Virtual Lab: Immersive VR Onboarding Experience for ERIL's DIME Labs

Project Proposer:	Dr. Ing. Joseph Zammit[1], *joseph.zammit@um.edu.mt, Department of Industrial and Manufacturing Engineering*
Main Supervisor(s):	Dr. Ing. Joseph Zammit, *joseph.zammit@um.edu.mt, Department of Industrial and Manufacturing Engineering*
Problem Background:	Extended Reality (XR) technologies, are revolutionizing the way we interact with digital content, merging the physical and virtual worlds to create seamless, immersive experiences. These technologies are particularly impactful in educational and industrial settings where they can transform traditional methods of learning and training. In the context of manufacturing, the rapid advancement of Industry 4.0—characterized by automation, data exchange, and manufacturing technologies—demands a workforce that is not only skilled in physical operations but also adept in digital competencies. Traditional onboarding and training methods often fall short in preparing new employees for the complexities of modern manufacturing environments, which are rich in technology and require a high level of interaction with digital systems. Thus the application and adoption of VR technologies within educational training and the local manufacturing industry is of increasing importance. The scope of this project is to investigate, the use of this technology and identify the potential adoption to facilitate onboarding and training within manufacturing settings.
Project Objective(s):	• Conduct a literature review on VR technology in manufacturing and virtual learning environments. • Explore the technical requirements and potential applications of VR in workplace training. • Design and develop a prototype VR onboarding experience for new RSOs and students within ERIL DIME Labs. • Evaluate the effectiveness of the VR experience in terms of user engagement and knowledge retention. • Document the development process and findings in a comprehensive project report.
Project Resources:	• **Equipment/Software:** Access to VR hardware and software development tools provided by [University Name]. • **Literature:** Access to existing research and publications available through university resources.
Industrial Partners involved:	• N/A
Expected Project Deliverables:	• A comprehensive literature review on VR in learning and manufacturing. • A fully developed VR onboarding module for DIME Labs. • Evaluation results of the VR experience with participants. • Final report detailing the project scope, development process, results, and recommendations for future improvements.

[1] Project proposer should be an academic form the Faculty of Engineering. This individual should also be listed as supervisor or co-supervisor.

Student background / interest:	• Digital Manufacturing • 3D modelling • Process Improvement; • Interested in manufacturing processes; • Information Communication Technology • Virtual Reality technology and tools.
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Augmented Training: AR Onboarding Solution for ERIL's DIME Labs.

Project Proposer:	Dr. Ing. Joseph Zammit[2], *joseph.zammit@um.edu.mt, Department of Industrial and Manufacturing Engineering*
Main Supervisor(s):	Dr. Ing. Joseph Zammit, *joseph.zammit@um.edu.mt, Department of Industrial and Manufacturing Engineering*
Co-supervisor (if any):	
Problem Background:	With rapid advancements in digital technologies, traditional training methods are increasingly inadequate for preparing new employees in complex, tech-rich environments. Augmented Reality (AR) offers a transformative approach by integrating digital information into the physical workplace, enhancing learning through interactive and engaging experiences. This project focuses on leveraging AR to improve onboarding and training processes at ERIL's DIME Labs, providing hands-on interactions and simulations that align with modern industrial needs. Thus the application and adoption of AR technologies within educational training and the local manufacturing industry is of increasing importance. The scope of this project is to investigate, the use of this technology and identify the potential adoption to facilitate onboarding and training within a manufacturing settings.
Project Objective(s):	• Conduct a literature review on AR applications in onboarding and training, focusing on its benefits and technological integration. • Explore AR's technical requirements and potential for enhancing training in industrial settings. • Design and develop a prototype AR onboarding solution tailored for new RSOs and students at ERIL's DIME Labs. • Evaluate the effectiveness of the AR solution in enhancing engagement, knowledge transfer, and retention. • Document the development process and findings in a detailed project report.
Project Resources:	• **Equipment/Software:** Access to AR development tools and hardware, provided by the university. • **Literature:** Utilization of research publications available through university resources.
Industrial Partners involved:	• N/A
Expected Project Deliverables:	• A comprehensive literature review on the use of AR in training and its impacts on learning and engagement. • A fully functional AR onboarding module for ERIL's DIME Labs. • Testing and refinement of the AR system based on user feedback. • Evaluation results documenting user engagement and learning outcomes. • A final project report detailing the scope, development process, results, and future recommendations.

[2] Project proposer should be an academic form the Faculty of Engineering. This individual should also be listed as supervisor or co-supervisor.

