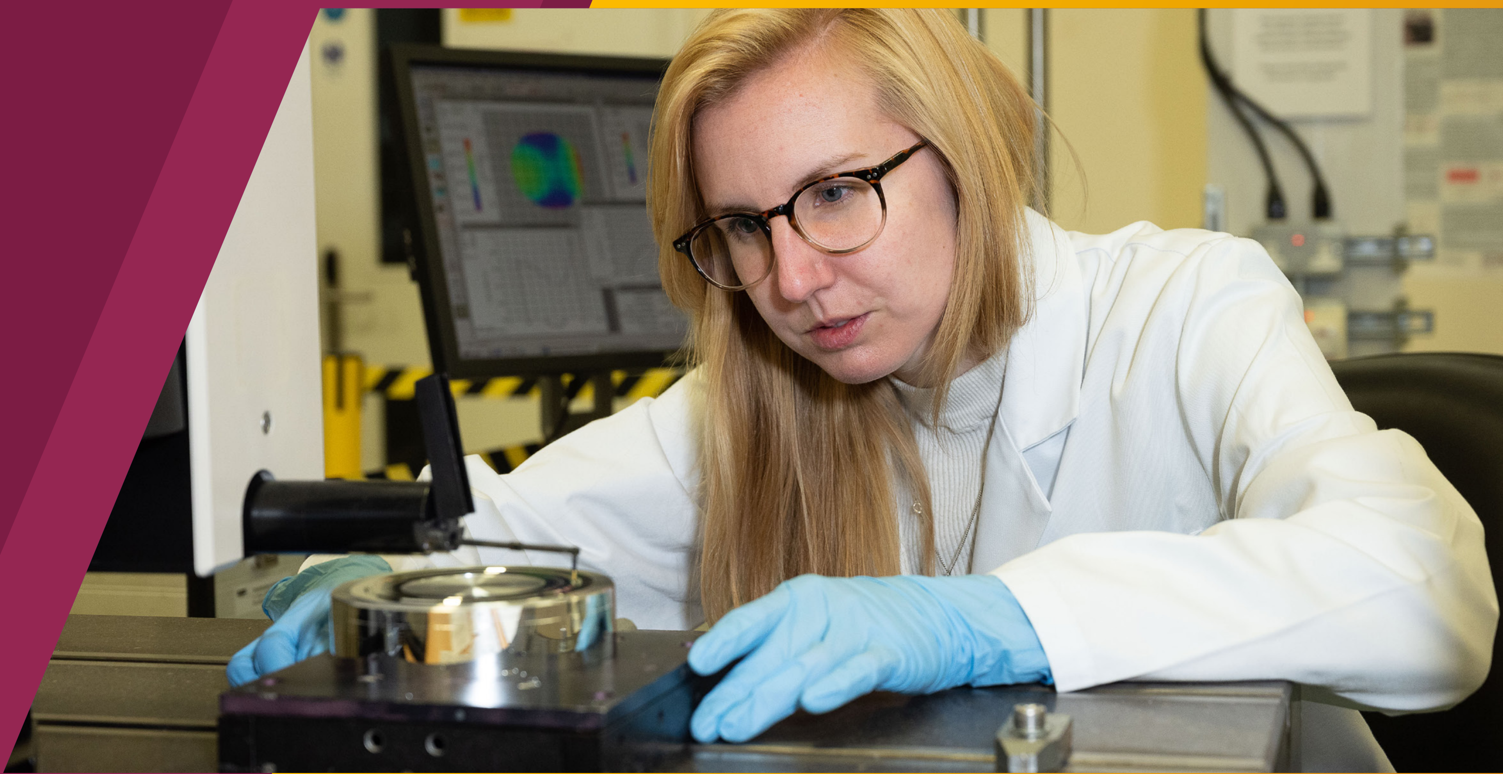
Manufacturing, Materials and Design group project day

Learning in partnership with industry
invitation to the industrial project presentations

Friday 25 April 2025, 9am - 4pm



Group project presentation day

www.cranfield.ac.uk/manufacturingpresentationday

Welcome to Cranfield's Manufacturing MSc group project presentation day.

Today is the culmination of over of 40,000 man-hours of work. We have 113 MSc students working on 28 projects from the 10 MSc courses across the Manufacturing, Materials and Design programmes.

The projects presented are investigating subject areas of interest to industry and/or current Cranfield University research topics. These projects require the interest and support from industry, the coordination and supervision by Cranfield University academic and research staff, access to both Cranfield facilities and resources provided by sponsoring companies, alongside administrative support to ensure the students learn, investigate and deliver.

As we approach the concluding stages of the group project activity, our students should be able to reflect on:

- the challenge of accepting/understanding a project brief and managing the necessary resources,
- coordinating the project activities and interaction with the clients,
- obtaining and analysing results,
- completing the work by delivering conclusions, recommendations and providing the client with any developed software or hardware.

All the work has been completed within a strict time period of no more than 12 weeks. This activity provides some preparation for our students to make the transition from education to employment.

We would like to thank the industry representatives for showing an interest in the work of our students. We value the support of Industry, from attending student presentations to, asking searching questions of our students, and sponsoring student projects.

Dr David Ayre
Manufacturing MSc
Group Project Co-ordinator

Project titles

1. Optimising multimodal logistics for a sustainable net zero future: The DHL case
2. Developing the digital twin proof of concept for gas turbines
3. Digital twin for proactive asset management and optimised operational performance in wastewater management
4. Developing the future of manufacturing in Defence – A Leidos perspective
5. Achieving high productivity and high performance of super duplex stainless steel using cold wire gas metal arc (CW-GMA) with in-process rolling
6. Study on the impact of the composition of aluminium wire arc additive manufacturing (WAAM) deposit on hydrogen diffusivity
7. Characterisation of coating system and optimisation of cure cycle
8. The game changing effect of graphene in the next generation of sustainable high-performance coatings
9. The definition of circular economy design environment
10. The application of Internet of Things (IoT) network to enhance farming at Alaziziah Palm Tree Farm in Saudi Arabia
11. AI-augmented cognitive agents for the next-generation workforce support in manufacturing
12. Application of blockchain for the aerospace supply chain
13. Sustainable material supply in aerospace manufacturing: A feasibility study and lifecycle assessment
14. Dynamic sustainability assessment of aerospace manufacturing processes
15. Evaluating the environmental and economic implications of aluminium manufacturing techniques
16. Optimising energy efficiency in induction melting at Brockmoor Foundry: A data-driven and ML-aided approach
17. Develop the manufacturing-readiness level of a stroke rehabilitation medical wearable device
18. Novel aluminium casting processes for sustainable aerospace manufacturing
19. Recycling aerospace alloys: Enabling the production of Ti-6Al-4V wires from recycled feedstock
20. The application of set-based concurrent engineering within lean agile product development process model at Atlas Copco
21. Improving the efficiency of boarding operation at airports by agent-based modelling and simulation
22. Application of Hardide chemical vapor deposition (CVD) tungsten carbide coatings for carbon capture and storage (CCS)
23. High-performance, lithium-free, Rare Earth-Free batteries using recycled aerospace-grade aluminium
24. Investigation of dry contact stiction/wear in Stellite 31 turbine blade dampers
25. Utility-scale battery energy storage system monetisation and optimisation
26. Feasibility study on the use of heterogeneous swarm robotics for railway inspection and maintenance
27. Implementing reliability-centred maintenance to drive efficiencies within maintenance
28. Smart predictive maintenance: Leveraging Internet of Things (IoT) for enhanced equipment reliability

Please note some of the presentation titles may change slightly to better reflect the work carried out throughout the project. Additionally, some presentations may be restricted and unavailable for general viewing.

Programme Friday 25 April 2025

There will be a brief introduction at 09:00 and a closing address at 15:30 in the Auditorium of the Vincent Building (Building 52a)

Room: LR1		**Open presentation**	
Start	**Finish**	**Project**	**Title**
9:15	10:00	GP1	Optimising multimodal logistics for a sustainable net zero future: The DHL case
10:00	10:45	GP3	Digital twin for proactive asset management and optimised operational performance in wastewater management
Break			
11:15	12:00	GP9	The definition of circular economy design environment
12:00	12:45	GP10	The application of Internet of Things (IoT) network to enhance farming at Alaziziah Palm Tree Farm in Saudi Arabia
Lunch Break			
14:00	14:45	GP11	AI-augmented cognitive agents for the next-generation workforce support in manufacturing
14:45	15:30	GP21	Improving the efficiency of boarding operation at airports by agent-based modelling and simulation

Room: LR2		**Open presentation**	
Start	**Finish**	**Project**	**Title**
09:15	10:00	GP13	Sustainable material supply in aerospace manufacturing: A feasibility study and lifecycle assessment
10:00	10:45	GP14	Dynamic sustainability assessment of aerospace manufacturing processes
Break			
11:15	12:00	GP15	Evaluating the environmental and economic implications of aluminium manufacturing techniques
12:00	12:45	GP19	Recycling aerospace alloys: Enabling the production of Ti-6Al-4V wires from recycled feedstock
Lunch Break			
14:00	14:45	GP20	The application of set-based concurrent engineering within lean agile product development process model at Atlas Copco
14:45	15:30	GP12	Application of blockchain for the aerospace supply chain

Room: LR3		Open presentation	
Start	**Finish**	**Project**	**Title**
09:15	10:00	GP6	Study on the impact of the composition of aluminium WAAM deposit on hydrogen diffusivity
10:00	10:45	GP22	Application of Hardide chemical vapor deposition (CVD) tungsten carbide coatings for carbon capture and storage (CCS)
Break			
11:15	12:00	GP25	Utility-scale battery energy storage system monetisation and optimisation
12:00	12:45	GP26	Feasibility study on the use of heterogeneous swarm robotics for railway inspection and maintenance
Lunch Break			
14:00	14:45	GP4	Developing the future of manufacturing in Defence – A Leidos perspective

Room: LR5		Closed Presentations (confidential)	
Start	**Finish**	**Project**	**Title**
09:15	10:00	GP27	Implementing reliability centred maintenance to drive efficiencies within maintenance
10:00	10:45	GP28	Smart predictive maintenance: Leveraging Internet of Things (IoT) for enhanced equipment reliability
11:15	12:00	GP8	The game changing effect of graphene in the next generation of sustainable high-performance coatings
12:00	12:45	GP24	Investigation of dry contact stiction/wear in Stellite 31 turbine blade dampers
Lunch Break			
14:00	14:45	GP5	Achieving high productivity and high performance of super duplex stainless steel using CW-GMA with in-process rolling
14:45	15:30	GP7	Characterisation of coating system and optimisation of cure cycle

Room: LR6		Closed Presentations (confidential)	
Start	**Finish**	**Project**	**Title**
09:15	10:00	GP16	Optimising energy efficiency in induction melting at Brockmoor Foundry: A data-driven and ML-aided approach
10:00	10:45	GP18	Novel aluminium casting processes for sustainable aerospace manufacturing
11:15	12:00	GP2	Developing the digital twin proof of concept for gas turbines
12:00	12:45	GP23	High-performance, lithium-free, Rare Earth-Free batteries using recycled aerospace-grade aluminium
Lunch Break			
14:00	14:45	GP17	Develop the manufacturing-readiness level of a stroke rehabilitation medical wearable device

Closing Address in Auditorium at 15:30pm. Presentation day end 15:40pm.

Group project 1

Optimising multimodal logistics for a sustainable net zero future: The DHL case

Team members

Gopal Krishna Ullattil

Academic background

2024 - 2025	Aerospace Manufacturing MSc, Cranfield University
2018 - 2022	Aeronautical Engineering BTech, Jain University

Work experience

2022 - 2024	Assistant Engineer, Axiscades Technologies Ltd

Marie Maraval

Academic background

2024 - 2025	Aerospace Manufacturing MSc, Cranfield University
2021 - 2024	Mechanical Engineering MSc, University of Technology of Compiègne

Work experience

2023 - 2024	Supply Chain Intern, Safran Electronics and Defense

Mardan Khoshdell

Academic background

2024 - 2025	Management and Information Systems MSc, Cranfield University
2011 - 2014	Computer Science BSc, Herat University

Work experience

2023 - 2024	Data Clerk, International Rescue Committee (IRC)
2022 - 2023	Data Management Officer, New Afghanistan Development Organisation (NADO)

Nihal Ramesh Salian

Academic background

2024 - 2025	Aerospace Manufacturing MSc, Cranfield University
2019 - 2023	Aeronautical Engineering, Mangalore Institute of Technology and Engineering

Work experience

2024 - 2024	CAE Trainee, ProSIM R&D Pvt Ltd
2024 - 2024	Administrator, Global Speed Time Trading and Services

L-R) Nihal Ramesh Salian, Marie Maraval, Mardan Khoshdell and Gopal Krisna Ullattil.

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Optimising multimodal logistics for a sustainable net zero future: The DHL case

Mr. Mardan Khoshdell
Mr. Nihal Ramesh Salian
Ms. Marie Maraval
Mr. Gopal Krishna Ullattil

Background

The United Kingdom targets net-zero emissions by 2050, with significant focus on expanding Sustainable Aviation Fuel (SAF) usage and electric vehicle (EV) adoption. This project supports the UK's sustainable logistics goals by optimising Fourth-Party Logistics (4PL) multimodal networks and enhancing the integration of sustainable fuels and electric vehicle solutions.

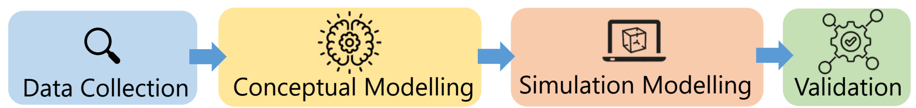
Aim

- Optimise multimodal logistics network.
- Apply Fourth-Party Logistics (4PL) principles.
- Integrate both air and road transportation.
- Enhance efficiency and sustainability in operations.

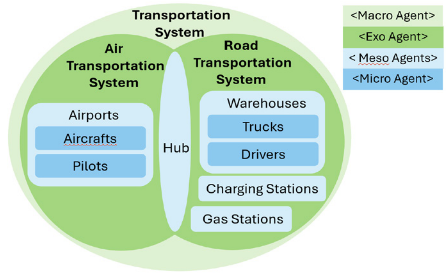
Objectives

- Review existing logistics strategies.
- Develop a conceptual model integrating road and air transport.
- Build a multimodal simulation model using AnyLogic.
- Conduct critical and scenario analysis to evaluate performance.

Methodology



Conceptual Model

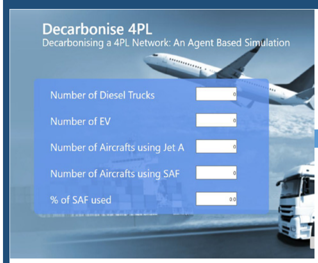


Transportation System

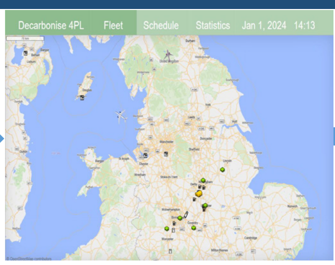
Research Gaps

•**Lack of integrated, modular 4PL designs** that scale across multiple transport modes (road + air) and incorporate sustainable fuels and electric vehicles.
•**Absence of a comprehensive system architecture** that addresses logistics at macro, exo, meso, and micro levels, focusing on sustainability and intermodal coordination.

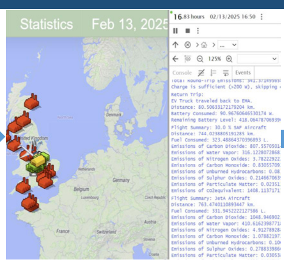
Simulation Model



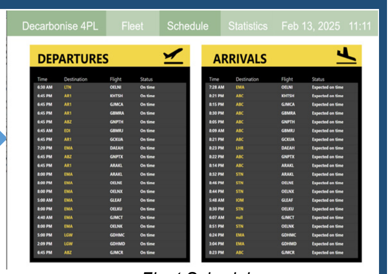
Input Dashboard of the Model



GIS map tracking fleet movements.



