



A short list of skills needed to build autonomous systems

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Introduction

UTC and UTRC

Business Units

UTC Building & Industrial Systems

Sikorsky



Otis



UTC Climate,
Controls & Security



UTC Propulsion & Aerospace Systems

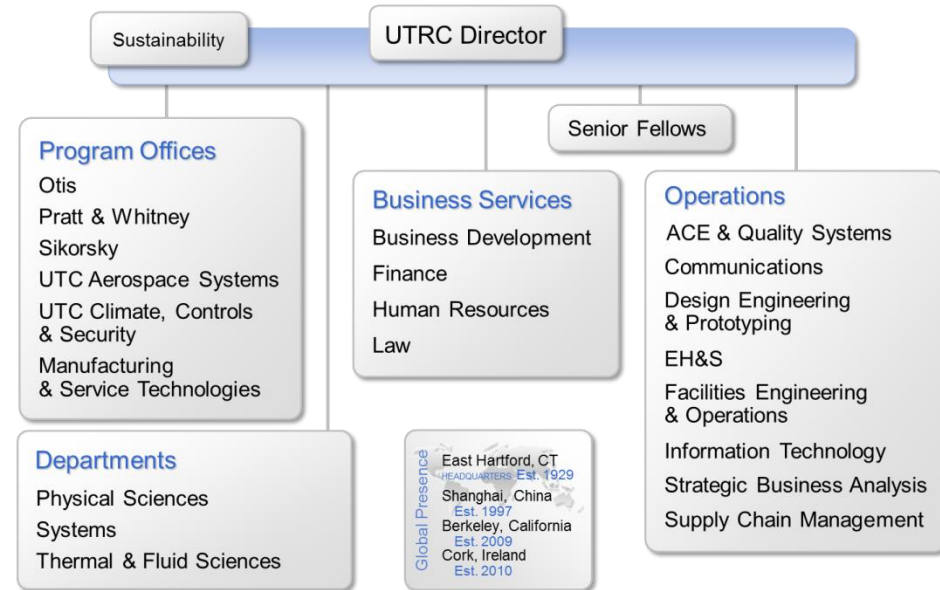
Pratt & Whitney



UTC Aerospace Systems



Research Center



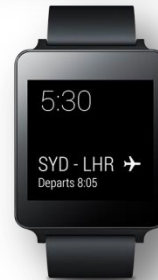
A technology trend

Moving towards autonomous systems

- Ubiquitous
- Interconnected
- Safety critical
- Serving Humans



(source: otis.com)



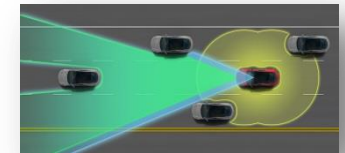
(source: google.com)



(source: wikipedia.org)



(source: airbus.com)

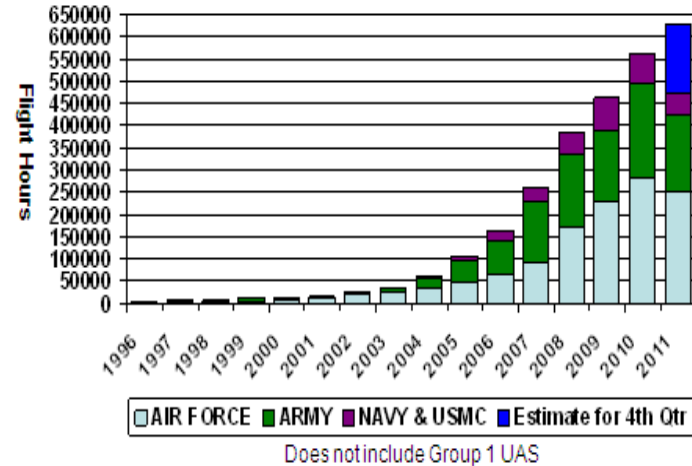


(source: teslamotors.com)

A technology trend

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UAS Flight Hours 1996-2011 (source: DoD "Unmanned Systems Integrated Roadmap FY2011-2036").

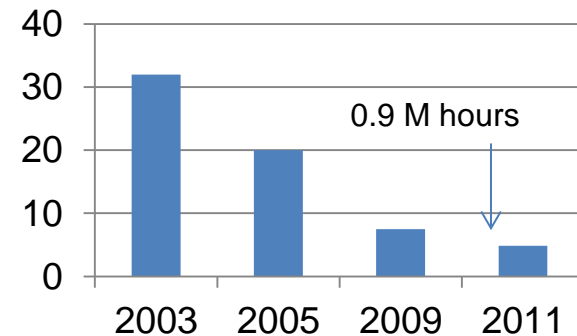


(source: howstuffworks.com)



(source: unmannedsystemstechnology.com)