Student background / interest:	• Digital Manufacturing • Augmented Reality Technology and Tools • 3D Modeling • Process Improvement • Information Communication Technology
IP Issues	☐ The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Enhancing machine operations - Integration of Digital Twin and Augmented Reality within a Smart Factory

Project Proposer:	Dr. Ing. Joseph Zammit[3], *joseph.zammit@um.edu.mt, Department of Industrial and Manufacturing Engineering*
Supervisor(s):	Dr. Ing. Joseph Zammit, *joseph.zammit@um.edu.mt, Department of Industrial and Manufacturing Engineering*
Co-supervisor[4] (if any):	Prof. Ing Emmanuel Francalanza, *emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering*
Problem Background	In the modern manufacturing industry, the visualization of manufacturing information is crucial for enhancing worker awareness and operational efficiency. Advanced visualization tools not only help in identifying production bottlenecks but also improve decision-making on the shop floor. The project involves creating a digital twin integrated with augmented reality (AR) for an SMC automation assembly machine consisting of three connected workstations. This system aims to enhance the maintenance and operation processes by providing real-time information via AR, sourced directly from the machine's PLCs and MES systems. The relevance of AR and digital twins in manufacturing aligns with Industry 4.0 initiatives, emphasizing the need for advanced technological integration in manufacturing operations.
Project Objective(s):	**Academic Objectives:** • Develop a digital twin of the SMC automation assembly machine. • Develope methods to extract and store operation data from the SMC automation assembly machine's PLCs and/or MES systems. • Create an AR application to display machine data and maintenance information overlaid on the physical machine. • Integrate real-time data from PLCs and/or MES systems into the digital twin and AR application. • Evaluate the system's effectiveness in real operational environments.
Project Resources	• **Equipment/Software:** Access to AR development tools and hardware, provided by the university. • **Literature:** Utilization of research publications available through university resources.
Industrial Partners involved:	• N/A
Expected Academic Project Deliverables:	• A detailed literature review on the application of Digital Twin and AR technologies for enhancing information visualization in manufacturing operations. • A functional digital twin model of the assembly machine. • An AR application capable of providing operational and maintenance data. • A framework for integrating the digital twin with the AR system and real-time data. • A comprehensive final report and presentation detailing the development process, system testing, and evaluation results.

[3] Project proposer should be an academic form the Faculty of Engineering. This individual should also be listed as supervisor or co-supervisor.

[4] Only one co-supervisor per project, if any.

Student background / interest:	• Digital Manufacturing • 3D modelling • Process Improvement; • Interested in manufacturing processes; • Information Communication Technology • Augmented Reality technology and tools.
IP Issues	☐ The project has patent possibilities; Potentially Yes.
Ethical and Data Protection Issues	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Characterization and 3D Printability of Novel Bio-based and Biodegradable Polymers

Project Proposer:	• Prof. Arif Rochman – arif.rochman@um.edu.mt *Department of Industrial and Manufacturing Engineering*
Supervisor:	• Prof. Arif Rochman – arif.rochman@um.edu.mt *Department of Industrial and Manufacturing Engineering*
Co-supervisor:	•
Problem Background	Bio-based polymers, derived from renewable resources like plant starches and cellulose, are emerging as promising alternatives to traditional petroleum-based polymers. While not all bio-based polymers are biodegradable, those that can decompose naturally under specific conditions into harmless components are ideal for single-use products. Several bio-based and biodegradable polymers are already in mass production, while others are still under development or in lab-scale production. This project aims to address the latter by focusing on two key aspects: 1. **Characterization** of such bio-based and biodegradable polymers to determine their thermo-mechanical properties, melting and flow/rheological behavior, etc. 2. To investigate their **3D Printability** using either fused filament fabrication (FFF) or fused granular fabrication (FGF) systems. This includes material characterization and testing of the 3D printed specimens.
Project Objectives:	• Review the existing bio-based and biodegradable polymers and the ones that will be provided. • Characterize the provided bio-based and biodegradable polymers. • Determine the suitable 3D printing technique(s) and potentially suitable printing parameters based on the characterization results. • Carry out 3D printing experiments, material characterization, parts' performance test, and analyze the results. •
Project Resources	• Single material and multi-material FFF 3D printers, FGF 3D printer, filament maker, filament dryers, and a set of polymer characterization equipment available at DIME. •
Industrial Partners involved:	• The bio-based and biodegradable polymer materials including their information as well as supports will be provided by a German company, Twins Crew GmbH. •
Expected Project Deliverables:	• Review of relevant literature. • Bio-based and biodegradable polymers' characterization results. • 3D printed parts from bio-based and biodegradable polymers. • 3D printed parts' performance test and material characterization results. •
Student background / interest:	• Polymer 3D printing, polymers processing and characterization. •
IP Issues	• ☐ The project has patent possibilities; please specify. •
Ethical and Data Protection Issues	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line. The student must then download the filled-in form as pdf, and send a copy to her/his supervisor and another copy to **research-ethics.eng@um.edu.mt**. The supervisor must send an email to

research-ethics.eng@um.edu.mt to confirm that the student has filled in the form correctly. If no issues are highlighted in the filled-in UREC form, then the form is just filed and the student can start her/his research. If not, FREC reviews the form and proceeds according to the issues raised. The student can only start once all the issues raised in the form have been resolved.