Tracking of Agents and Emissions



Fleet Schedule

Results: Scenario Analysis

Current - 2024

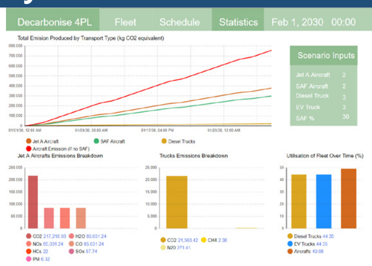
- 0% of SAF
- 0% of Electric Trucks
- 6 Diesel Truck
- 6 Airplane with Jet A Fuel
- **778,005** kg CO2e/ month

Future – 2030

- 30% of SAF
- 50% Electric Trucks
- 3 Diesel Truck
- 2 Airplane with Jet A Fuel
- **698,749** Kg CO2e / month

Scan QR Code for Simulation

~10.5% Reductions In Emissions



2030 Scenario

Benefits

- **Supports sustainable logistics** by tracking and reducing transport emissions.
- **Improves decision-making** through simulation of routes, schedules, and refueling.
- **Scalable model** adaptable to other transport modes (rail, sea).

Conclusion and Future Work

The simulation demonstrates a 4PL approach integrating sustainable fuels and EVs by maintaining efficiency and thereby reducing emissions. Future work will focus on real-time data integration and optimisation.

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Group project 2

Developing the digital twin proof of concept for gas turbines

Team members

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Academic background

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2018 - 2022	Information Technology BTech, Mukesh Patel School of Technology Management and Engineering (MPSTME) NMIMS

Work experience

2021 - 2022	System Analyst, HDFC Bank

Suhas Gowda Nanda Kumar

Academic background

2024 - 2025	Management and Information Systems MSc, Cranfield University
2020 - 2023	Computer Science BSc, Bangalore University

Work experience

2024 - 2024	Associate, Amazon

Omar Ibrahim

Academic background

2024 - 2025	Management and Information Systems MSc, Cranfield University
2019 - 2023	Business Information Technology BTech, Princess Sumaya University for Technology

Work experience

2023 - 2024	SAP Functional Consultant, SkyTech SAP Gold Partner

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Academic background

2024 - 2025	Management and Information Systems MSc, Cranfield University
2019 - 2023	Digital Marketing and Social Media, Princess Sumaya University for Technology

Work experience

2023 - 2024	Junior Functional ERP Consultant, Aquantima

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This groups poster is confidential

Group project 3

Digital twin for proactive asset management and optimised operational performance in wastewater management

Team members

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Academic background

2024 - 2025 Management and Information Systems MSc, Cranfield University

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Work experience

2017 - 2020 Associate, CS Internet, Sutherland Global Service

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Academic background

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Jiarui Zhou

Academic background

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2019 - 2023 Mechanical Design and Manufacturing and its Automation, Jiangsu Normal University

Yongjie Xu

Academic background

2024 - 2025 Aerospace Manufacturing MSc, Cranfield University

2021 - 2023 Aircraft Manufacturing Engineering, Shandong Jiaotong University

(L-R) Yongjie Xu, Angelin Daniel, Songze Li and Jiarui Zhou.

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Digital twin for proactive asset management and optimised operational performance in wastewater management

Mr. Jiarui Zhou   Mr. Yongjie Xu   Mr. Songze Li   Ms. Angelin Nuria Daniel

Background

- **Context:**
The traditional wastewater management systems in the UK, often reliant on SCADA and manual inspections, face limitations in predictive capacity, real-time responsiveness, and regulatory adaptability.
- **Problem:**
Challenges such as aging infrastructure, data fragmentation, and stricter phosphorus discharge limits demand an advanced system for predictive maintenance and operational optimization.

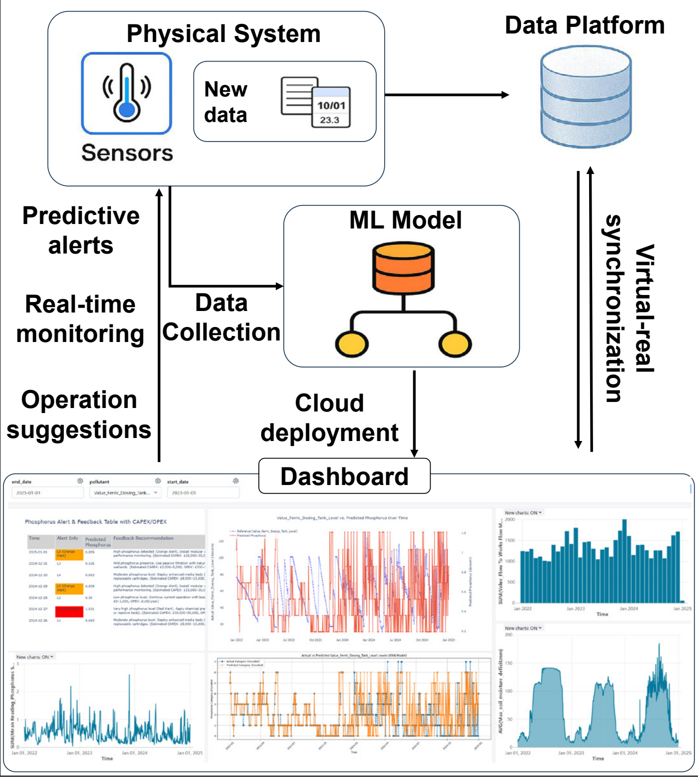
Aims

Develop a Digital Twin to predict phosphorus levels and improve compliance, efficiency, and cost for Anglian Water.

Objective

- Identify high-risk wastewater accumulation areas
- Integrate multi-source data
- Apply data preprocessing techniques
- Train ML models for phosphorus prediction
- Deploy the DT system with real-time visualization

Result

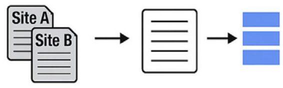


Methodology

Area Profiling

Data Preprocessing

Missing Value Handling
Data Integration
Normalization

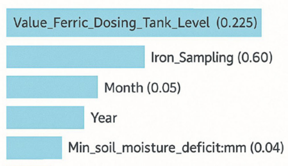


ML & Deployment

Phosphorus Alert Table

Time	Alert Info	Predicted Phosphorus
2025-01-01	L5 (Orange Alert)	0.859
2024-12-31	L3	0.526
2024-12-30	L4	0.693
2024-12-29	L5 (Orange Alert)	0.859
2024-12-28	L2	0.36
2024-12-27	L6 (Red Alert)	1.031
2024-12-26	L4	0.693
2024-12-25	L7 (Red Alert)	1.21

Feature Selection



Conclusion

- This project validates the use of digital twins + machine learning to predict phosphorus concentration in wastewater networks.
- The KNN model showed the best performance (76% accuracy, Kappa 0.721), especially in identifying high concentration levels.
- The limitations of intermediate level forecasting indicate that future work can be carried out in terms of data balancing.

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From sensors to insights — enabling smarter wastewater operations.

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2025

Group project 4

Developing the future of manufacturing in Defence – A Leidos perspective

Team members

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Academic background

2024 - 2025	Engineering and Management of Manufacturing Systems MSc, Cranfield University
2020 - 2023	Management Engineering BSc, University of Pisa

Marine Jamois

Academic background

2024 - 2025	Aerospace Manufacturing MSc, Cranfield University
2022 - 2024	Mechanical and Industrial Engineering Combined BSc/MSc, IMT Nord-Europe

Work experience

2024 - 2024	Project Management Engineer Internship, ONERA, The French Aerospace Lab
2023 - 2023	Production and Project Management Engineer Internship, AirLiquide

Elia Gazzarini

Academic background

2024 - 2025	Engineering and Management of Manufacturing Systems MSc, Cranfield University
2019 - 2023	Industrial Engineering BSc, Politecnico di Bari

Robin Laneé

Academic background

2024 - 2025	Management and Information Systems MSc, Cranfield University
2020 - 2024	Bioinformatics, École Centrale de Nantes

(L-R) Elia Gazzarini, Marine Jamois, Robin Laneé and Dario Basili.

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Developing the future of manufacturing in Defence – A Leidos perspective

Dario Basili Robin Lanée
Marine Jamois Elia Gazzarini

Background

The **Defence** sector is under growing pressure to ramp-up its production. However, heavy reliance on manual process limits both scalability and adaptability, creating a need for automation. **Industry 4.0** technologies has proven to bring several benefits:

- Labor Productivity +15/30%
- Machine Downtime -30/50%
- Throughput +10/30%
- Forecasting Accuracy: 85%

Aim & Objectives

Develop an integrated framework for **automation** and digital transformation for defence manufacturing to enable **flexibility** and **ramp-up** production.

- Review manufacturing trends
- Target Key Performance Indicators and assess technologies
- Map factory elements and interactions
- Design roadmap for technologies deployment

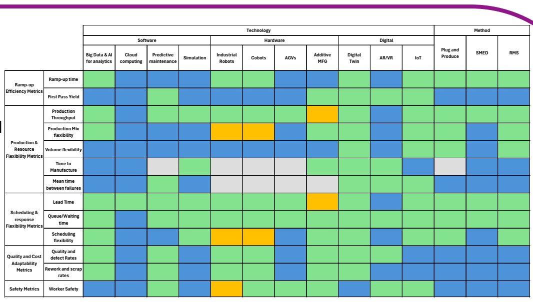
Methodology

Definition of objectives → Literature review → Identification of relevant technologies & methods → Definition of the pertinent KPIs → Determine technologies impact on KPIs → Creation of conceptual models → Structure of the roadmap → Validation

Results

The interactions between technologies and KPIs are defined as follows:

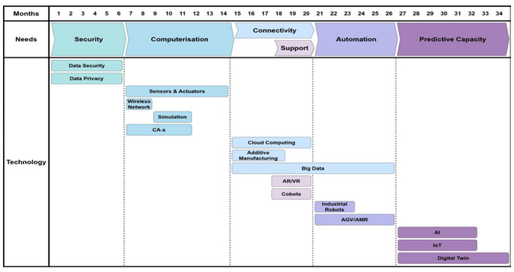
- Strong beneficial interaction
- Medium beneficial interaction
- Beneficial interaction with reservations
- No proven interaction



Technologies impact on KPIs

Validation: Two case studies are used to validate the results:

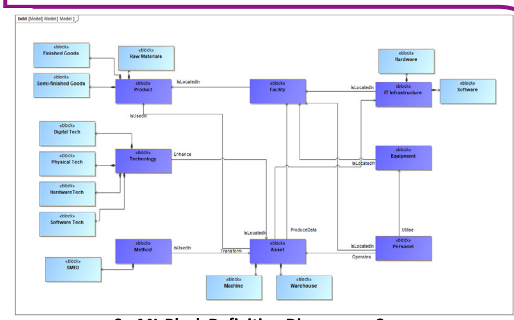
- ✓ a Leidos case
- ✓ an industrial case



Technologies Implementation Roadmap

Research gaps

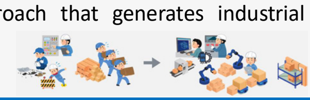
There is a lack of **structured frameworks** for evaluating each technology's contribution to operational ramp-up, scalability, and long-term flexibility in a greenfield facility.



SysML Block Definition Diagram on Cameo

Benefits

Integrating KPIs, technologies, methods, factory elements, and implementation over time, in a comprehensive approach that generates industrial knowledge



Conclusion

This project successfully demonstrates that the implementation of selected technologies would reduce ramp-up time and increase production flexibility. Moreover, it provides a comprehensive deployment timeline through a strategic roadmap.

Future Work

- Incorporate feasibility study conclusions to refine the implementation roadmap
- Expand Cameo diagram to develop a Digital Twin

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Group project 5

Achieving high productivity and high performance of super duplex stainless steel using CW-GMA with in-process rolling

Team members

Arash Azhang

Academic background

2024 - 2025	Metal Additive Manufacturing MSc, Cranfield University
2016 - 2019	Biomedical Engineering MSc, University Science and Research Branch IAU, Tehran, Iran

Work experience

2020 - 2024	Engineering Design, Project Evaluator, VIAN Steel Complex
2015 - 2020	Research and Development Manager, Pooyan Teb Hegmataneh, Iran

Sreehari Kadamathukuttiyil Harikumar

Academic background

2024 - 2025	Aerospace Materials MSc, Cranfield University
2012 - 2015	Applied Physics BSc, Mahatma Gandhi University

Work experience

2015 - 2024	Prototyping Engineer, SNL Crafted Technologies and Engineering

Mohammed Alshamrani

Academic background

2024 - 2025	Metal Additive Manufacturing MSc, Cranfield University

Work experience

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(L-R) Arash Azhang, Mohammed Alshamrani and Sreehari Harikumar.

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Achieving high productivity and high performance of super duplex stainless steel using CW-GMA with in-process rolling

Mr. Arash Azhang Mr. Mohammed Alshamrani
Mr. Sreehari Kadamathukuttiyil Harikumar

Background

- Super Duplex Stainless Steels (SDSSs) are valued for their high strength and corrosion resistance, making them suitable for demanding environments.
- Wire Direct Energy Deposition (WDED), particularly using Cold Wire Gas Metal Arc (CW-GMA), enables high deposition rates and efficient thermal control, making it promising for manufacturing complex components from advanced alloys like SDSSs.
- A key challenge in WDED of SDSSs is coarse grain structure and an unfavorable austenite/ferrite phase ratio. A significant gap in current research is the exploration of in-process rolling during deposition, which offers the potential to refine grain structures and phase distribution.

Aim

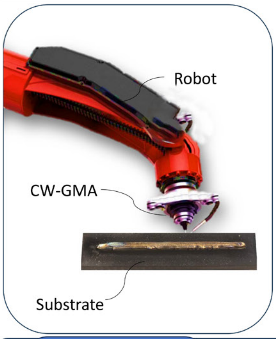
This project aims to integrate in-process rolling with the CW-GMA process to manufacture SDSS with refined microstructures, a balanced austenite/ferrite phase ratio, and improved mechanical properties without additional post-deposition heat treatments.

Objectives

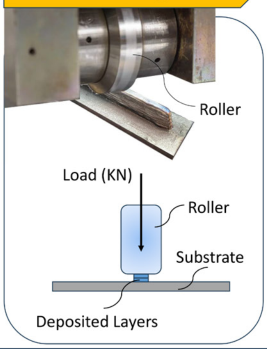
- Integrate in-process rolling with CW-GMA process
- Select optimised CW-GMA parameters (material input and energy input) to achieve different initial microstructures.
- Optimise in-process rolling parameters (rolling force) to achieve grain refinement.
- Determine correlations between process parameters and material properties.

