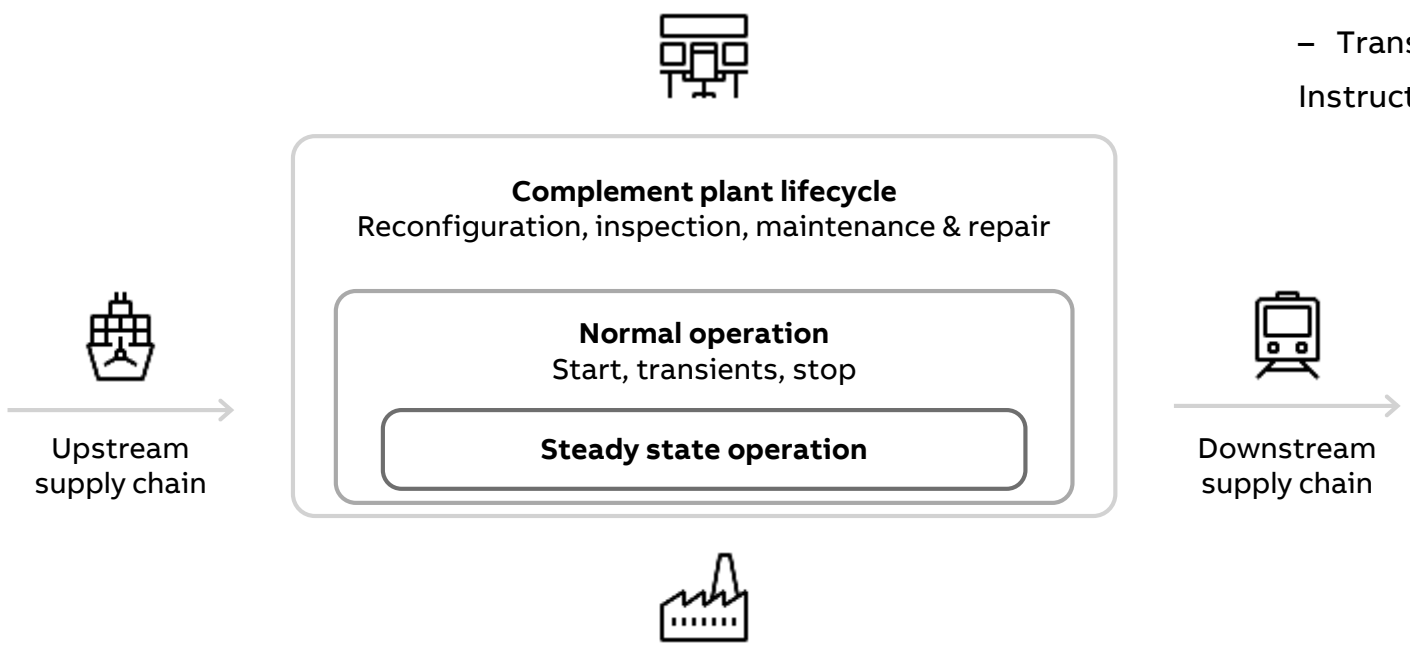
Autonomous

Discover – deal with what we don't know

React to unexpected, rare events:

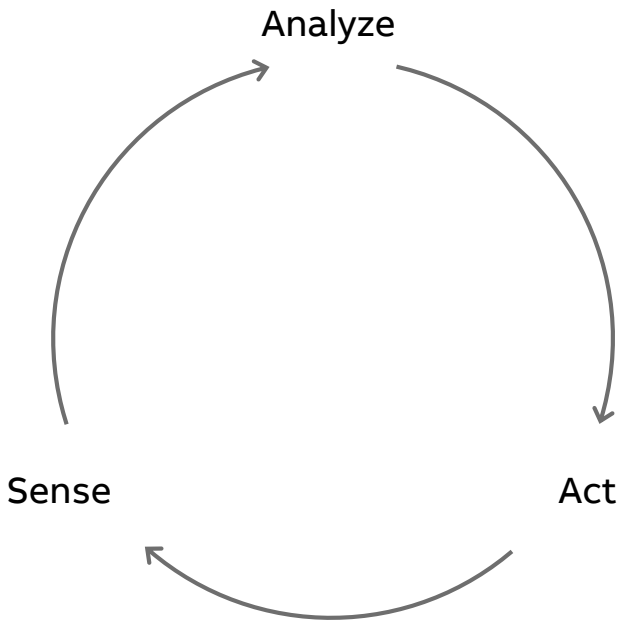
- Reconfiguration, maintenance, repair
- Transport & supply chain

