SAM|XL: Leveraging ROS for Aerospace Manufacturing Processes

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ROS-Industrial Conference

Stuttgart

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Smart Advanced Manufacturing

TU Delft

I. **Introduction SAM|XL**

II. The challenge of automated aerospace manufacturing

III. Use-case from GKN Fokker Aerospace

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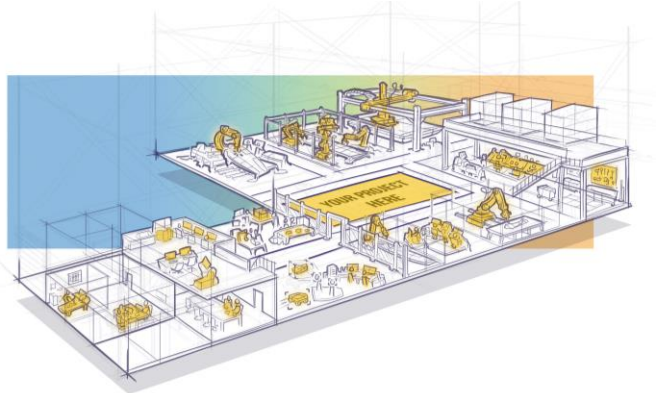
Smart Advanced Manufacturing XL

- Collaborative Research Centre in Delft, The Netherlands
- **Started by:**
  - Industrial partners from the aerospace industry
  - TU Delft Aerospace Engineering
  - TU Delft Cognitive Robotics
- **Mission**:
  - Contribute to *Smart Manufacturing* in Aerospace Companies
- **By Offering:**
  - Community
  - 2000 m2 dedicated space
  - Support and Expertise



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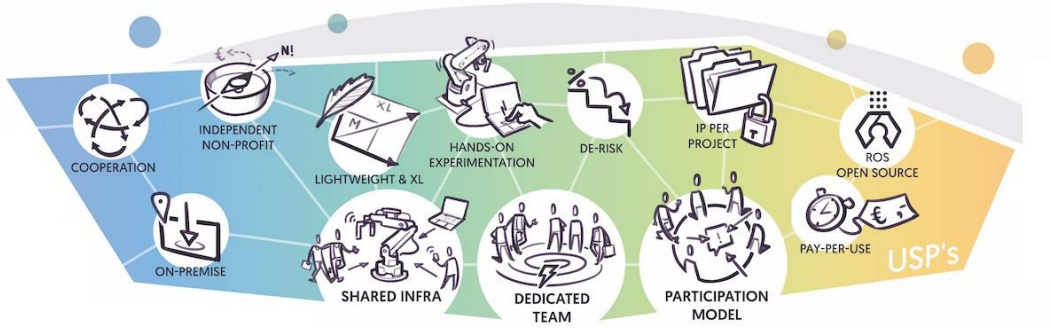
EUROPEAN UNION
European Regional Development Fund

POWERING smart industry



Unique *participation model* focussed around different project types

1. Infrastructure Projects
   - *Upgrade of toolbox*
2. Proof-of-concept Projects
   - *Generic technology trials for the community*
3. Industrialisation Projects
   - *Specific solutions ready for implementation at participant*

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Why manufacturing in aerospace is a challenge

- Many different processes that almost always require:
  - Human dexterity,
  - Craftsmanship and
  - Adaptation to variations

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Why manufacturing in aerospace is a challenge

Source: GKN Fokker Aerostructures “Along the bondline”

Why manufacturing in aerospace is a challenge

The robot flub isn't a complete loss. Boeing learned some valuable lessons from its "first very deep dive into that type of technology," Clark said.
"It's taught us how to design for automation."

Source: Seattle Times

Boeing ditched the robots on its 777 line. Like Tesla, it needed the human touch

Source: Los Angeles Times

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What makes Aerospace manufacturing challenging?