Methodology

Deposition

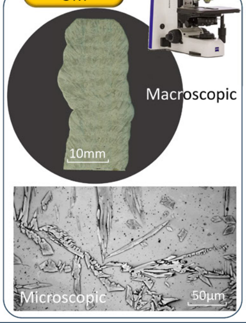


Rolling

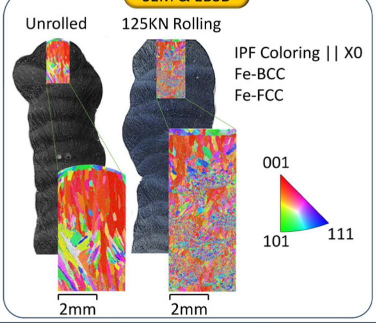


Analysis

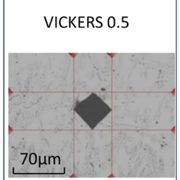
OM



SEM & EBSD

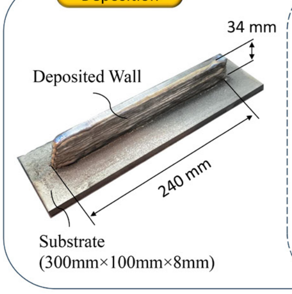


HARDNESS

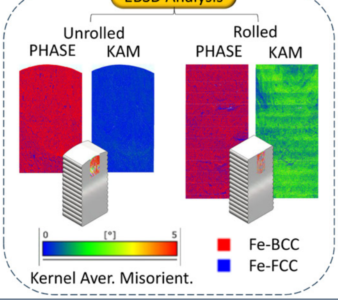


Results

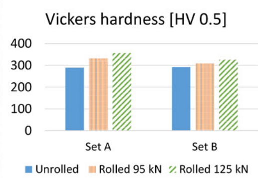
Deposition



EBSD Analysis



Hardness



Conclusion

- **Interlayer rolling during CW-GMA**
  - ✓ Effectively promotes austenite formation.
  - ✓ Significantly increases dislocation density in SDSS.
  - ✓ Greatly refine microstructure
- **Microstructural changes lead to:**
  - ✓ Enhanced strength and hardness.
- **In-process rolling is a promising strategy for**
  - ✓ Enhancing material properties od SDSS.

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Group project 6

Study on the impact of the composition of aluminium wire arc additive manufacturing (WAAM) deposit on hydrogen diffusivity

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Academic background

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Work experience

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>> Return to programme

Study on the impact of the composition of aluminium WAAM deposit on hydrogen diffusivity

Kowshik Ramachandran
Soroosh Cheraghzadeh
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Zhan Liu

Background

Hydrogen offers great potential for low-carbon energy, but its storage and transport are challenging due to diffusion in metals, reducing ductility and causing cracking. Aluminium alloys are promising for hydrogen containment due to their low density, corrosion resistance, and strong mechanical properties. In this context, Wire Arc Additive Manufacturing (WAAM) technology provides high deposition rates, cost efficiency, and suitability for large-scale aluminium components.

This project examines hydrogen diffusivity and absorption in aluminium alloys produced using WAAM, with a particular focus on the influence of alloying elements such as Sc & Mg on hydrogen diffusion characteristics in comparison to pure Al.

Aim & Objective

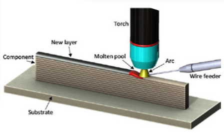
Aim: To investigate hydrogen diffusivity and absorption in aluminium alloys produced via WAAM, focusing on the effects of alloying elements like scandium and magnesium.

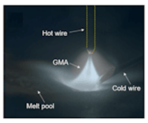
1. Review of hydrogen trapping mechanisms in aluminium alloys, including intermetallic compounds, solid solution effects, microstructural features, and mechanical trapping.
2. Manufacture aluminium alloys containing Sc and Mg using the WAAM process to explore both intermetallic and solid solution-based hydrogen trapping behaviours.
3. Analyse the variation in hydrogen diffusivity with different solute states (intermetallic vs. solid solution), and compare with pure Al under laboratory conditions.

Methodology

Manufacturing Process

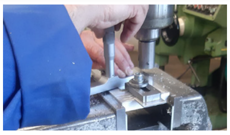
Adding Sc & Mg to Al alloy by WAAM (CMT and Pluse mode)





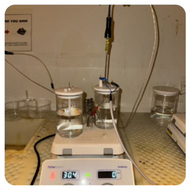
Sample Preparation

Machining the sample for testing as per ASTM G148



Testing Stage

Testing hydrogen diffusivity using a Devanathan cell

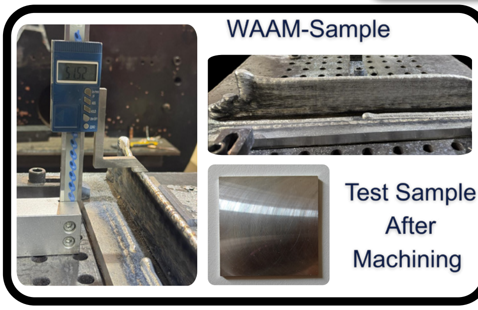


Analyzing Stage

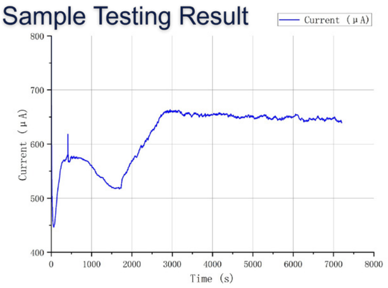
Composition by EDS & microstructure by SEM

Results

WAAM-Sample



First Sample Testing Result



Discussion

Literature review shows that adding elements like Sc and Mg affects hydrogen diffusion in aluminium alloys through intermetallic formation and solid solution strengthening. Compared to pure aluminium, these alloys alter hydrogen transport, suggesting improved potential for storage and transport. Experimental work is underway to further investigate hydrogen diffusivity in such alloy systems.

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Group project 7

Characterisation of coating system and optimisation of cure cycle

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Work experience

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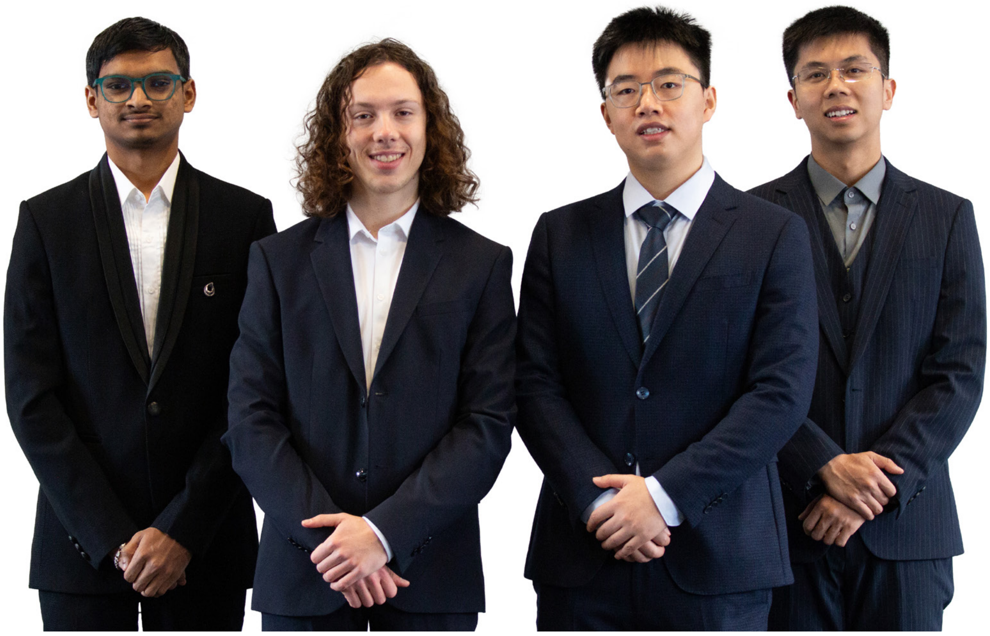

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>> Return to programme

Characterisation of Polymer Coating System and Cure Cycle

Mr. Wenjie Xie   Mr. Florian Du Reau De La Gaignonniere
Mr. Zirui Wang   Mr. Santhosh Kumar Ramireddy Chandrasekar

Background

With the increasing demand for high-performance insulation driven by advancements in electrical system towards higher frequencies, voltages, and miniaturisation, high-performance polymers have become preferred coating materials due to their excellent insulating properties. Current polymer resin systems, such as polyamide-imide (PAI), typically suffer from lengthy curing cycles, restricting their wider application for electric generators/motors.

Aim & Objectives

Aim: To reduce the curing time of polymer insulation while maintaining the electric and mechanical performance.

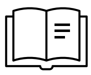
Objectives:

- Use thermal and chemical analysis to investigate the curing kinetics and chemical groups conversions during curing.
- Use electric and mechanical tests to observe how different processes influence the performance properties.
- Propose an alternative curing process.

Methodology

Planning & Requirements identification → **Curing kinetics analysis** → **Coating properties validation**


Gantt Chart


Literature Review


DSC


DMA

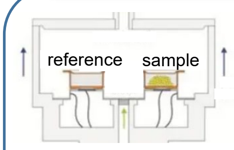

FTIR


Microscope

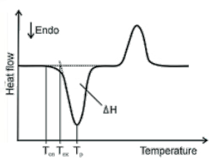

EIS


Adhesion tests

Curing kinetics

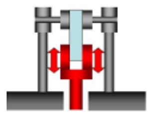


Schematic diagram of DSC

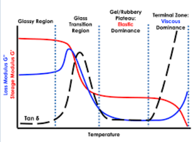


Schematic result of DSC

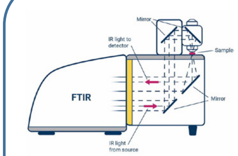
Reaction rates, transition temperatures, and reaction mechanisms


Tension with DMA

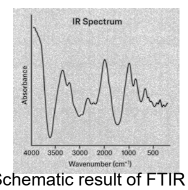
Viscoelastic behaviour and glass transition region



Schematic diagram of DMA result



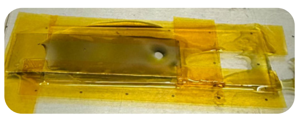
Schematic diagram of FTIR



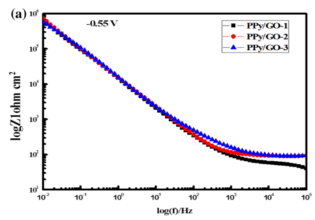
Schematic result of FTIR

Chemical bonds and functional groups

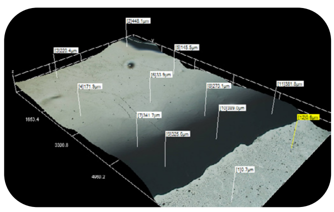
Coating Validation


Capacitor preparation for EIS

Dielectric properties: loss factor and dielectric constant



Bode plot of a typical polymer obtained with EIS


Hirox Micro sample Image

Microscope: defects' presence and thickness

Conclusion

- Glass transition temperature and degree of cure were successfully determined with DMA.
- Processing time can be influenced by soft cure and post-cure.
- Heatflow analysis (DSC) is masked by solvent presence.

Outlook

- Expand curing kinetic analysis with a shorter time and higher temperature (< degradation temperature).
- Investigate the effects of cure & post-cure on the adhesion & dielectric properties.
- Propose a process equal to or better than the current one.

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Group project 8

The game changing effect of graphene in the next generation of sustainable high-performance coatings

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This groups poster is confidential

Group project 9

The definition of circular economy design environment

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The definition of circular economy design environment

Mr. Cheng Chih Wu, Mr. Dhyanam Mehta, Mr. Shazeb Farzal, Mr. Vijay Anand Muruganantham

Background

OTT HydroMet develops meteorological solutions that need to be converted into smart and remanufacturable products.

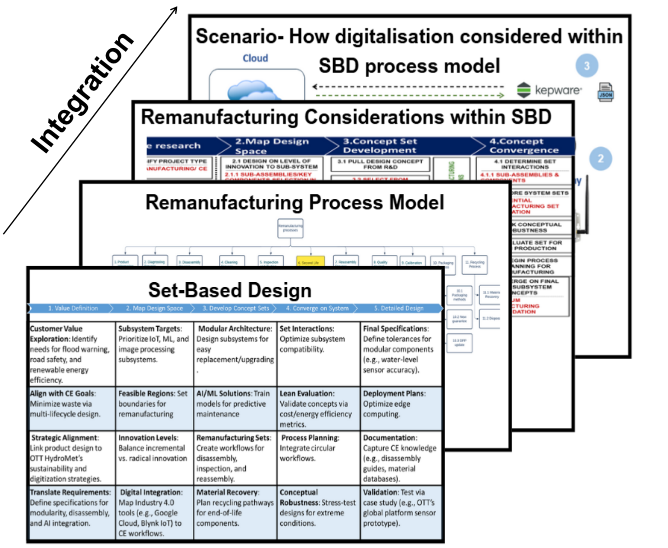
Aim

To define a Circular Economy Design Environment (CEDE) that supports multiple lifecycles of smart products by integrating AI and set-based design.

Objectives

1. Review circular economy practices.
2. Define Circular Economy Design Environment.
3. Case study validation.

Model for CEDE



IoT Framework

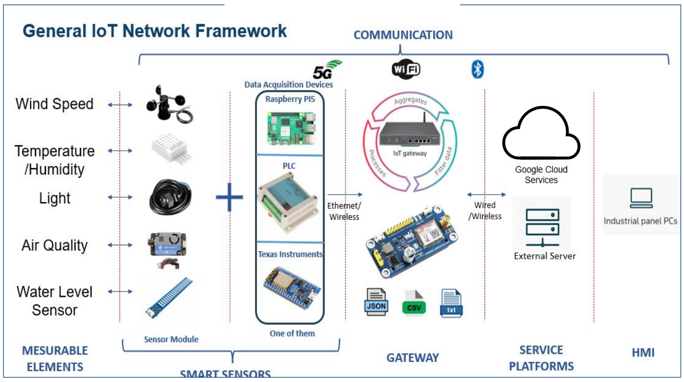
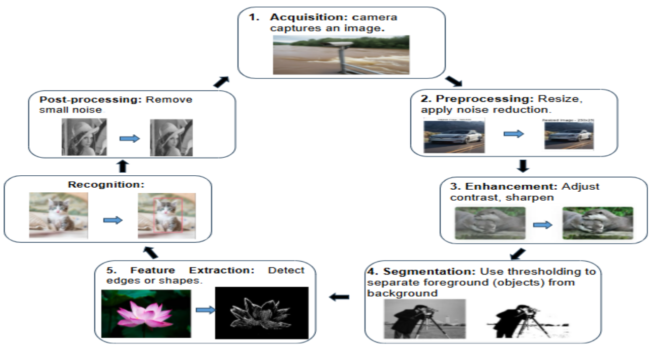


Image Processing Activities



Machine Learning(ML) Research Papers

Data-Driven Smart Agriculture: Use of AI/ML Technologies for Enhancing Crop Prediction - Islam et al., 2025

Algorithm	**Long Short-Term Memory Networks (LSTM)** **Auto-Regressive Integrated Moving Average (ARIMA)** **Support Vector Machine (SVM)**
Specific application	Crop Prediction, Yield Estimation, Crop Calendar Development.
Data processing	**Data Type**: Weather data, soil data, crop yield data, GIS data **Sources**: Reliable sources, satellite data, sensors **Format**: Normalized and cleaned data for machine learning model input **Input**: Raw weather data (temperature, rainfall, soil moisture), soil data, historical data **Output**: Crop suitability classification, weather predictions, yield estimates, planting recommendations.
How decision is made	How the ML application is making the decision.

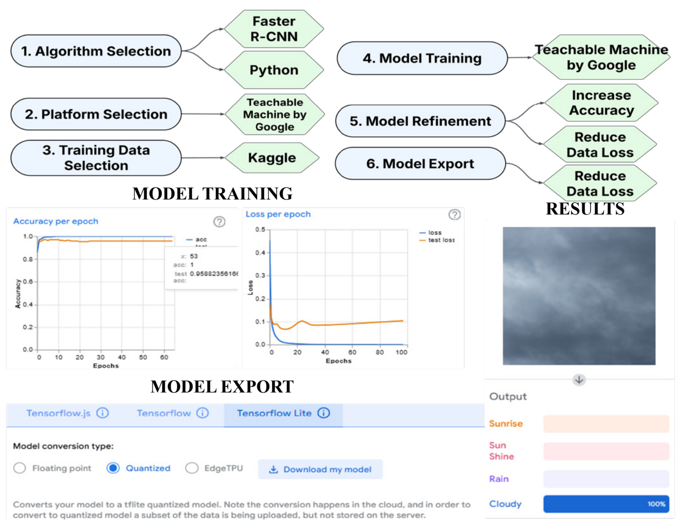
AI-Based Weather Monitoring System Using Faster R-CNN and IoT - Murugan et al., 2022

Algorithm	**Faster R-CNN** (Region-based Convolutional Neural Network): Used for image classification. Combines region proposal networks and convolutional layers to detect and classify weather conditions (sunny, rainy, etc.). Trained via the Teachable Machine platform.
Specific Application	Real-time weather monitoring and classification (sunny, rainy, etc.) using IoT and AI. Results displayed on the Blynk mobile app for users in agriculture, logistics, and disaster management.
Data Processing	**Data Type**: Images (JPEG/PNG). **Sources**: ESP32 camera module captures real-time images; pre-recorded videos converted to images. **Format**: Images pre-processed using filters, segmented to remove noise, and resized for input into Faster R-CNN. **Input**: Raw images; **Output**: Weather classification labels.
How Decision is Made	Faster R-CNN extracts features from input images, identifies weather patterns, and classifies them. Results are sent to the Blynk app via IoT for real-time display. Accuracy reported as 95–100% for trained images.