Instructions: What

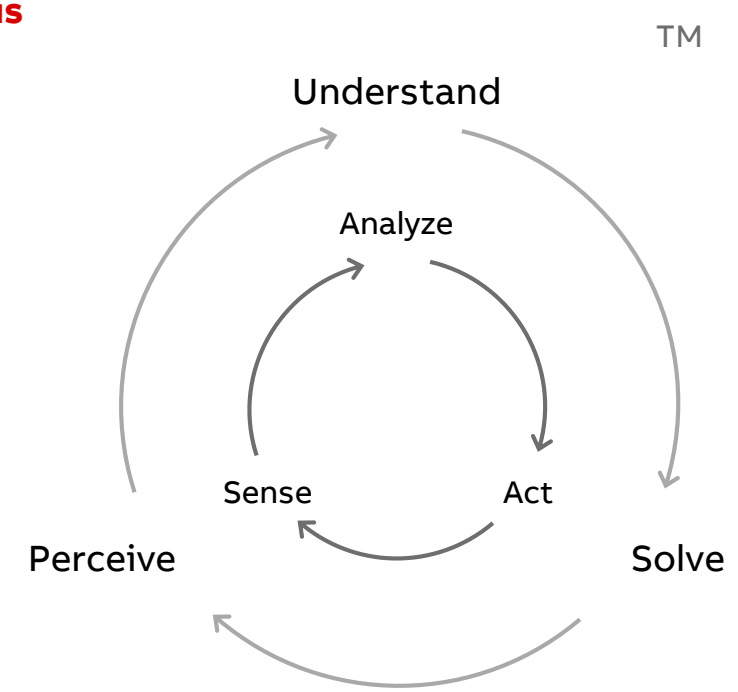


Automated systems move towards autonomous

Automated



Autonomous



Steady state control › Normal operation Start, transients, stop › Complete plant lifecycle

Artificial Intelligence implemented

End-to-end coverage on the Ability stack

Distributed AI functions

Functions typically central

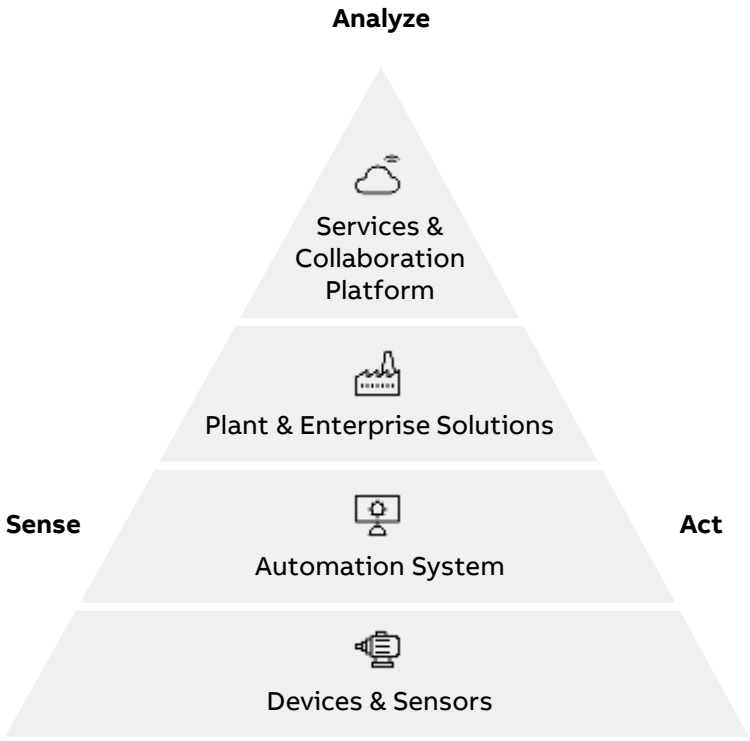
- Learning: better learning through more data across different sites