- Many different processes that almost always require:
  - Human dexterity,
  - Craftsmanship and
  - Adaptation to variations
- Large part sizes
- Products/processes that are all *kind of* similar… (high mix)
- A long legacy of approved and certified processes
  - High quality and robustness requirements (Airworthiness Certification)

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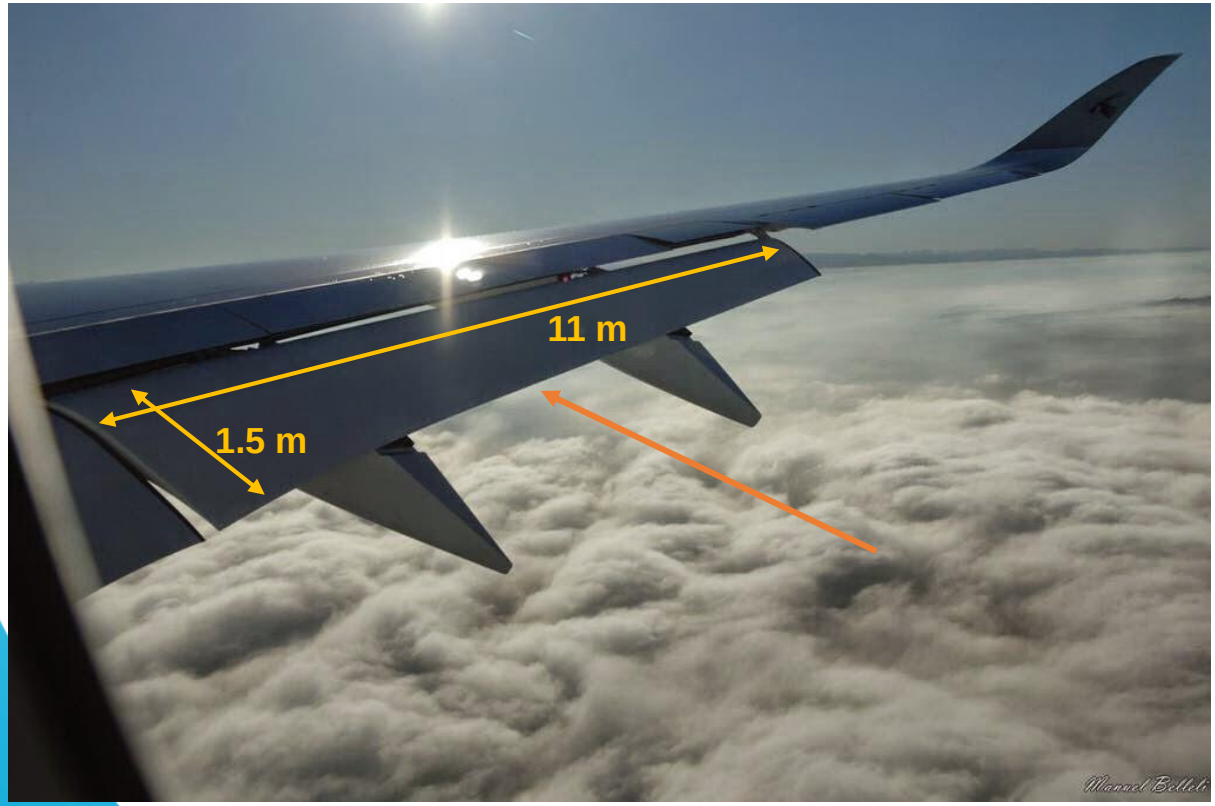
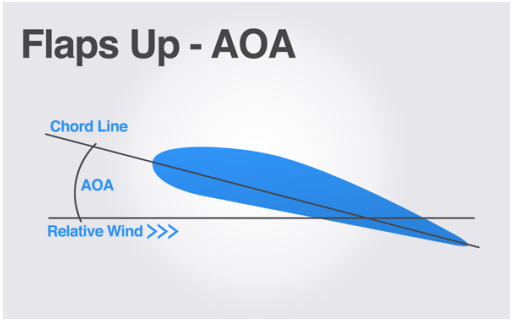
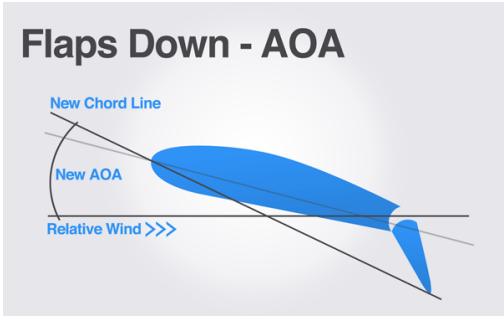
Use-case: GKN Fokker - Drilling A350 Flap