Automated Pest Detection with DNN on the Edge for Precision Agriculture - Albanese et al., 2021

Algorithm	**Modified LeNet-5, VGG16(**Visual Geometry Group **), and MobileNetV2 - Convolutional Neural Networks (CNNs) for pest detection**
Specific Application	Automated pest detection in apple orchards using pheromone-based traps, targeting codling moth detection.
Data Processing	**Data Type: Raw images** captured, **Sources**: camera **Sony IMX219,** **Format**: not mentioned, **Input**: Raw images from the sensor **Output**: Inference results (pest detection classifications).
How Decision is Made	Images pre-processed with sliding windows to extract ROIs. ROIs classified by LeNet-5 model Metrics: Accuracy, Precision, Recall, F-score

ML Application of Weather Prediction



Conclusion

a. The Circular Economy Design Environment will need the integration of several models including SBD, Remanufacturing, and Digitalization.
b. Integrating the digital considerations in CEDE will require a deep understanding and applications of various enabling technologies, such as IoT, ML, and Image Processing.

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Mr. Adrian Crawford

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Group project 10

The application of Internet of Things (IoT) network to enhance farming at Alaziziah Palm Tree Farm in Saudi Arabia

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>> Return to programme

The application of Internet of Things (IoT) network to enhance farming at Alaziziah Palm Trees Farm in Saudi Arabia

Ms. Freda Naa Ayorkor Otoo
Ms. Gabriella Marseglia
Ms. Giulia Sciannimanico
Mr. Olusolabomi Temowo

Background

Date palm farming is crucial to Saudi Arabia. However, current irrigation practices (100–150L every 2 days) cause overuse and high costs. Optimising irrigation with IoT can reduce waste, save diesel, and improve crop yield and quality.

Aim

Implement an IoT system to optimise irrigation at Alaziziah Farm and demonstrate its impact on cost, sustainability, and fruit quality.

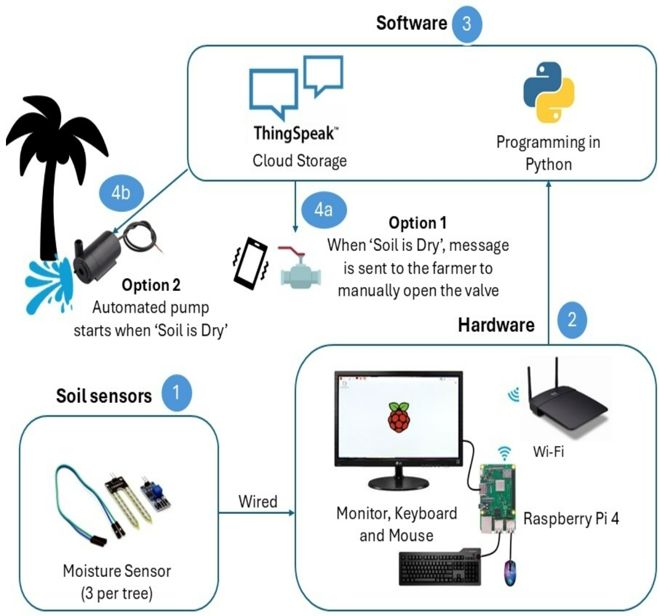
Objectives

1. Deploy IoT sensors to monitor soil moisture.
2. Optimise irrigation volume and schedule using real-time data.
3. Evaluate cost savings and farm-wide scalability.

Methodology

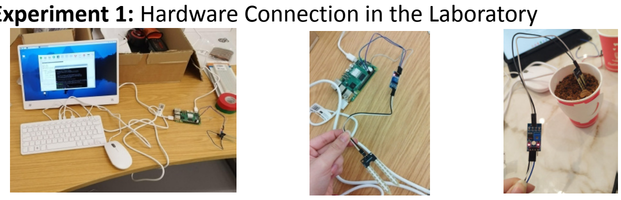
Literature Review → Definition of IoT Architecture → Implementation → Monitoring → Analysis and Calculations → Alerts and Automation

IoT Architecture

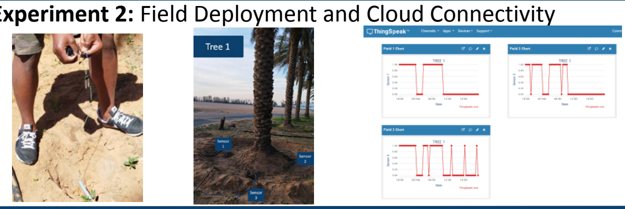


IoT Implementation

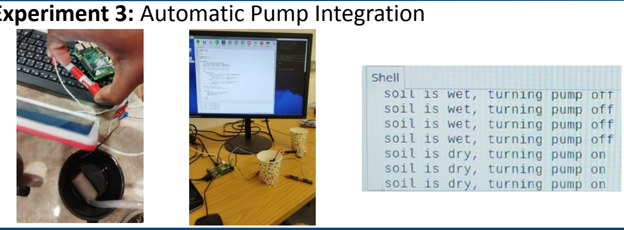
Experiment 1: Hardware Connection in the Laboratory



Experiment 2: Field Deployment and Cloud Connectivity

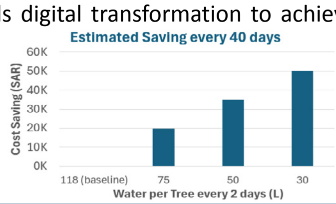


Experiment 3: Automatic Pump Integration



Conclusions

1. The IoT implementation has proven to be a good manner to monitor the soil moisture to decide the amount of irrigation.
2. The implemented IoT architecture is the first step towards digital transformation to achieve smart farming.
3. Real-time monitoring and accurate data helped to perform the mathematical calculation for water pump usage and rationalise the cost of its operations.



Future work

1. Scale the IoT system farm-wide.
2. Improve farmer data input of pump operations for accuracy and reliability.
3. Use consistent field data to refine cost models and irrigation algorithms.

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Industrial Supervisor: Abdulaziz Aljumaiah

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2025

ALAZIZIAHFARM.COM

Group project 11

AI-augmented cognitive agents for the next-generation workforce support in manufacturing

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Tengfei Yu

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AI-augmented cognitive agents for the next-generation workforce support in manufacturing

Qizhe Yang
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1 introduction

At present, the manufacturing industry faces challenges such as information asymmetry, cognitive burden and the need for rapid decision making. The project aims to develop a virtual agent called a Meta-level Cognitive Agent (M-LCA) to support the next generation workforce in manufacturing . Based on artificial intelligence and augmentation technologies, M-LCA aims to address the issues of information fragmentation and cognitive burden in manufacturing, improve decision-making efficiency and worker collaboration.

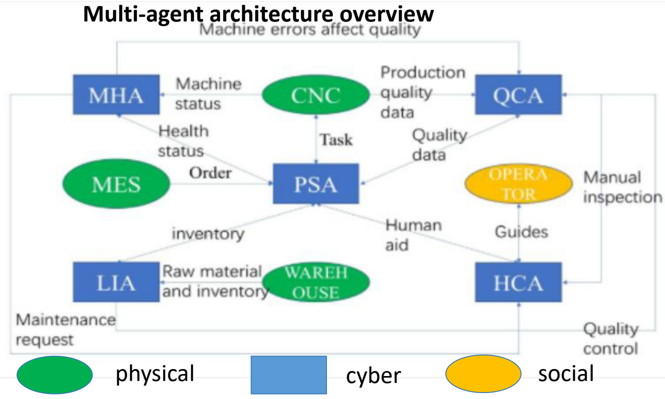
2 Aim and objections

Aim:
To develop a Meta-level Cognitive Agent (M-LCA) that integrates the physical-digital-social framework in manufacturing, reducing cognitive burden and enhancing decision-making efficiency through AI-driven strategies.

Objectives:
1. Defining Information Asymmetry: Analyzing information and intelligence gaps in manufacturing through the physical-digital-social lens.
2. Design M-LCA: Develop agents with domain knowledge by combining four reasoning modes and seven types of intelligence.
3. The M-LCA prototype, within the Physical-Digital-Social framework, reduces cognitive burden, speeds up decision-making in manufacturing.

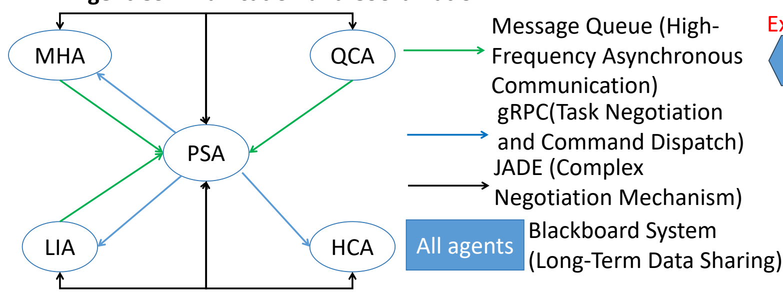
3 Research Methodology

Multi-agent architecture overview



MHA – Machine Health Agent (LSTM + Attention)
QCA – Quality Control Agent (YOLOv5 + CNN)
PSA – Production Scheduling Agent (GraphSAGE + A3C)
LIA – Logistics & Inventory Agent(XGBoost + Time Features)
HCA – Human-Machine Collaboration Agent (BERT + Intent Recognition + Task Recommendation)

Agent Communication and Coordination



4 System Implementation & Collaboration

Core Agent Functions

PSA: Dynamic scheduling & rework decisions (integrating orders, equipment status, and inventory).
MHA: Tool wear prediction (vibration/temperature monitoring) for maintenance planning.
QCA: High-precision defect detection (surface flaws, dimensional errors), with real-time CNC parameter adjustment.
LIA: XGBoost demand forecasting for JIT replenishment and urgent procurement (collaborating with PSA).
HCA: BERT-based instruction parsing + AR/voice assistance for emergency response and task allocation.

Collaboration

Communication:Message queue (async), gRPC (negotiation), JADE (conflict resolution), blackboard (data sharing).

5 Preliminary conclusion

1. Benefits of preliminary verification
2. The inevitability of technology integration
3.Key challenges and risks（Technology acceptance，Data Security and privacy）
4. Core needs of workforce transformation(Man-machine collaboration optimization)

Expanding human capabilities, not replacing them

6 Future work

Focus on the collaborative evolution of technology, application scenarios, ethics, and ecosystems by advancing key technologies like multi-modal interaction, edge intelligence, and dynamic knowledge graphs, while establishing ethical frameworks for data governance and human-machine responsibility to drive interdisciplinary integration and standardized ecosystem development.

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Group project 12

Application of blockchain for the aerospace supply chain

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Application of blockchain for the aerospace supply chain

Ms. Shubha Kunchitigara Palya Narasimhaiah, Mr. Clément Lambalieu,
Mr. Haochen Pan, Mr. Ashbel Antonio Rego

1 Background

- The Aerospace manufacturing supply chain involves complex logistics, multiple stakeholders and critical component tracking.
- Traditional tracking systems face challenges like inefficiencies & lack transparency. Blockchain addresses these challenges by providing a decentralized, immutable ledger for secure and verifiable data storage.

2 Aim and objectives

To develop a **blockchain network** for an **aerospace supply chain**, enhancing traceability, data security, and efficiency in **tracking critical components** key manufacturing and sustainability metrics.

1. Identify requirements of the aerospace supply chain
2. Develop a basic blockchain network to monitor the various stages of aircrafts panels manufacturing
3. Integrate IoT sensors to set up continuous monitoring

3 Methodology

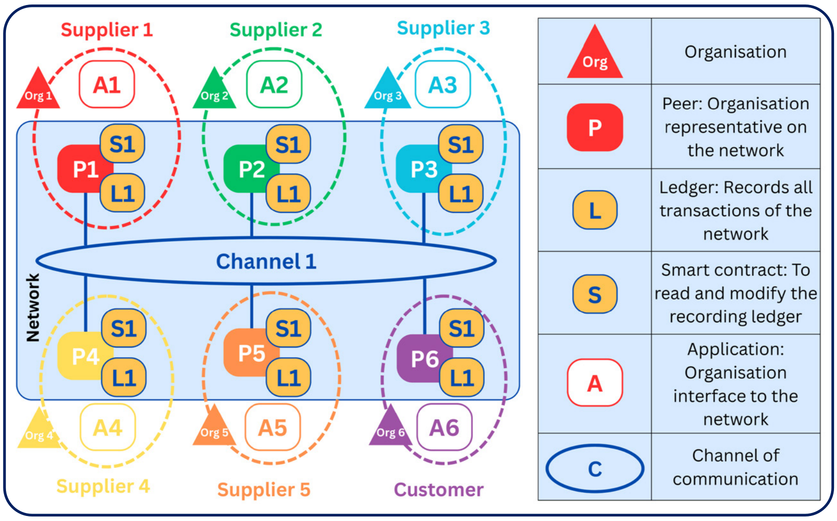
Understand blockchain principles → Literature review → Aerospace supply chain requirements → Blockchain network Proof-Of-Concept → Sensor-connected IoT network

4 Blockchain

<u>What is a Blockchain</u>?
A **decentralized**, **tamper-proof** digital **ledger** that **records transactions securely**.

<u>Benefits of blockchain in aerospace supply chain</u>

- **Real-time tracking**
- **Tamper-proof** records
- Builds **trust** between stakeholders
- **Counterfeit** elements detection

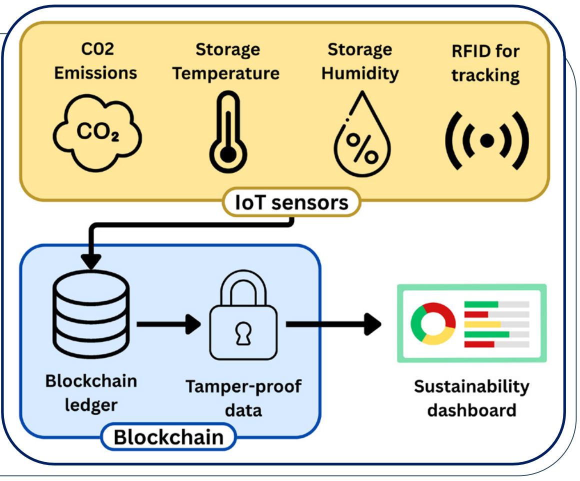


The developed network enables **any party** within the supply chain to **record components characteristics and movements**, and **consult the past data**, at any time.
All organisations **locally store** the ledger and smart contracts, **enabling consensus** between them, and **preventing tampering** of the data.

5 Sustainability and IoT

Sustainability Outcomes:

- **Facilitates circular economy**
  Trace and reduce wastes, reuse parts, recycle material
- **Emission tracking**
- **Quality compliance**
- Long-term business relations enhancing future actions towards sustainability



6 Conclusion

The developed proof-of-concept Blockchain network enables the final customer to **track securely** and **in real time the movement** and **sustainability metrics** of the ordered components.

