SAM|XL: Leveraging ROS for Aerospace Manufacturing Processes

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I. Introduction SAM|XL
II. The challenge of automated aerospace manufacturing
III. Use-case from GKN Fokker Aerospace
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
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
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.”

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

Source: Seattle Times
Source: Los Angeles Times
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

Flaps Up - AOA

Flaps Down - AOA

Figure 9-3 Effect of Flaps on Landing Point
Use-case: GKN Fokker - Drilling A350 Flap

Assembly incl. Drilling and Fastening

Separate Parts

Fully Finished 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
Other Aspects

• Stations are used for multiple process steps. No fixed automation solution possible.

• Crew is working alongside the system.

• Environment (semi) structured but still challenging (e.g. debris, equipment, people).
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
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
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
Contact Information

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