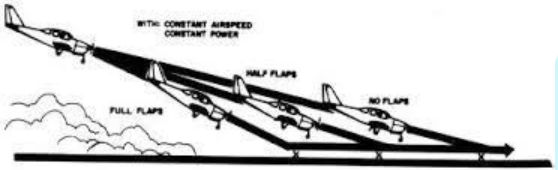


Figure 9–3 Effect of Flaps on Landing Point

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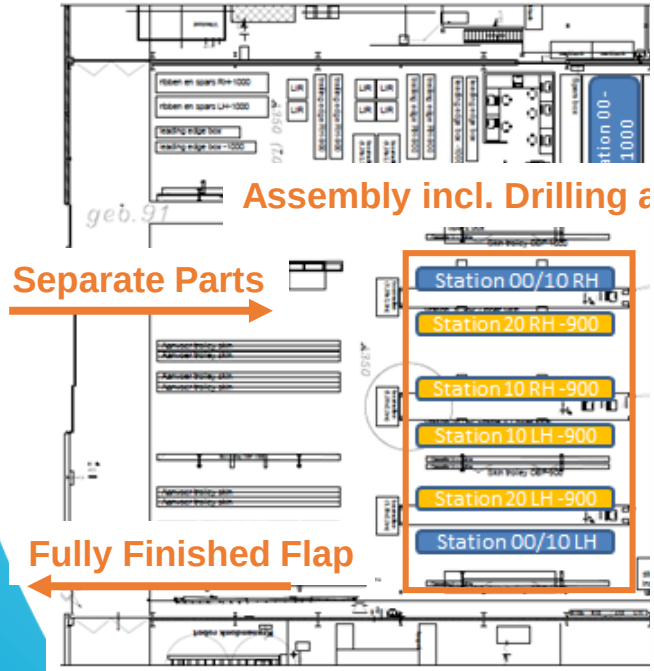
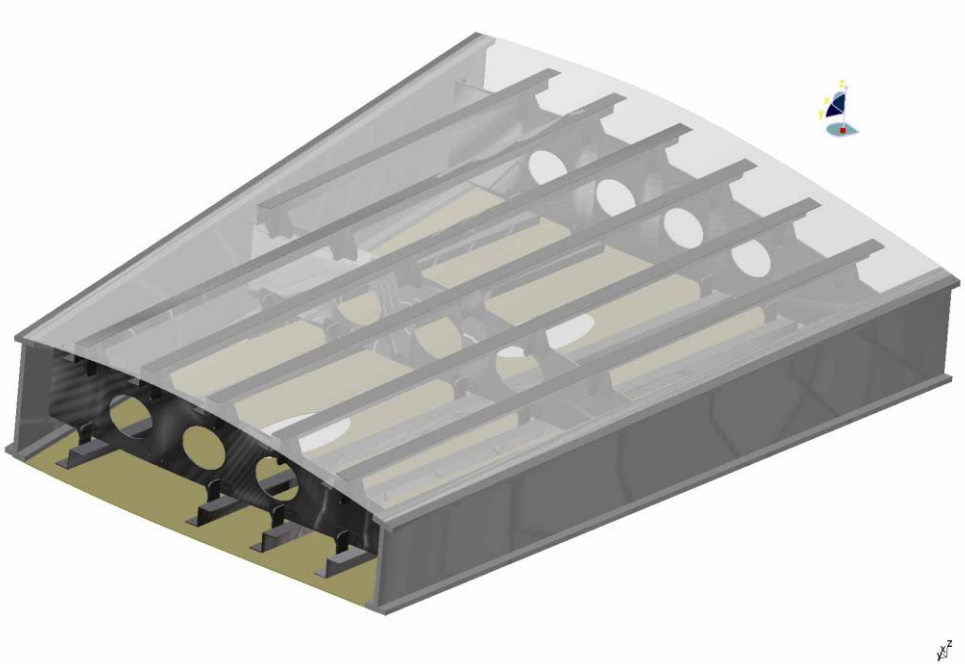
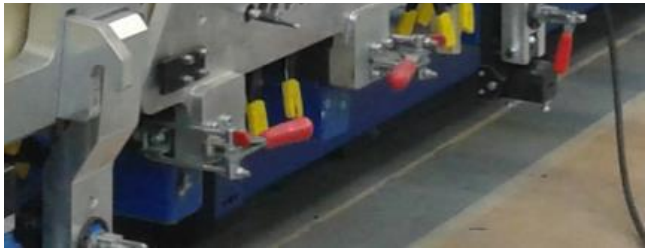
Use-case: GKN Fokker - Drilling A350 Flap