Future Work

- Enhance stakeholder participation in the network proof-of-concept
- Scale up the network for commercial launch
- Develop a user-friendly interface for blockchain interaction and real-time data visualization

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Group project 13

Sustainable material supply in aerospace manufacturing: A feasibility study and lifecycle assessment

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Sustainable material supply in aerospace manufacturing: A feasibility study and lifecycle assessment

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Project Background

The aerospace industry is a major contributor to global greenhouse gas emissions. Traditional manufacturing relies on non-renewable materials and energy-intensive processes, necessitating a shift to **sustainable materials** (e.g., recycled aluminum, carbon fibre, bio-composites) to reduce ecological impacts.

Aim

Systematically review the current state of **sustainable material options** for aerospace manufacturing and evaluate their **environmental lifecycle impacts**.

Objectives

- Systematically evaluate **feasibility** of sustainable materials
- Develop **a lifecycle assessment (LCA)** model
- Propose actionable **improvement strategies**

Methodology

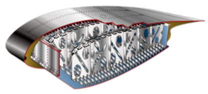
Systematic Literature Review → Component and Material Selection → Data Collection and Analysis → LCA Modelling → Propose actions

Systematic literature review: PRISMA 2020

Identification
- Journal articles, Conference proceedings, in English
- Scopus n = 1346
- Web of Science n = 315

Screening
- Databases combined, Duplicates removed → Records after duplicates removed n = 1661
- Keyword and abstract screened → Records after keywords and abstract screened n = 511

Included
- Full text review → Records included after full text review n = 460



Aircraft Wing Skin

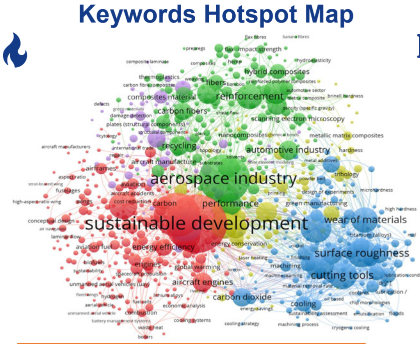
Aluminum AA2050
VS
CFRP T800S/3900-2B

Cradle to grave Life Cycle Analysis

- Goal & Scope Definition
- LCI - Inventory Analysis
- LCIA - Impact Assessment
- Interpretation

Preliminary Results

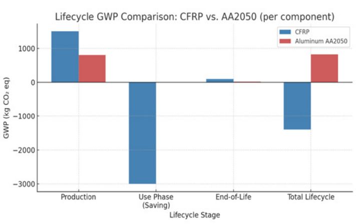
Keywords Hotspot Map



Material Research

Material Category	Specific Material Names	Number of articles	Main Application Areas	Sustainability Advantages
Recycled Metals	Recycled Aluminium	161	Fuselage structure, skin	Reduces primary bauxite mining (5-10% energy vs virgin Al)
Advanced Alloys	Al-Li alloys (AA2050/2099) , Ti-6Al-4V	138	Wings, frames, engine parts	Lightweight (3-5% density reduction), fuel savings
Synthetic Composites	CFRP, GFRP	115	Primary structures (B787), interior panels	High strength-weight ratio; recycling challenges
Bio-based Composites	Flax/bamboo+ epoxy, PLA-based	37	Interior components, storage	Biodegradable; needs fire/moisture resistance improvements
Nano-enhanced	Graphene-Al, CNT-Mg alloys	9	Bearings, thermal protection	Enhanced performance; high cost

LCA Results



Initial Conclusions

- CFRP and recycled metals offer lower environmental impact than conventional materials.
- The LCA model revealed clear differences in material sustainability.
- CFRP scores well, with significantly lower carbon emissions in the use phase, and ecotoxicity.

Future Scope

- More research is needed on the durability and mechanical strength of sustainable materials.
- LCA models can be improved using company level data inputs on detailed components like wing skins.
- Future studies can guide the industry toward greener material choices

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Group project 14

Dynamic sustainability assessment of aerospace manufacturing processes

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Dynamic sustainability assessment of aerospace manufacturing process

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Background

- The aerospace manufacturing industry is facing significant challenges to reduce environmental impact and improve resource efficiency.
- Traditional life cycle assessment (LCA), which is often static, makes it difficult to capture dynamic changes and complex interactions in manufacturing systems.
- Dynamic Life Cycle Assessment (DLCA) integrates simulation modeling to simulate the dynamic behavior of manufacturing systems in real time to more accurately predict long-term sustainability performance.

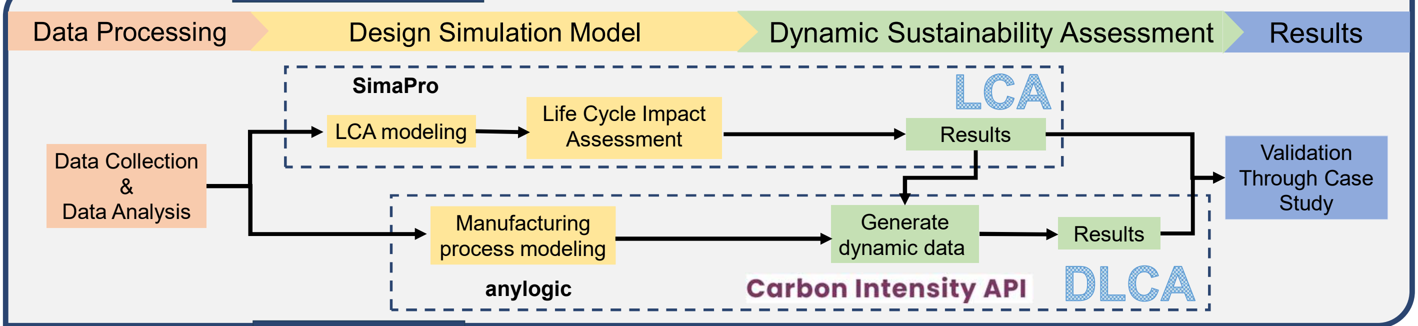
Aim

To develop and validate a simulation-based dynamic sustainability assessment model specifically tailored for aerospace manufacturing processes.

Objectives

- Critically review current research and identify gaps in dynamic sustainability assessment methods within manufacturing.
- Develop an integrated framework combining LCA with dynamic simulation modeling techniques.
- Validate the developed model through a practical aerospace manufacturing case study, with the objective of assessing its effectiveness.

Methodology



Results

In this project, a DLCA simulation of the shot peening process during the manufacturing of an aircraft wing panel was carried out. As shown in Fig. 1, the whole process flow of the panel was first modelled in SimaPro, including main sub-processes, IP, CP, PS, Fs, etc. As shown in Fig. 2, the midpoint impact results were then calculated in Simapro.

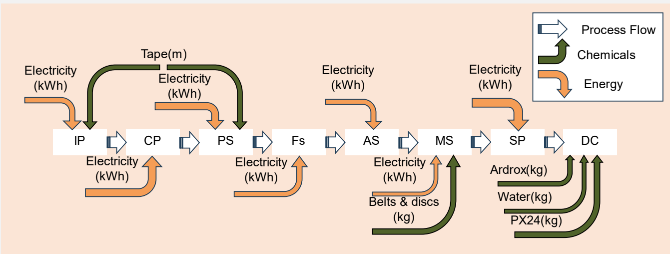


Figure 1. Manufacturing process material flow

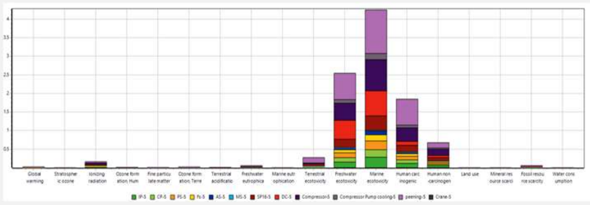


Figure 2. Midpoint impact results

By importing both LCA data and time-dependent UK carbon intensity emission data into the dynamic simulation framework (Fig. 3), this approach enables the analysis of CO_2 emissions over time.

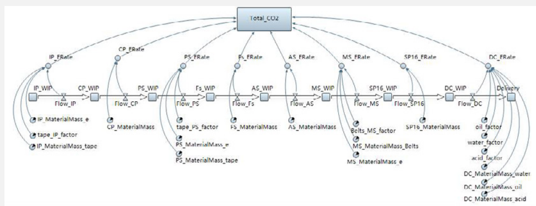


Figure 3. Anylogic modeling diagram

Conclusion & Future work

This research develops an integrated assessment framework that combines LCA with System Dynamic simulation modelling and validates the effectiveness of the developed model through real aerospace manufacturing case studies. In future work, this research may enhance the framework by automating data integration by connecting Simapro with Anylogic to create a more convenient and fast dynamic sustainability assessment system.

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Group project 15

Evaluating the environmental and economic implications of aluminium manufacturing techniques

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Environmental and economic analysis of different aluminium manufacturing techniques

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Background

Aluminium is widely used in industries such as aerospace and automotive due to its lightweight and high durability. However, its production can be energy-intensive and environmentally impactful.

This project evaluates Investment Casting, Sand Casting, and Die Casting processes using C355 and A357 aluminium alloys, highlighting environmental and economic trade-offs in energy use, waste generation, and cost efficiency.

Aim & Objectives

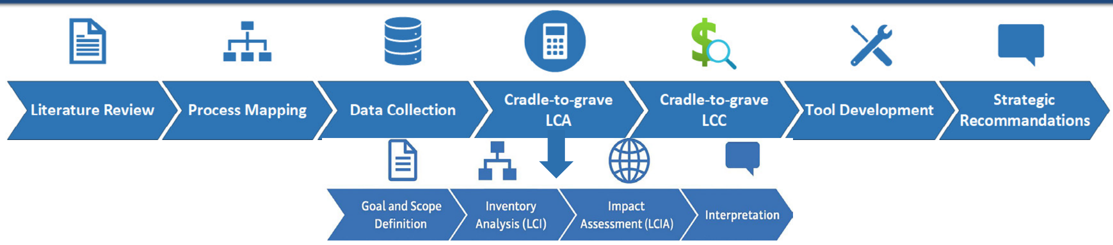
Aim:

A Life Cycle Assessment based evaluation of the environmental and economic impacts of Investment Casting, Die Casting , and Sand Casting using C355 and A357 aluminium alloys with focus on energy consumption, emissions, and key sustainability factors.

Objectives:

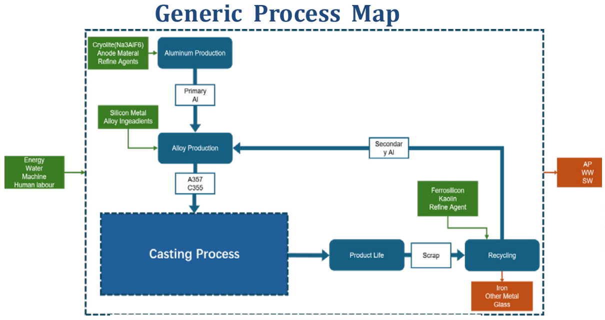
- Develop detailed process maps for investment casting, sand casting, and die casting of aluminium alloys C355 and A357.
- Perform a cradle-to-grave life cycle assessment to evaluate and interpret the environmental impacts per 1kg of final cast product.
- Analyze the total life cycle costs including raw materials, energy consumption, processing efficiency, and waste management across the three casting processes.
- Propose optimization strategies to reduce emissions, improve energy efficiency, and minimize costs in aluminium casting processes.

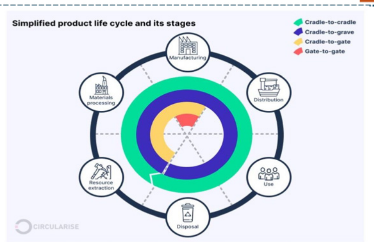
Methodology



Preliminary Results

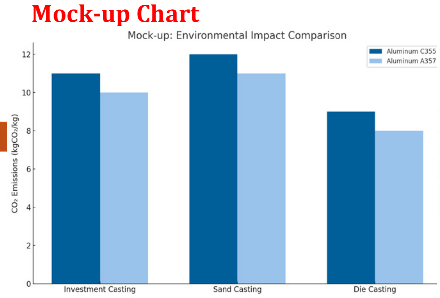
Generic Process Map



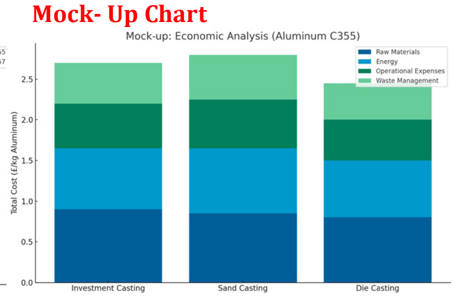


Visualisation of a simplified product life cycle and its stages.(A. Shah, N.R. Baral, A. Manandhar, 2016)

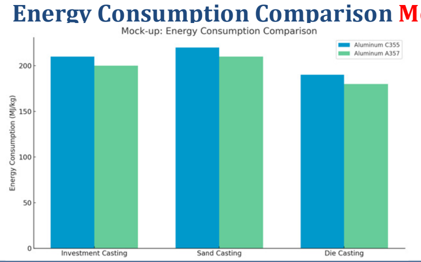
Environmental Impact Comparison Mock-up Chart



Economic Analysis (Aluminium C355) Mock- Up Chart



Energy Consumption Comparison Mock- Up Chart



Preliminary Conclusion

- A cradle-to-grave LCA and LCC of 1kg A357 and C355 aluminium alloy products are done to analyze different casting methods.
- An analytical tool is developed in excel to quickly showcase the environmental and economical influence of specific conditions.
- Optimization strategies are proposed to help reduce the environmental impact and increase the economic cases of Al alloy casting.

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Group project 16

Optimising energy efficiency in induction melting at Brockmoor Foundry: A data-driven and ML-aided approach

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Optimising energy efficiency in induction melting at Brockmoor Foundry: A data-driven and ML-aided approach

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Background

Energy efficiency in metal melting is a critical challenge in foundry operations, particularly for SMEs like Brockmoor, a UK-based green sand-casting factory specialising in spheroidal grade iron. **High energy consumption** in induction furnaces is influenced by **multiple process variables**, including superheat temperature, charge material quality and furnace power. Understanding how these **factors interact** is essential for **optimising energy use and reducing costs**. This project applies a **Design of Experiments (DoE)** approach to systematically analyse the **impact of key melting parameters on specific energy consumption (SEC).**

Aims & objectives

The main **aim** of this study is to develop a **data-driven approach** to improve metal melting at Brockmoor Foundry.

Objectives:

- Identify the critical **key performance indicators** (KPIs) for metal melting.
- Investigate the **factor impacts** and **interactions** affecting this process.

Methodology

PRISMA Method: Systematically collected research papers to identify relevant studies.

Filtering Process Variables: Applied the XY Matrix Method to rank and filter down to a few critical parameters.

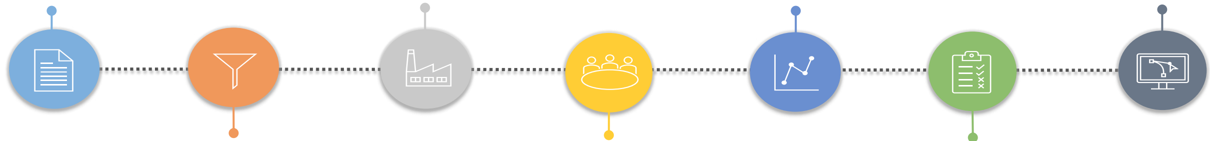
Company Visit & Process Observation: Visited Brockmoor Foundry to observe processes, ask questions and validate research findings.

AHP Analysis: Collaborated with company experts to prioritise the most critical variables and validate the literature review.

Six Sigma & DoE: Collected and analysed data to optimise process performance.