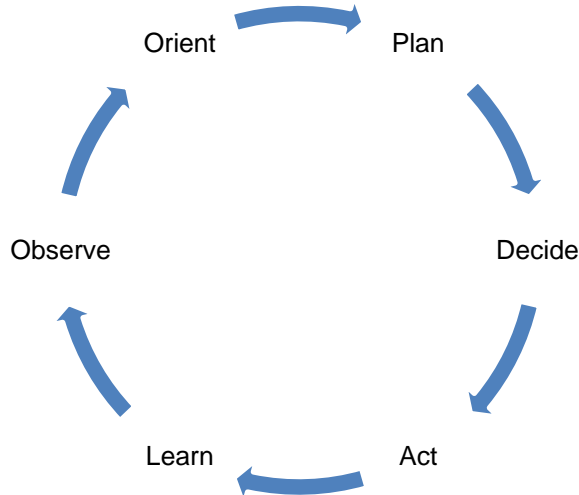
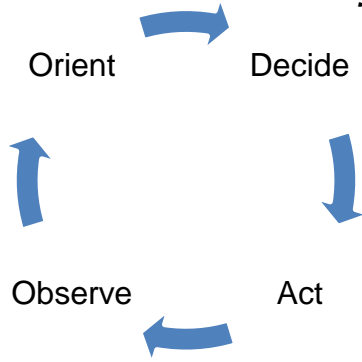
Mishaps x 1e5 hours



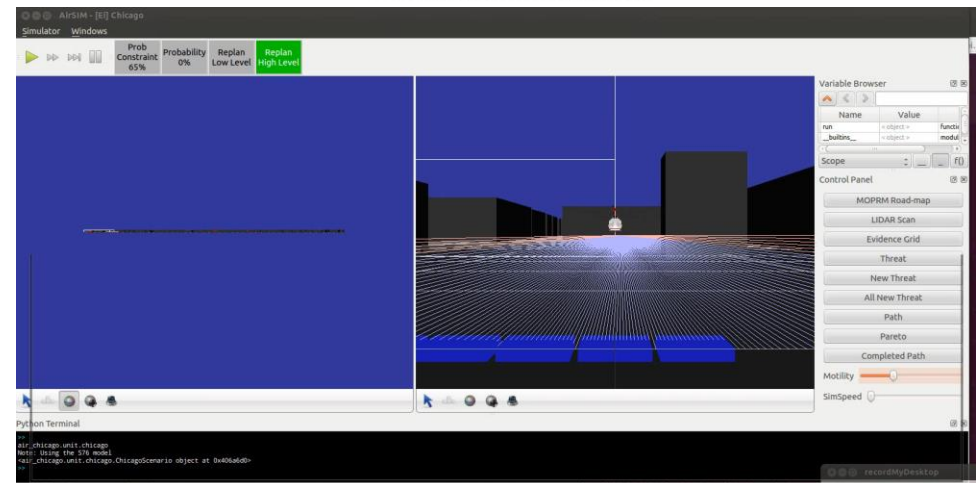
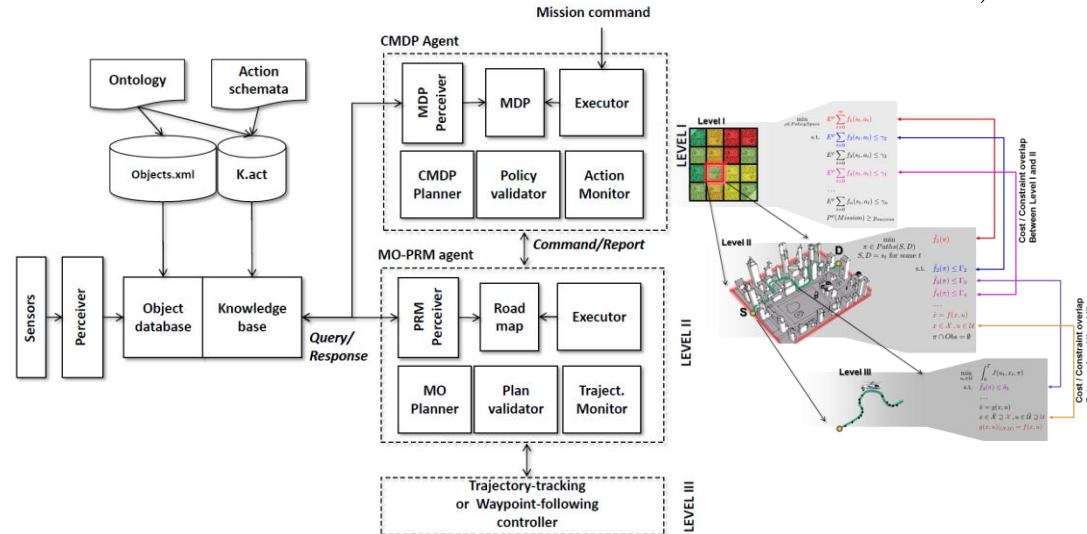
Office of the Secretary of Defense, "Unmanned aerial vehicle reliability study," 2003 & J. Gertler, "U.S. unmanned aerial systems," 2012.