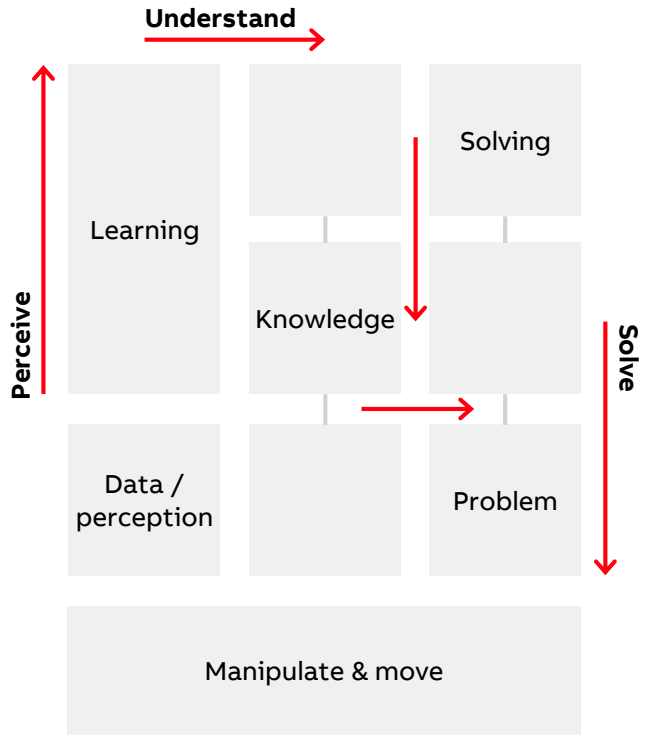
Functions that can be spread across the stack

- Knowledge: created centrally (learning), applied locally
- Problem solving: combine solution approaches across the hierarchy where best suited

Functions typically local

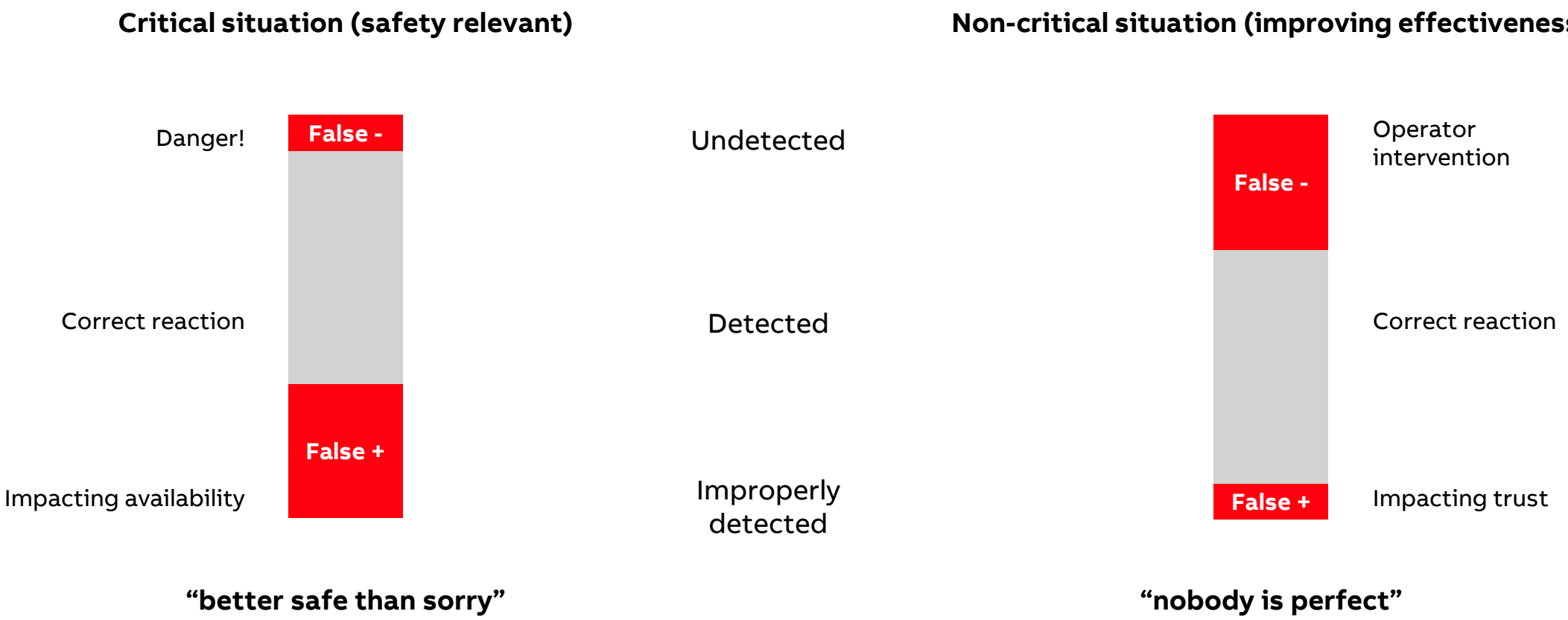
- Perception: on-site situational awareness
- Manipulation and movement: local interaction