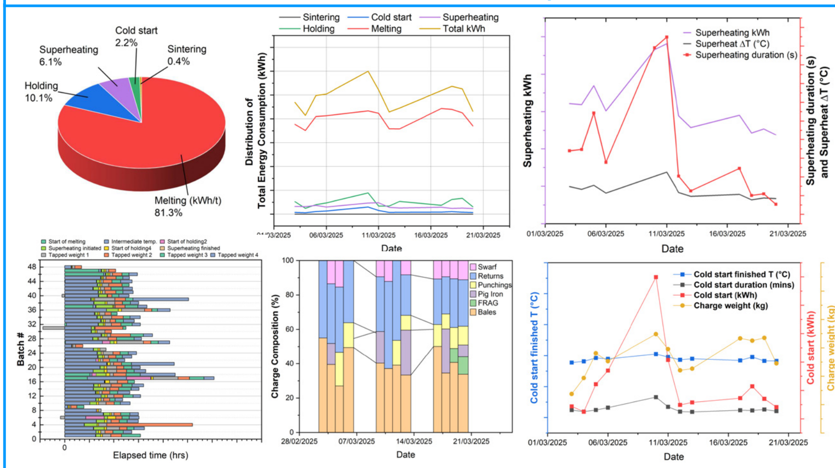
Optimisation & Validation: Examined factor interactions and assessed the impact on energy efficiency.

ML Algorithm Development: Prepared the fundamentals to a Machine learning predictive model.



Results

Parameter Effect Study



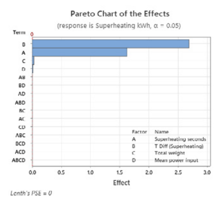
DOE Analysis

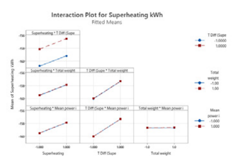
Factor	Low Level (-1)	High Level (+1)	Units
Charge Material	-1	+1	kg
Superheat Temperature	-1	+1	°C
Furnace Power	-1	+1	MW
Charge % Composition	-1	+1	%

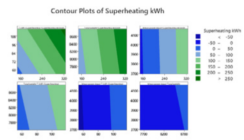
Factor	Low Level (-1)	High Level (+1)	Units
Superheating duration	-1	+1	s
T Diff (Superheating)	-1	+1	°C
Total weight	-1	+1	kg
Mean power input	-1	+1	kW

Regression Equation in Uncoded Units

Superheating kWh = -158.7
+ 0.8113 SH duration
+ 1.342 T Diff + 0.01510 Total weight
+ 0.007400 Mean power input
+ 0.000008 SH duration*T Diff







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Group project 17

Develop the manufacturing-readiness level of a stroke rehabilitation medical wearable device

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This groups poster is confidential

Group project 18

Novel aluminium casting processes for sustainable aerospace manufacturing

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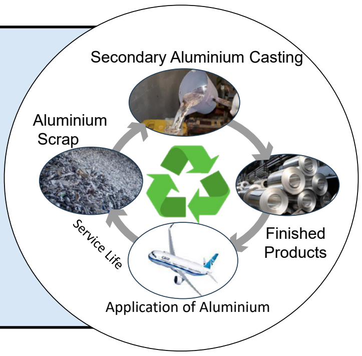
Novel aluminum casting processes for sustainable aerospace manufacturing

Hongsen Qiu, Joel Colaco, Kewei Fu, Kishan Gowda, Yifan Hu

Background

Recycled aluminum use in aerospace is limited due to diminished mechanical properties. Also, traditional casting methods not only consume significant energy but are susceptible to introducing impurities leading to defects. This research explores sedimentation as a sustainable method to improve casting quality.



Aim & Objectives

Aim: To develop a refined aluminum recycling method for sustainable use in aerospace applications.

Objectives:

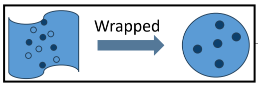
- Study flow and inclusion behavior.
- Study the effect of liquid flow temperature on inclusion sedimentation.

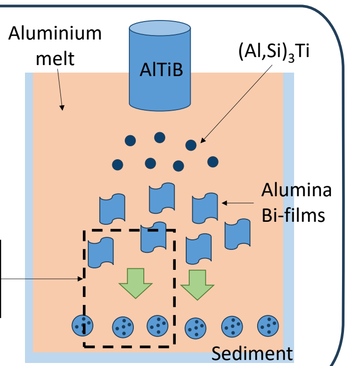
Methodology

Literature review → CFD Modeling → Simulation → Analyze Results & Conclusion

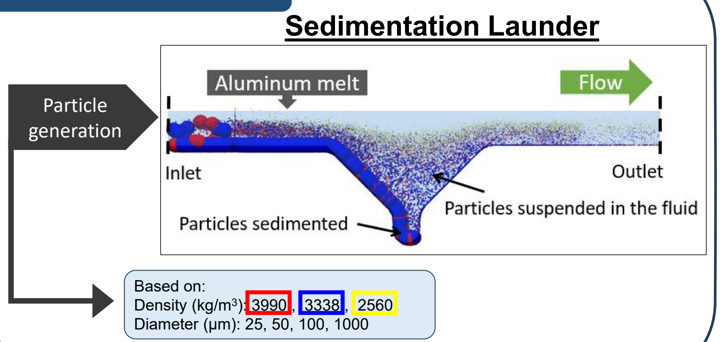
Research Content

Schematic shows the sedimentation process of bi-films





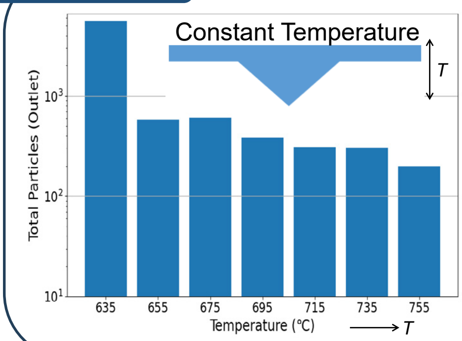
Simulation

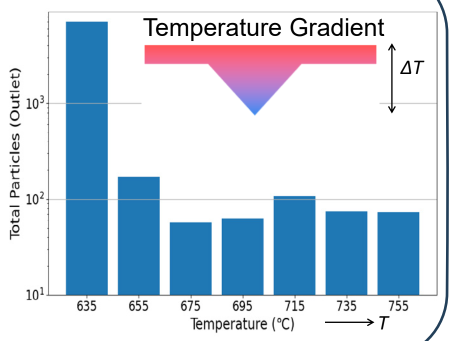


Key Findings

- Sedimentation increases with increasing fluid temperature.
- Sedimentation increases with thermal gradient.
- Promising pathway towards sustainable aero-castings.

Results





Innovate UK – ATI: Ultra Clean CAST Digital Liquid Metal Manufacturing

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Group project 19

Recycling aerospace alloys: Enabling the production of Ti6Al4V wires from recycled feedstock

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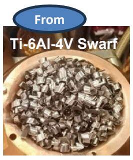
Recycling aerospace alloys: Enabling the production of Ti-6Al-4V wires from recycled feedstock

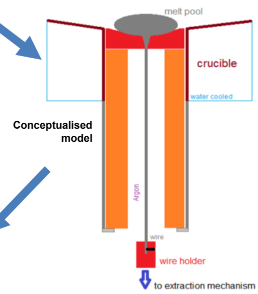
Aiwen Lu, Anvesh Sriramaiah, Shivaprasad Jayaram, Zhengdong Li

BACKGROUND

1) **Ti-6Al-4V** is a high-performance alloy with properties beneficial for applications in many sectors
2) **wires** used in **additive manufacturing** for aerospace and medical applications.
3) **continuous casting** of molten Ti-6Al-4V into wire offers a **sustainable** near-net-shape process with **reduced waste** and process time

From





To

AIM

To enable the direct production of wires for additive manufacturing from Ti-6Al-4V alloy machining waste (swarf) as a source material for high-quality feedstock in the aerospace manufacturing sector.

METHODOLOGY

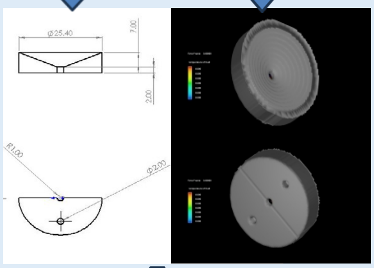
Literature Review	Mould Design	CFD Simulations
Continuous casting process, Manufacturing Process CFD Simulations	(SolidWorks) Suction Casting Centrifugal Casting	(FLOW 3D) Casting simulation

OBJECTIVES

1. Review technologies for Continuous casting process.
2. Assessing the results of processes.
3. Create 3D CAD models for the moulds.
4. Perform CFD simulations to investigate the design and the process.
5. Optimisation for design and process parameters.

DESIGN → EXPERIMENT → SIMULATIONS

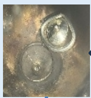
Mould Design → Model for simulation



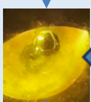
ARC MELTING

Arc melting to understand continuous casting process

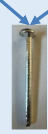
Using lead-free solder alloy as test case (lower melting point)



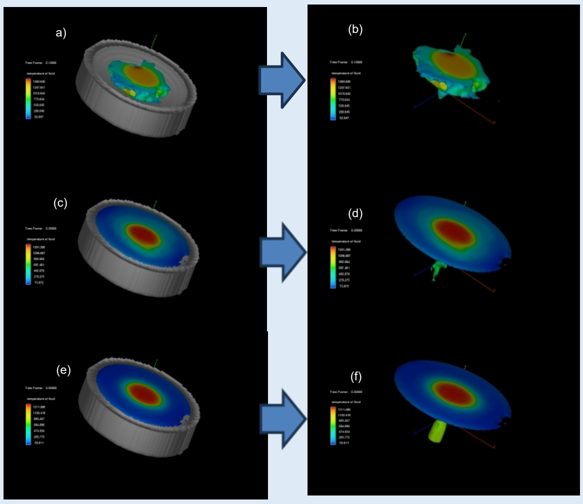
Solder material placed in crucible



Arc melting process



5 mm rod (thick wire) from solder



PRELIMINARY CONCLUSIONS

1. Flow strongly dependent on properties of the materials (Ti-6Al-4V, solder) and their properties (viscosity, surface tension, melting point, ...)
2. Discontinuous flow of molten metal was observed
3. Surface defects and incomplete rods/wires resulted from the experiments
4. Location of melting and casting needs to be separated
5. CFD simulations provided insights towards achieving a continuous flow

Future

- from gravity casting to continuous wire casting
- improved control of heat gradients throughout the process
- achieving thermal gradients naturally
- possibility of coated moulds to achieve suitable thermal gradients
- develop and test different extraction mechanisms

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION

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Group project 20

The application of set-based concurrent engineering within lean agile product development process model at Atlas Copco

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>> Return to programme

The application of set-based concurrent engineering within lean agile product development process model at Atlas Copco

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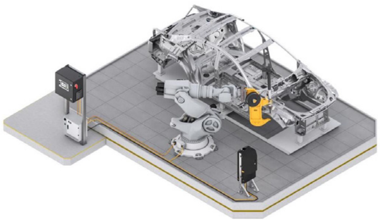
Anirudh Arun Durg

Adarsh Swayajith Elamplavil

Salman Ayedh Alqahtani

Background

Atlas Copco aims to improve the product development process by implementing smart Lean Product Development within an agile framework.



Aim

Designing an Air-Tube Interface by applying Smart Lean Agile PD Process Model and Generative AI CAD, driven by data analysis to ensure consistent rivet delivery and maximise air efficiency.

Objectives

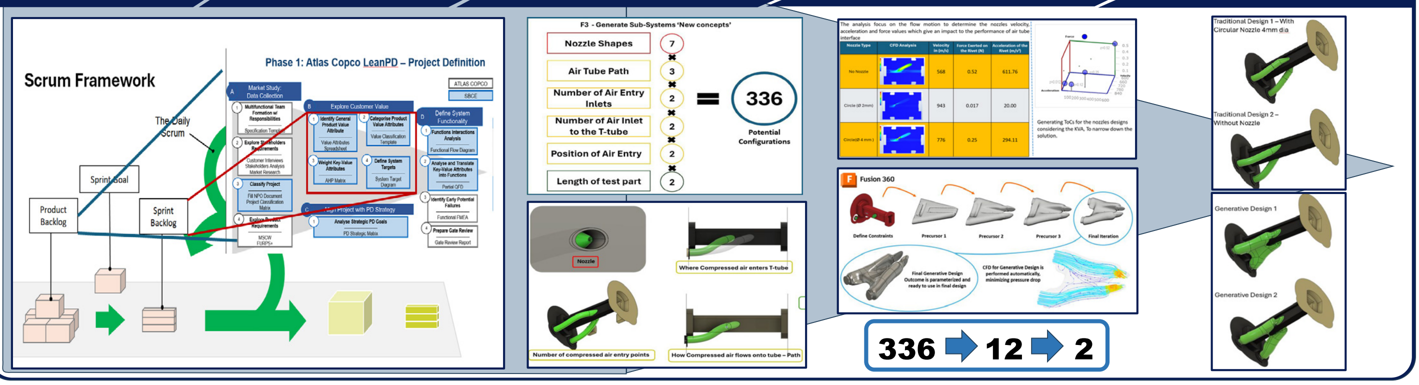
1. Generate alternative Air-Tube Interface designs to enhance airflow and energy efficiency.
2. Optimise input parameters to achieve consistent rivet delivery while reducing air consumption.

Research Methodology

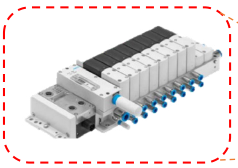
- Brain storming
- Literature Review
- Defining Scrum Framework
- Computer Aided Design
- Generative Computer Aided Design
- Computational Fluid Dynamics
- Generate Trade off Curves
- Analysis of Tested Parameters
- Identify The Most Influential Parameter
- 3D Printing & Testing

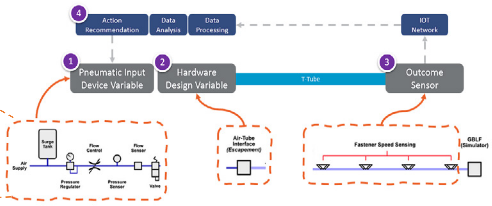
Smart Lean Agile PD implementation of the Air-Tube Interface

1. Define Value → 2. Map Design Space → 3. Develop Concept Sets → 4. Converge on Systems → 5. Detailed Design

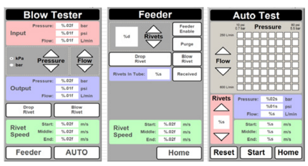


Data Analysis





The FESTO VTEM IoT terminal controlled air pressure, mass flow rate, and blow time to the system. Trade-off curves were applied to determine parameter settings for consistent rivet delivery and reduce air consumption.



Conclusion

1. The Lean Agile PD model helped to produce quality alternative design solutions of "Air-Tube Interface" that being tested at the company facilities.
2. The Generative AI CAD from Autodesk "Fusion 360" has demonstrated to be good tool to support the generation of the design solutions with CFD simulations but limited to components level.
3. The Trade-Off Curves has been used for data modelling of pneumatic parameters to enable consistent rivet delivery while maximising air efficiency.

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Group project 21

Improving the efficiency of boarding operation at airports by agent-based modelling and simulation

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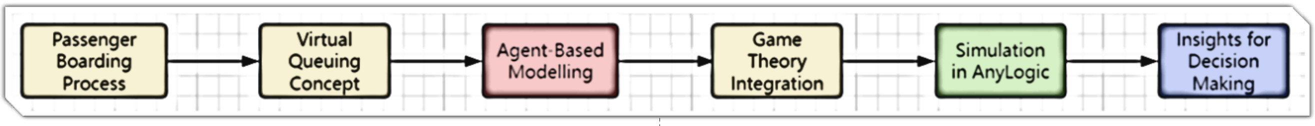
>> Return to programme

Improving the efficiency of boarding operation at airports by agent-based modelling and simulation

Shiyun Wang   Haihang Chen   Dehai Guan   Linli Yang

Introduction & Aim



WHY Boarding Efficiency Matters?