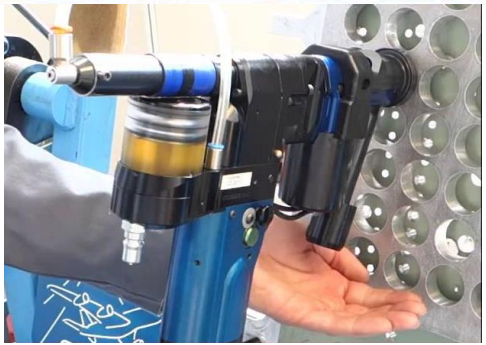






Automated Drilling Process

- Automated Drilling Unit (ADU):
  - Low craftsmanship involved
- Accuracy comes from jig and ADU
  - Drill-to-jig clearance: 0.20 mm
- Repetitive Task: not challenging for manufacturing staff
- Drilling remains the same, no need for process requalification



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Other Aspects

- Stations are used for multiple process steps. No fixed automation solution possible
- Crew is workin
- Environment (s g. debris, equipment, pec

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Project Legacy and Goals

- Project already ongoing in different forms:
  - Manual cart with Cobot -> almost production ready
  - AGV with Cobot qualified up to TRL 5 by system integrator

- Goal:
  - Beginning 2021 first autonomous drilling system deployed (incl. autonomous “self-driving” capability) TRL 5 -> TRL 9
  - Scale-up soon after

System Concept

- Fleet of AGV/SDVs for transport
  - SLAM using (safety) lidar
  - Commercially available, different vendors
  - Most use ROS in their technology
  - CE marking remains a challenge
- Fleet of Integrated Drilling Systems for process
  - Custom integration
    - Cobot (e.g. UR, IIWA, FANUC, Doosan)
    - Electronic Automated Drilling Unit (Seti-Tec)
    - Safety and Communication Onboard
    - Limited Battery Life: media connection at drill stations
- Coordination nodes for planning and control

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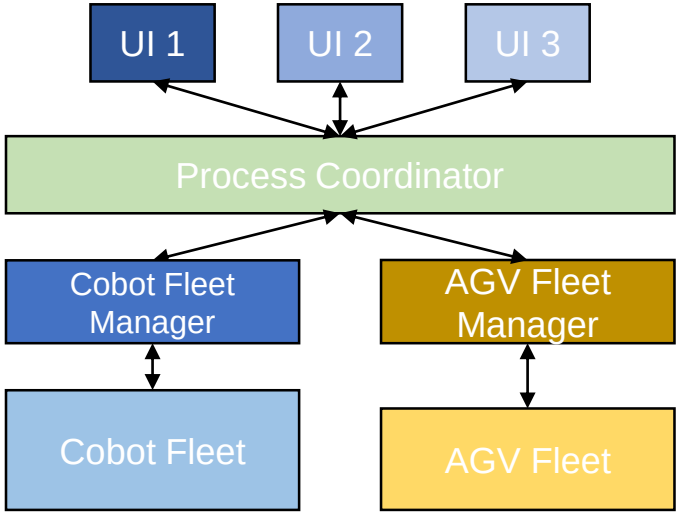
Process Logic

- Multiple integrated drilling systems collaborate to finish the process.

- Multiple autonomous vehicles are used to transport the drilling systems from:
  - Service Bay-to-Flap Stations (6x), and from
  - drill location-to-drill location (aprox. 12x per flap station)
- Time on drill location estimate: 15-25 minutes. One AGV can “service” multiple drilling systems.
- Rough positioning of drill system by AGV
  - Positioning with lidar <1cm/<1deg
- Fine positioning comes from (optical) calibration on drill jig

Modularity aids development over time



Gradual ramp-up and complexity increase

- Start with one AGV + Cobot
- Gain knowledge, remove bugs
- Increase fleet:
  - Increase sophistication in coordination.
- Several ROS based modules with their specific responsibility

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Summary

- SAM|XL supports to support aerospace manufacturing companies in their automation challenges
  - Later technology transfer to other industries
- With knowledge, practical know-how and a relevant environment
- ROS is our platform of choice, to maximize reuse, collaboration and separation into functional components
- Ultimately we want participants to grow and develop together with us

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