Autonomy

Extending beyond physics-based decision making



$$\phi = \neg \text{Fail} \cup \left(\text{FStart} \wedge \text{FPickup} \wedge \text{FDropoff} \wedge \text{G}(\text{Start} \rightarrow \text{XFPickup} \wedge \text{Dropoff} \rightarrow \text{XFStart}) \right)$$



Future needs

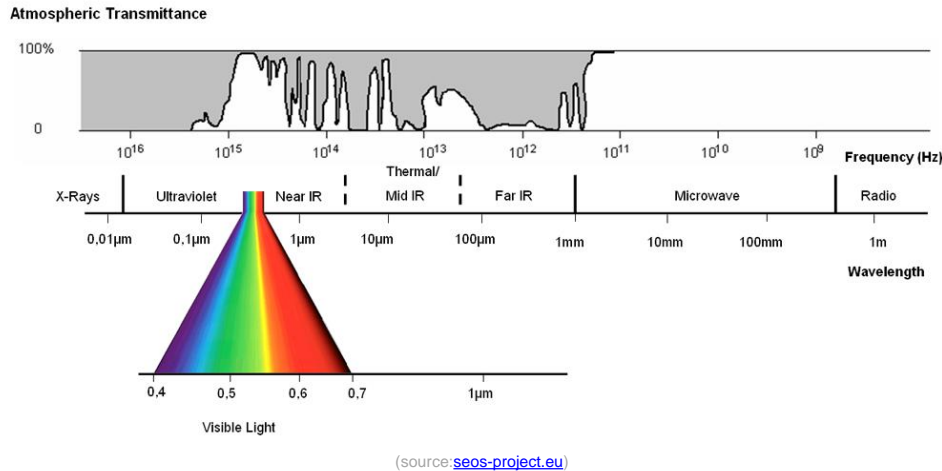
My short lists

- Perception
- Knowledge representation & reasoning
- Human-Systems Interaction
- Multi-agent systems
- Learning/Teaching
- Systems engineering
 - SW/HW/Comm. Architectures
 - Design processes
 - V&V

Future needs

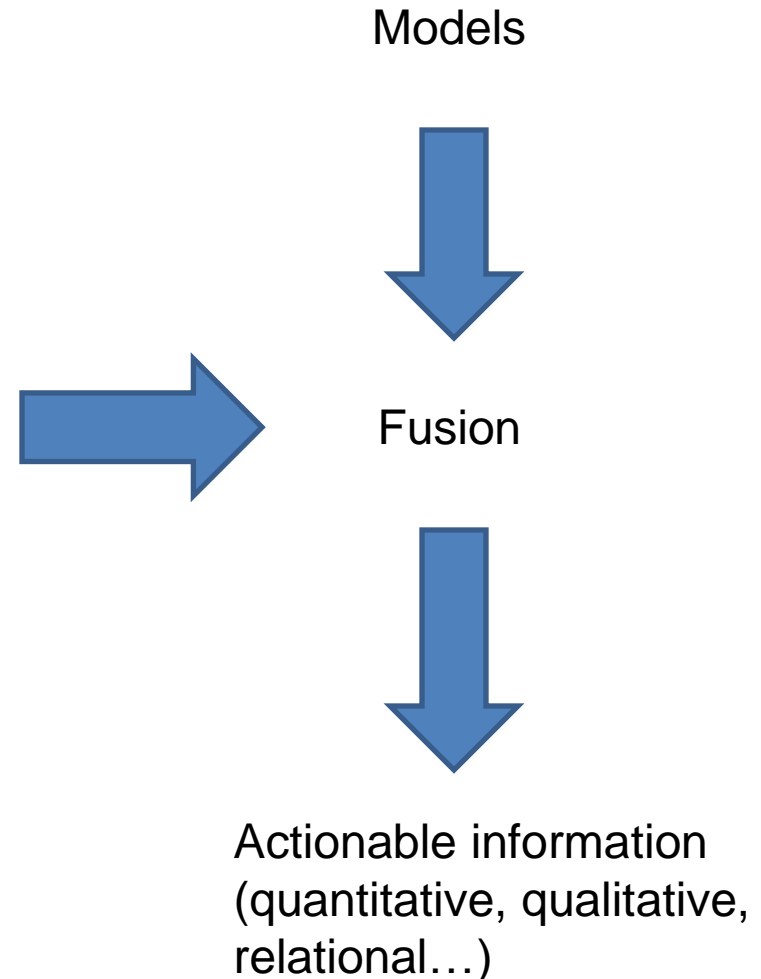
Example: from sensing to actionable information

Electromagnetic spectrum



Acoustic
Physiological
.....

Data sources (many)



Impact on curriculum

Some principles...

- Modeling (with emphasis on the *physical*)
- Human factors
- Sensing the world: modalities, processing, perception
- Logic, principles and limits of automated reasoning
- Multi-agent systems: beyond Byzantine agreement or time synchronization
 - Common operating picture
 - Coordination
- Model-based design

Other skills

Non technical but important

- Breadth
- Curiosity
- Ability to work in a team