- Reduce turnaround time
- Minimise delays & congestion
- Improve passenger experience
- Enhance airport operations

WHY Agent-Based Modelling (ABM)?

- Simulates individual behaviours
- Reflects real-world interactions
- Scalable & flexible
- Supports data-driven decisions

Project Aim

- Simulate boarding with ABM in AnyLogic
- Use Game Theory to model decisions
- Apply Virtual Queuing to optimise flow
- Identify efficient boarding strategies

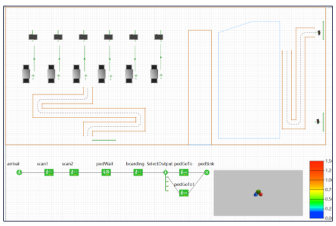
Innovation

- Integrate Virtual Queuing into ABM
- Behaviour-focused simulation
- Insights for sustainable operations

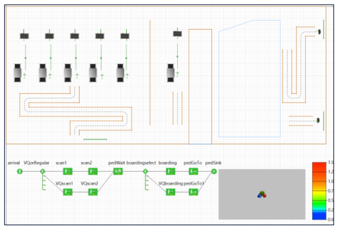
Methodology & Result

Build Agent-Based model

Develop an agent-based airport boarding model and simulate it to reduce queue congestion and enhance boarding efficiency.

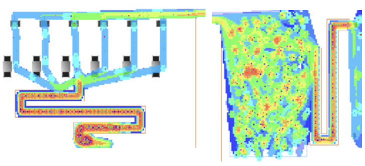


Regular Model

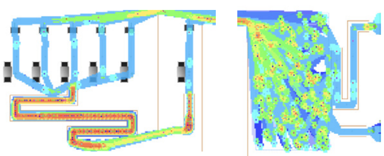


Application of VQ model

Results



Regular Security Check & Boarding



VQ Security Check & Boarding

Conclusion

It is evident that the application of VQ has improved the queueing situation for security checks and boarding

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Group project 22

Application of Hardide chemical vapor deposition (CVD) tungsten carbide coatings for carbon capture and storage (CCS)

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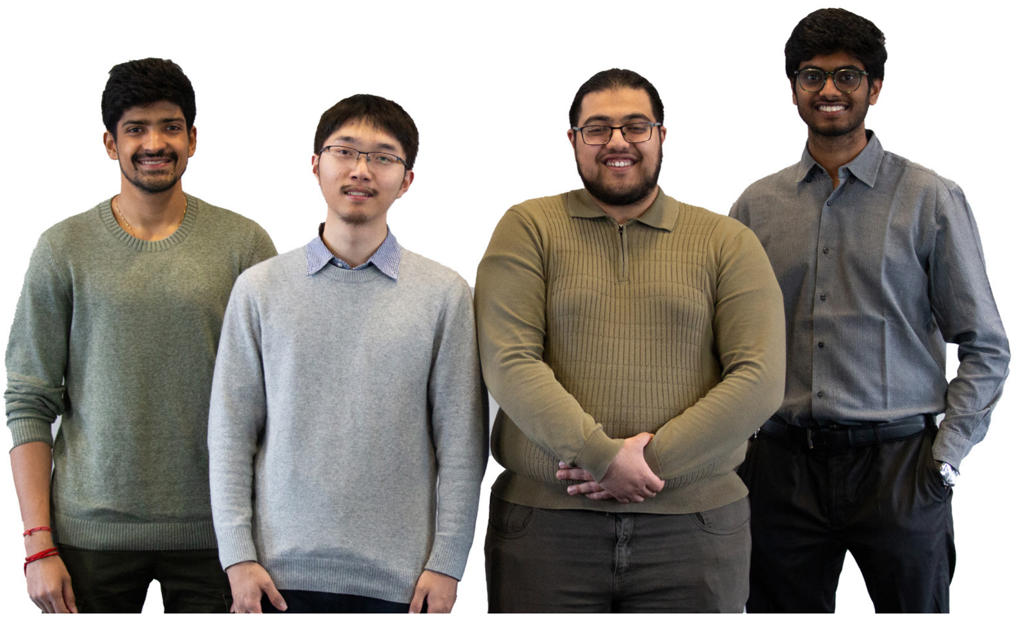

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Application of Hardide chemical vapor deposition (CVD) tungsten carbide coatings for carbon capture and storage (CCS)

Mr Abdurrahmaan Akhtar, Mr Arun Kumar Marimuthu, Mr Shivnarain Ravichandran, Mr Xincheng Gu

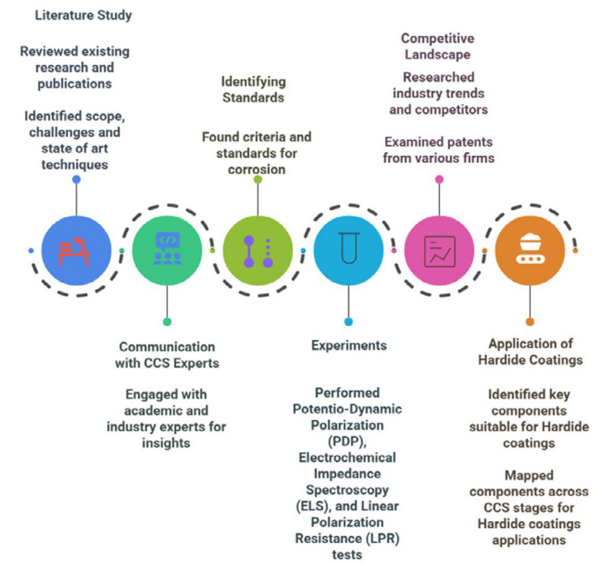
Research Background and Motivation

Carbon Capture and Storage (CCS) is crucial for reducing industrial CO_2 emissions, with significant UK government investment supporting its development. Critical components in CCS can face corrosion and degradation. Hardide's coating could extend their lifespan of these components, minimizing maintenance time and costs.

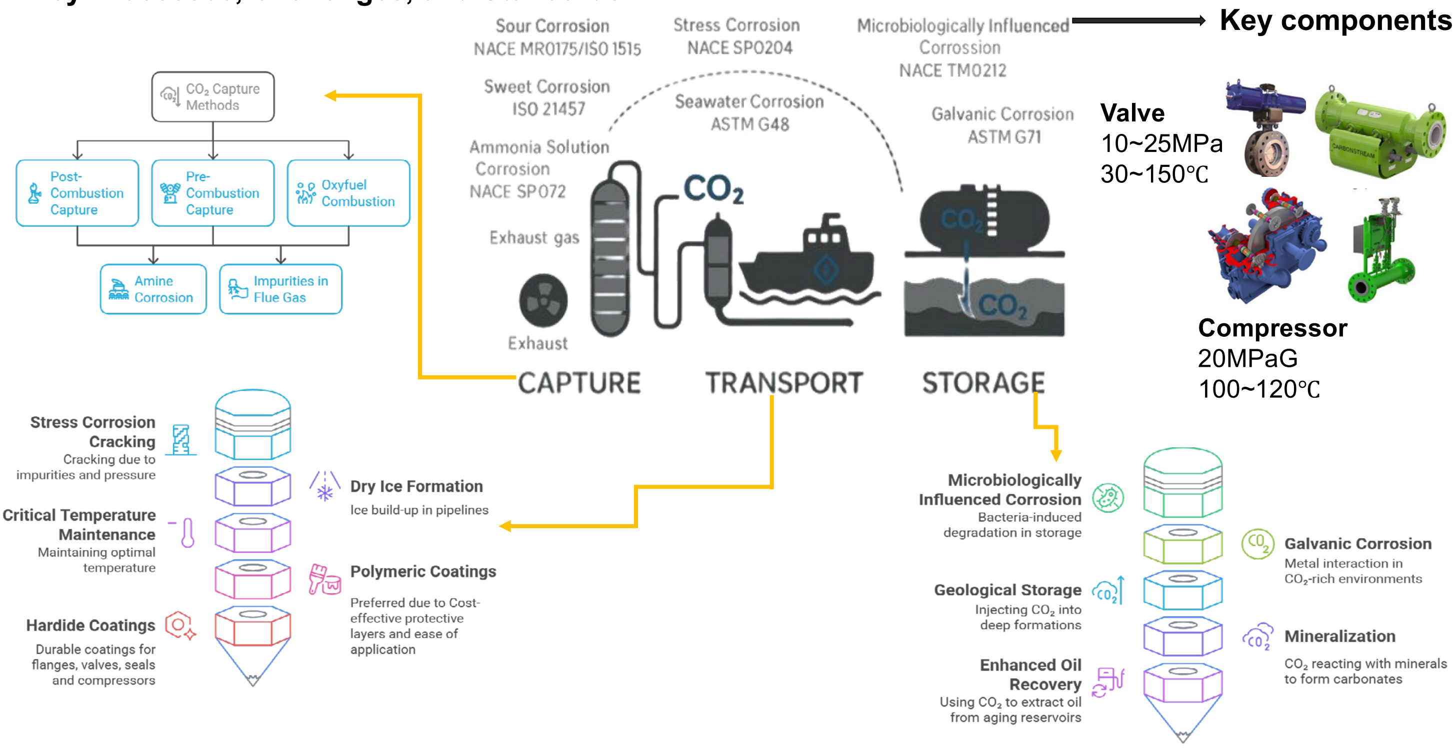
Project Aim and Objectives

- **Main Aim:** Conduct an in-depth feasibility study of Hardide's CVD tungsten carbide coating to assess its applications in Carbon Capture and Storage (CCS).
- **Objectives:**
  - Identify critical components in CCS where CVD tungsten carbide coatings may be advantageous.
  - Review standards and testing requirements for materials selection and qualification in CCS.
  - Recommend potential entry points for Hardide into the CCS market.

Research Methodology



Key Processes, Challenges, and Standards



Conclusions and Recommendations

- ❑ Hardide Coatings are ideal for CO2 transport – compressors, valves, and storage.
- ❑ Focus on proven CCS processes – CO2 compression and transportation.
- ❑ Explore industry collaborations – for future CCS applications.

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Group project 23

High-performance, lithium-free, Rare Earth-Free batteries using recycled aerospace-grade aluminium

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>> Return to programme

High-performance, lithium-free, Rare Earth-Free batteries using recycled aerospace-grade aluminium

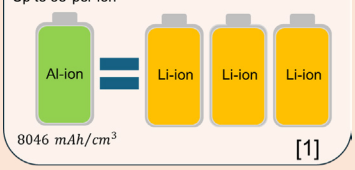
Ms. Shwetha Ramaswamy, Mr. Heshitha Dewmee Kariyawasam Paranavithana, Mr. Luca Caruso, Mr. Pol Argelich Abad

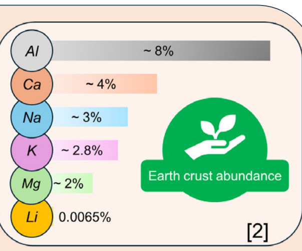
13 Al 26.98 Aluminum

Background

Higher energy density and capacity

Up to 3e⁻ per ion





No thermal runaway → No fire hazard

- One of the most recycled metals → around 75% of produced Al is still utilised today [3]
- Recycled Al saves nominally up to 95% of the energy needed to make new aluminium [3]

Aim & Objectives

Aim: To assess the technical feasibility of replacing high purity Al (99.99%) anodes with commercially pure Al (99%) and Al alloys in Al-ion batteries (AIBs)

Objectives:

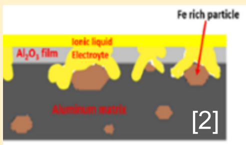
1. Review the effect of impurities and alloying elements in Al & selection of alloys of interest
2. Evaluate materials' characteristics and surface preparation strategies such as electropolishing
3. Confirm the effect of electropolishing
4. Evaluate the electrochemical characteristics of selected Al grades in comparison to high purity Al (99.99%)

Methodology

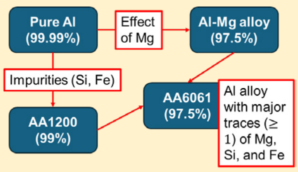
Literature review & Al-alloys selection → **Material characterisation** → **Surface preparation** → **Electropolishing optimisation** → **Electrochemical testing** → **Design rules & recommendations**

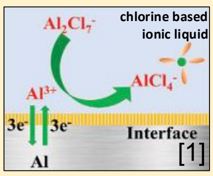
Literature Review & Al-alloys selection

- Unlike other metal anodes, Al forms a particularly stable natural oxide film on its surface which affects anode reactions during charge and discharge [1,4]
- A main impurity in alloyed Al is iron (Fe). This precipitates as intermetallic phases (Al_3Fe) in the Al matrix and induces localized corrosion which weakens the oxide layer and eases electrolyte's access to the substrate [4]



- Alloyed Al can suppress formation of a dense oxide film → Literature reports AIBs with Al-Mg alloy anode showing longer life than those with pure Al anode [1]



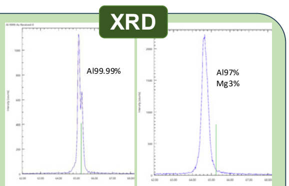


At the **anode**: $Al + 7AlCl_4^- \leftrightarrow 4Al_2Cl_7^- + 3e^-$

Material characterisation

Coherence correlation interferometry (CCI)
- Surface Topography

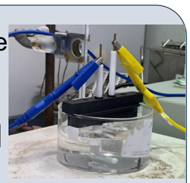
X-ray diffraction (XRD)
- Phase Identification
- Crystallinity
- Residual Stress



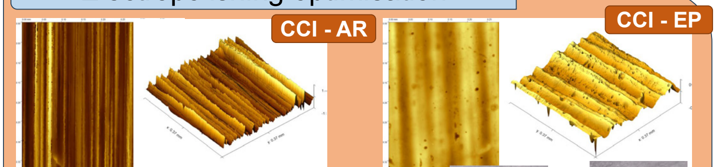
Surface preparation: electropolishing

→ Aims to remove surface Al oxide and reduce the intensity of active sites for enhanced ions exchange, boosting reversibility of electrochemical reactions at the anode [1,5]

→ *Ethaline* was used as the electrolyte

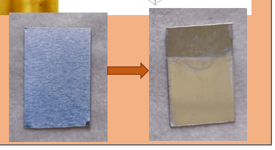


Electropolishing optimisation



→ Surface roughness improved

→ Quality of the electrolyte is affected by usage: process performance degrades after 4hrs



Electrochemical testing

Linear Sweep Voltammetry (LSV) ↔ **Electrochemical Impedance Spectroscopy (EIS)** ↔ **Cyclic Voltammetry (CV)** → **Stripping/ plating**

- LSV: Passivation; Electrochemical stability window
- EIS: Impedance
- CV: Cell conditioning; Redox peaks; Cycle performance
- Stripping/plating: Material removal & deposition efficiency

References

1. https://doi.org/10.1002/adma.202102026
2. https://doi.org/10.1016/j.pmatsci.2024.101322
3. https://www.aluminum.org/Recycling
4. https://doi.org/10.3390/ma16030933
5. https://doi.org/10.1002/elan.202100669

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Group project 24

Investigation of dry contact stiction/wear in Stellite 31 turbine blade dampers

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>> Return to programme

Investigation of dry contact stiction/wear in Stellite 31 turbine blade dampers

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Background

Siemens Energy manufactures A-35 industrial gas turbines. Future advancements in fuels and materials aim to enable operation at higher temperatures. To tackle wear and oxidation challenges, solutions are being explored to meet evolving consumer demands.

Objectives

The project aims to:
- Identify the underlying wear mechanism occurring in an HP gas turbine between the blade and damper and use external factors to provide evidence.
- Create a timeline of the wear mechanism.
- Propose recommendations and solutions to reduce the wear.