Deterministic vs. AI systems

Roles in autonomous systems



Artificial Intelligence is key technology for the next level of industrial progress

AI: “The ability to learn or understand or to deal with new or trying situations”[1]

Human

Systems designed by experts

+ Intuition
+ Creativity
+ Expertise
– Computation

Augmented

Experts supported by algorithms

Amplifying human potential

Artificial

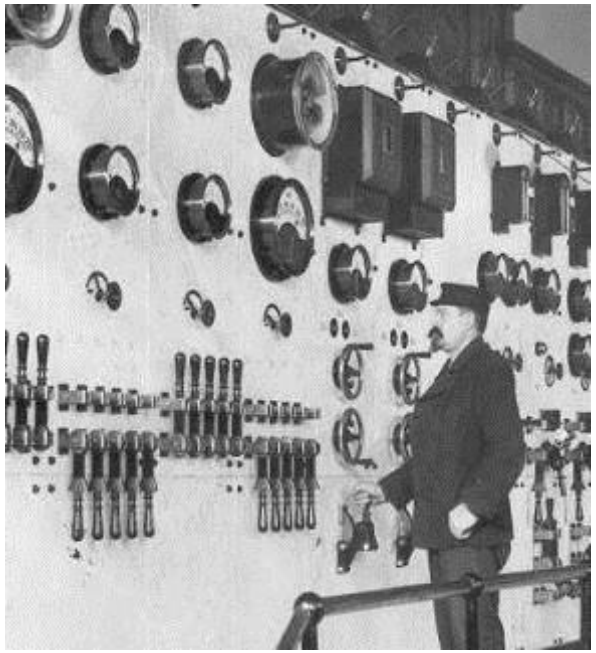
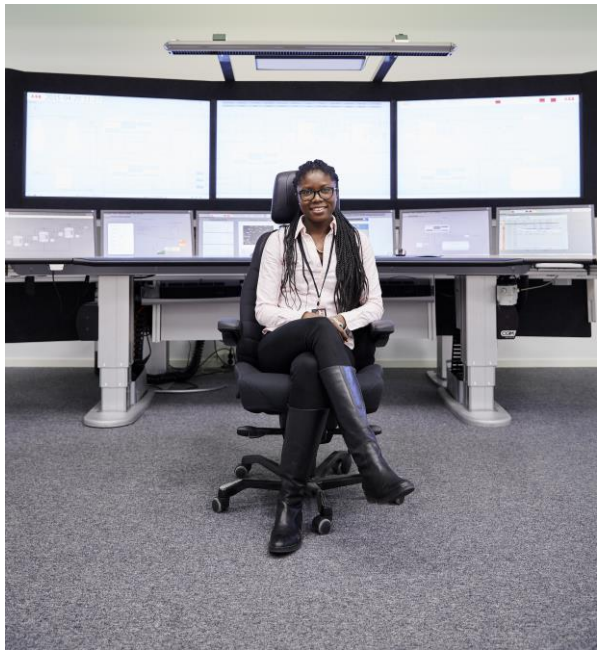
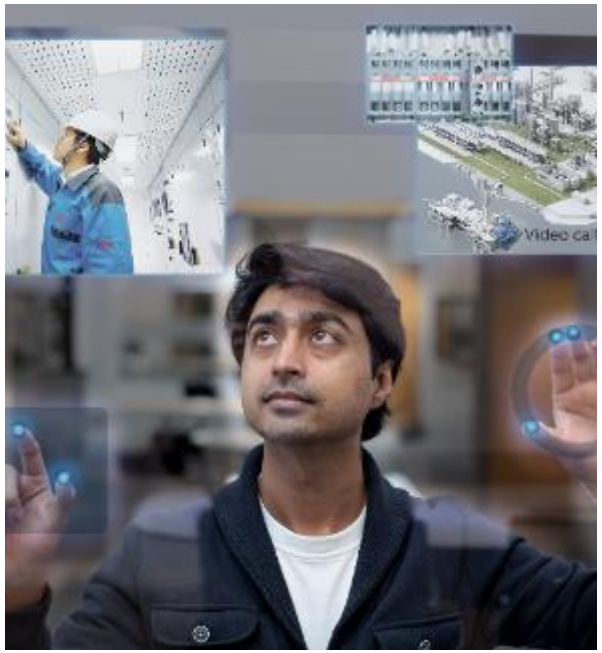
Knowledge learned from data