Methodology

1. Literature review
2. Identification of the damaged areas and wear mechanisms
3. Surface elemental analysis
4. Cross-sections analysis
5. Discussion of the findings

Results

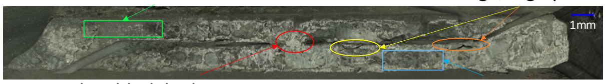
DAMPER

Material: Stellite 31

Confocal micrographs

Pressure side

Undamaged area = low contact point | Material breakage, high plasticity areas



Material welded, high-pressure point | Stellite 31 loss

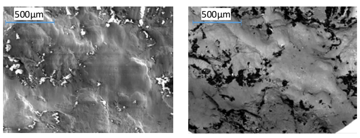
Suction side

Vertical marks from material rubbing | Stellite 31 loss

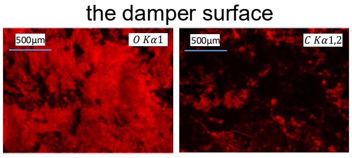
Undamaged area = low contact point

SEM/EDS

- Al, Ti, and Pt particles on the surface which are CMSX-4 elements.
- Al-Pt coating materials from the blade are regularly present.
- Presence of O superior to 15wt% is possible evidence of oxide formation
- C presence (above 15wt%) can be evidence of carbide formation or fuel contamination



(left) SE and (right) BSE image of the damper surface



(left) O (right) C map surface

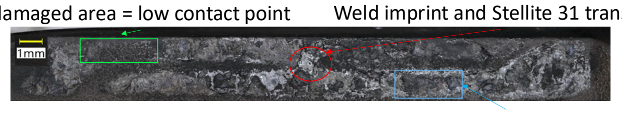
BLADE UNDER-PLATFORM

Material: CMSX-4 with Pt-Al coating

Confocal micrographs

Pressure side

Undamaged area = low contact point | Weld imprint and Stellite 31 transfer



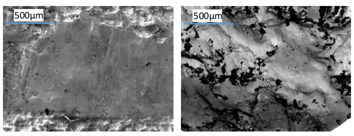
Stellite 31 deposit according to EDS

Suction side

Vertical marks from material rubbing | Stellite 31 deposit according to EDS

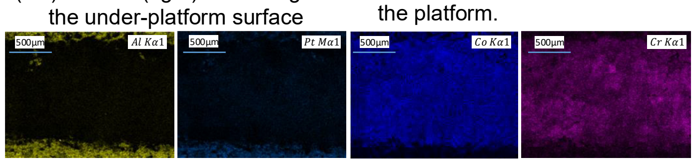
Undamaged area = low contact point

SEM/EDS



(left) SE and (right) BSE image of the under-platform surface

- Al-Pt coating present in untouched areas
- Presence of Cr above 8wt%, Co above 19wt% in the worn areas.
- Hence, the material is transferred from the damper to the platform.



(From left to right) Al, Pt, Co, Cr maps of a defect area of the blade

Next steps & conclusions

Confocal microscopy showed an inhomogeneous contact between the under-platform and damper surface with heavier wear on the pressure side. As confocal microscopy and EDS analysis underline material transfer occurs between the damper and the blade under-platform, adhesive wear is highly probable. The next experiments will look for further evidence of adhesive wear.

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Group project 25

Utility-scale battery energy storage system monetisation and optimisation

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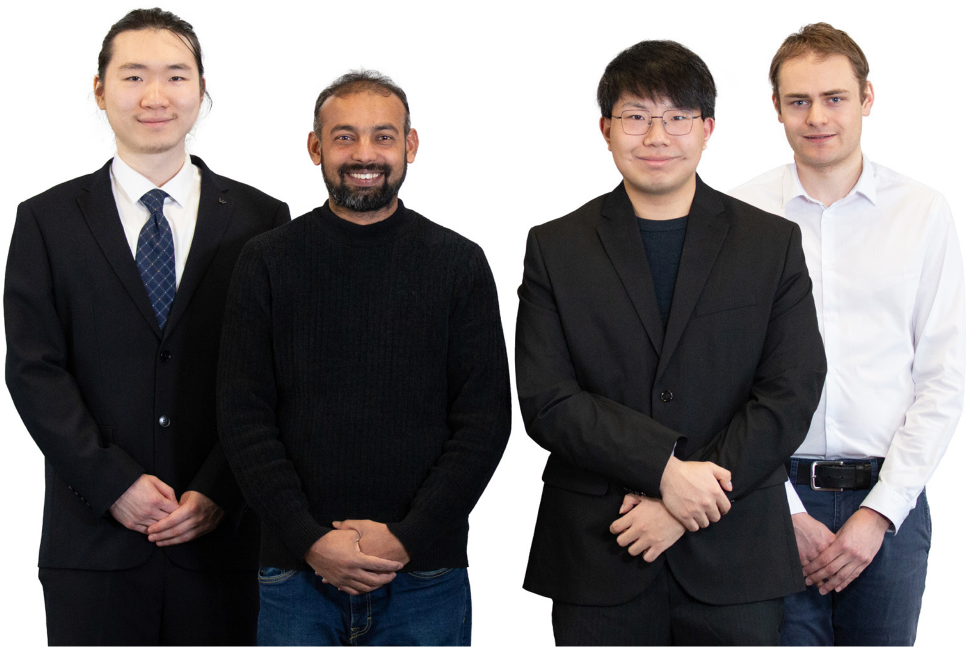

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>> Return to programme

Utility-scale battery energy storage system monetisation and optimisation

Gaël Bourroux, Yimin Shen, Zhicheng Fan, Muhammad Shahid Latif

Background

Wind and solar are projected to supply 68% of global electricity by 2030. Their intermittency poses a challenge, necessitating solutions like utility-scale Battery Energy Storage Systems (BESS), which store energy and release it when demand requires, thus ensuring grid stability. Moreover, BESS offer significant revenue opportunities, which include arbitrage (buying electricity at low prices and selling at high prices) and ancillary services (maintaining supply-demand balance via frequency regulation). However, these opportunities vary across jurisdictions, due to distinct market structures and regulations. This study addresses optimisation challenges and identifies the optimal country in terms of BESS investment potential.

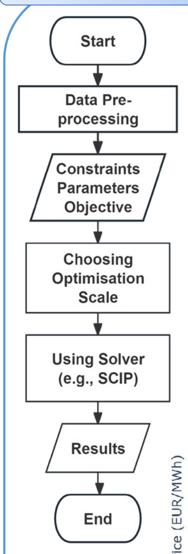
Aims and Objectives

Aim: To identify the most promising country for BESS investment among selected candidates, and to provide insights into operational optimisation for enhanced revenue generation.
Objectives: 1. Compare BESS revenue opportunities across various countries; 2. Assess and rank country investment potential; 3. Develop Python programs to estimate revenue; 4. Provide insights into further optimisation and engage with the community to get better results.

Methodology

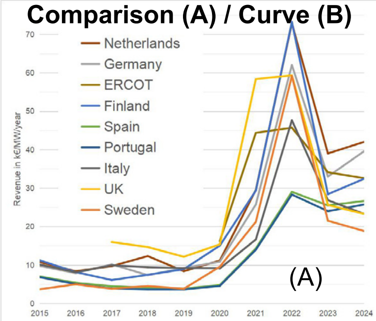
PRISMA Systematic Literature Review → BESS Revenue Criterion Establishment → Data Retrieval for Selected Countries → Data Processing by Optimisation Program → Decision Making Using Analytical Hierarchy Process (AHP) → Framework for Future Work for Stakeholders → Kaggle Challenge to Engage Community

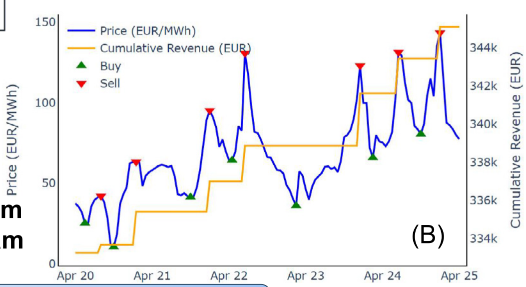
Results



Block Diagram of the Program

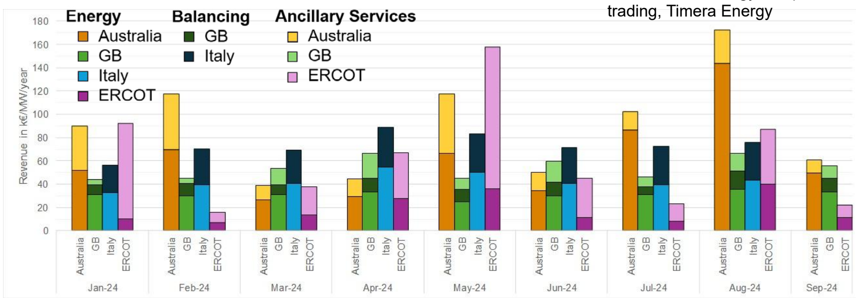
Day-ahead Market Revenue Comparison (A) / Curve (B)





Revenue Breakdown across the Selected Regions

Data Sources: Modo Energy, Enspired trading, Timera Energy



The AHP Matrix

Results in %	Netherlands	Germany	ERCOT	Spain	Italy	Finland	Portugal	UK	Sweden	Australia	Korea
Day-ahead market	16	15	12	10	9	12	10	9	7	0	0
Balancing market	34	22	6	4	10	7	8	5	1	4	0
Ancillary services	14	3	4	16	14	17	8	4	16	3	0
Current mix	12	12	13	12	6	7	12	10	7	8	1
Forecast mix	10	10	7	11	9	8	12	11	9	11	2
BESS expansion	7	26	25	7	10	1	1	12	2	10	0
Public incentives	13	8	13	5	3	13	13	5	8	13	8
FINAL SCORE	15.3	14.0	11.4	9.4	9.1	9.1	8.9	8.2	7.2	6.4	1.2

Key Takeaways

- Participation in wholesale market (day-ahead and intraday) generates only minor part of the total revenue, while ancillary services would be more promising.
- Optimisation algorithms are critical. Typical algorithm includes Mixed Integer Linear Programming (MILP).
- Mix of generation, estimated expansion, and policies are also important factors to consider.

Conclusion and Future Work

- Based on our comparative analysis, the Netherlands emerges as the most favourable country for BESS investment, followed by Germany and the ERCOT region in Texas, USA.
- Further research will explore the integration of multiple revenue streams to enhance the operational strategies of BESS.

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Group project 26

Feasibility study on the use of heterogeneous swarm robotics for railway inspection and maintenance

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>> Return to programme

Feasibility study on the use of heterogeneous swarm robotics for railway inspection and maintenance

Yiming Bin, Runhan Li, Wenrui Xiang, Haixiang Ma, Zhuyan Zhang

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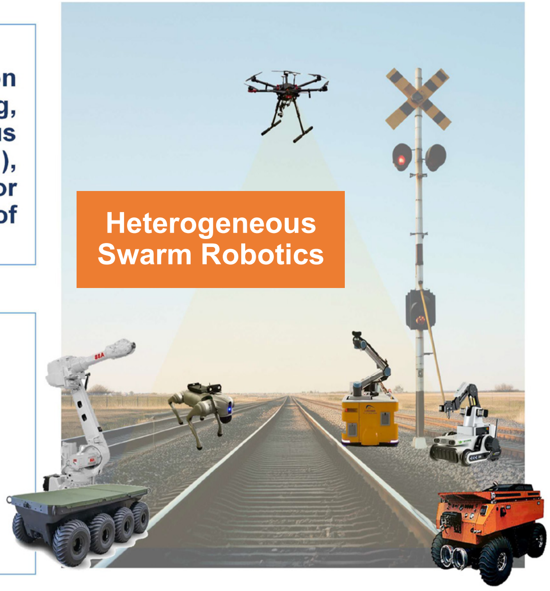
Background

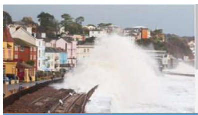
Traditional railway inspection and maintenance mainly depend on manual work and fixed schedules, which could be time-consuming, costly, and ineffective. With the rapid advancement of autonomous technologies(robotics arms, drones, quadrupeds, small crawlers, etc.), it is possible to use heterogeneous swarm robotics as a viable tool for modern railway inspections and maintenance, to achieve new levels of railway industry efficiency.



Objectives

1. **Identify the challenges associated with deploying heterogeneous swarm robotics in railway environments.**
2. **Develop a conceptual framework for the coordinated operation of diverse robotic systems.**
3. **Assess the feasibility of Heterogeneous Swarm Robotics Method through TRL-based standard.**
4. **Provide system simulations to support the feasibility.**

Methodology



Flood Scenario

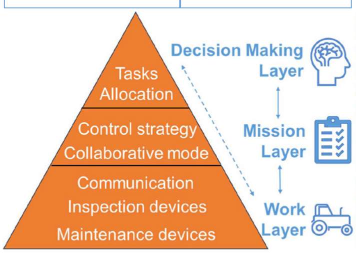
Task allocation

Collaborative Control

Swarm robots Execution

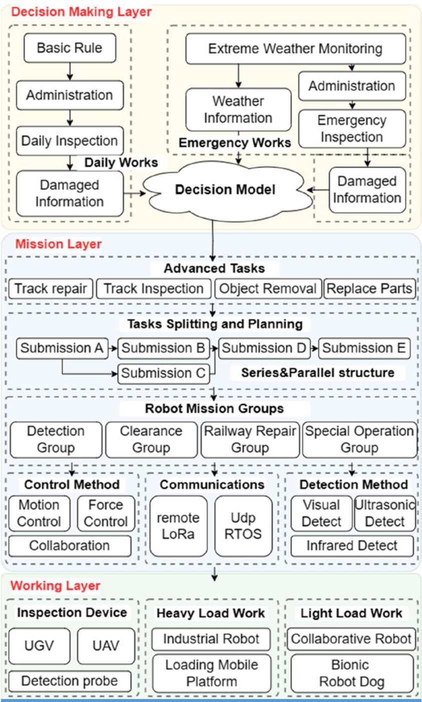
TRL&KVA Feasibility Evaluation

TRL Criteria	KVA Criteria
Performance	Academic Development
Engineering	Industrial Implementation
Operation	
Value & Risk	



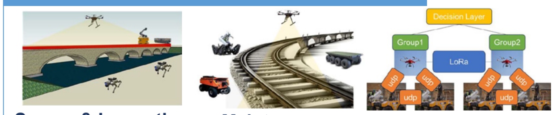
Heterogeneous Swarm Robots System: Brief Architecture

Results



Robotics System Framework

Task Analysis & Technology selection



Survey & Inspection — Maintenance — Communications

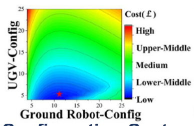
Simulation

Flood Severity

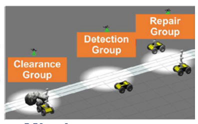
Multi-tasks

Robot Group Configuration

Total Costs



Configuration-Costs Optimization



Mission process Simulation

Feasibility Analysis

System analysis: TRL3

Performance Readiness

Simulations can be conducted. based on designed framework.

Engineering Readiness

Mechanical properties and life need to be further developed.

Operation Readiness

Robot groups can only finish tasks with specified instructions.

Value & Risk

Robot system can reduce manual work but may be less robust.

Technical analysis: KVA

Algorithm Type	Academic	Industrial
Ruled-based	5	3
Optimization	3	3
DRL	3	1
Communication	5	3
Multi-robots' Collaboration	3	3
Drones	5	3
Industrial Robot	5	5
All-Terrain Unmanned Vehicle	4	3
Quadruped Robot	3	2

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Group project 27

Implementing reliability centred maintenance to drive efficiencies within maintenance

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This groups poster is confidential

Group project 28

Smart predictive maintenance: Leveraging Internet of Things (IoT) for enhanced equipment reliability

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