– Intuition
– Creativity
+ Expertise
+ Computation

1. Webster referring to intelligence

Operator environments: Increasing amount of data presented

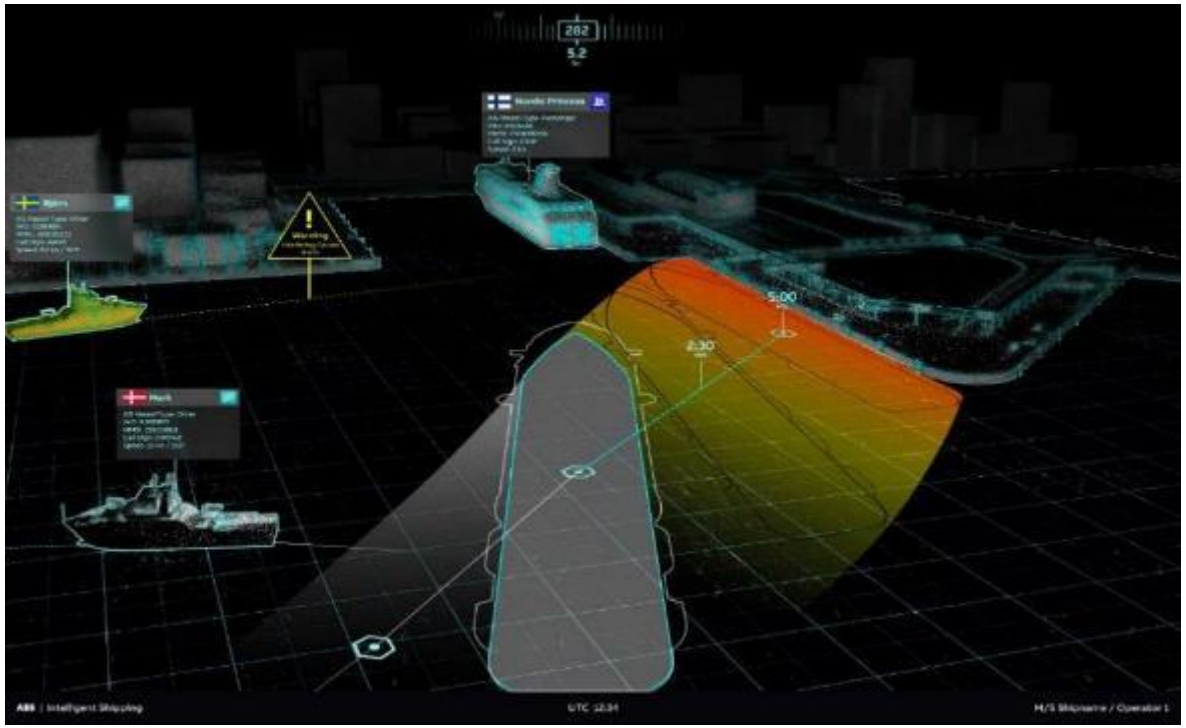
Complexity beyond human comprehension

~1910	~1990	~Today	Future
			

Decision making: human operator – Data based support: artificial intelligence

Steering towards autonomous ships

Transforming the way ships are operated



Changing the view of the captain

Manipulate and move

Autonomous robots designed for target segments

“Data center sheriff”

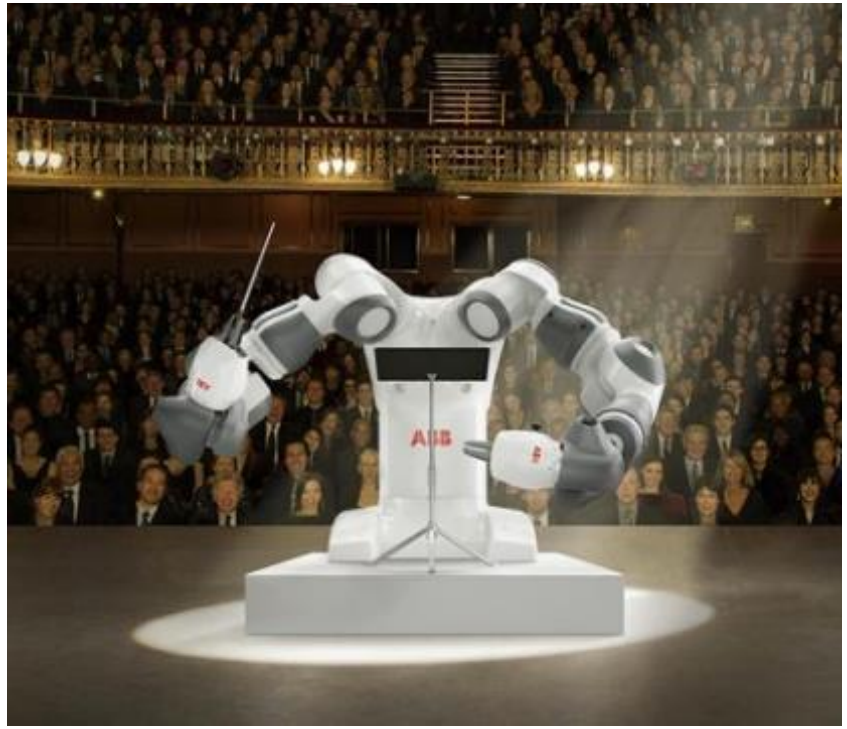
“Motor crawler”

“Transformer diver”

“Plant helicopter”

Conclusions

- AI helps expanding automation systems' capabilities towards handling more unplanned situations
- Seamless interaction between deterministic, reliable control algorithms and AI solutions are key to success
- The availability of complete, correct, and consistent data to train AI algorithms is essential
- The interaction between humans and AI systems lead to the creation of the augmented expert, combining best of both worlds



The key focus shall always be the customer's challenge, AI is just one of the tools to be applied

ABB is building a bridge to the future


ABB