Configuration Design of A Modular & Stable 'Above the Knee Prosthesis'

Project Proposer:	Prof. Jonathan C. BORG, jonathan.borg@um.edu.mt, Dept of Industrial & Manufacturing Engineering
Co-supervisor (if any):	Nicholas Patiniott (RSO II), nicholas.patiniott@um.edu.mt
Problem Background:	For a number of reasons including traffic accidents, diseases (eg. diabetes) or effects of civil wars and terrorism, a number of individuals will in their life time have their lower limb (LL) amputated, sometimes below and sometimes above the knee. Current prosthesis tend to be both costly as well as not aesthetically pleasing. To offset this situation, this project aims to apply engineering knowledge to optimize existing knee and foot prosthesis solutions generated as part of the University's PREMIER (https://www.um.edu.mt/projects/premier/) research project. Through this project, the existing PREMIER knee and foot solutions will be improved to make them more reliable and at the same time complimentary to each other to ensure overall *balance* and *stability* to the amputee. Thus, this project aims at seeking to optimize a number of solution parameters of the PREMIER prosthesis to result in a stable, low cost, structurally sound and aesthetically pleasing *Above the Knee Prosthesis (AKP).*
Project Objective(s):	The overall aim is to design a stylish, low-cost, structurally sound *AKP* providing sufficient degrees of freedom and allowing the user to perform a number of useful daily tasks without fear of imbalance/stability. To achieve this goal, the project has the following objectives: • To review the existing PREMIER project prosthetic knee and prosthetic foot solutions and in particular their strengths and weaknesses; • To review/understand how humans achieve stability and balance when walking; • To perform an FMEA of the PREMIER Knee and Foot prosthetic solutions; • To identify the overall AKP structural configuration that enhances amputee balance and structural stability; • To build and test an improved physical prototype of the selected AKP configuration;
Project Resources:	• Budget: Sponsored by University through PREMIER/TRAKE Project
Industrial Partners involved:	• Nil
Expected Project Deliverables:	• A review of *PREMIER Knee and Foot systems* & Configuration Design • A set of alternative AKP solution configurations that enhance stability; • A prototype model of the improved AKP configuration solution; • DFMA of the chosen AKP solution; • Detailed drawings/virtual 3D models of the final AKP configuration solution;
Student background / interest:	• Engineering Product Design • 3D CAD modelling using Autodesk Inventor/Fusion 360; • Interested in 3D-Printing & Mechatronics; • Interested in taking up a career in R&D / Biomedical/Manufacturing Industry;
IP Issues	This project has IP potential
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/ facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Design of a 3D Printed ExoSkeleton for Human-Centred Industrial Operations

Project Proposer:	Prof. Jonathan C. BORG, jonathan.borg@um.edu.mt, Dept of Industrial & Manufacturing Engineering
Co-supervisor (if any):	Prof. Jonathan C. BORG, jonathan.borg@um.edu.mt, Dept of Industrial & Manufacturing Engineering
Problem Background:	Human-centered operations in industry (eg maintenance tasks) often involve complex, nuanced tasks that require adaptability, decision-making, and fine motor skills—capabilities where humans excel. Industrial robots, despite their efficiency in repetitive and high-precision tasks, lack the ability to adapt quickly to unpredictable scenarios and perform tasks requiring human judgment and empathy. Exoskeleton systems, on the other hand, can enhance human abilities, allowing industrial workers to perform physically demanding tasks with increased strength and endurance, while still leveraging their innate cognitive and perceptual skills. This combination ensures that tasks are completed effectively and safely, capitalizing on the strengths of both human flexibility and robotic support, making exoskeleton-enhanced humans more suitable for human-centered operations in a range of industries. But can exoskeletons be developed at a low cost to make them more feasible. Can part of these exoskeletons be developed from say 3D printed materials? What actuators can be used to make a relatively cheap yet practially useful exoskeleton? These are some of the questions that this final project aims to address.
Project Objective(s):	The overall aim is to design a stylish, low-cost, structurally sound Exoskeleton providing sufficient degrees of freedom and allowing the user to perform a number of useful industrial operations (eg using screwdrivers for long hours) . To achieve this goal, the project has the following objectives: • to review existing upper body exoskeleton solutions and in particular their working principles, strengths and weaknesses; • to identify a set of industrial activities performed by humans (in particular through the upper limbs) in a manufacturing environment that cannot be easily and efficiently replicated by industrial robots; • to synthesize alternative design concpts of an upper body Exoskeleton that considers alternative working principles as well as possible configurations; • to detail one selected *upper body* Exoskeleton solution concept; • to build a physical prototype of the selected Exoskeleton solution concept;
Project Resources:	• Budget: Sponsored by University through PREMIER/TRAKE Project
Industrial Partners involved:	• Nil
Expected Project Deliverables:	• A review of *exoskeleton solution systems* in particular for the upper body; • A set of alternative exoskeleton solution concepts/working principles; • Virtual 3D models of the *upper body* exoskeleton solution systems; • Prototype model(s) of the selected *upper body* exoskeleton solution concept • FMEA and DFMA exercise of the chosen solution concept
Student background / interest:	• Engineering Product Design • 3D CAD modelling using Autodesk Inventor/Fusion 360; • Interested in 3D-Printing & Mechatronics; • Interested in taking up a career in R&D / Biomedical/Manufacturing Industry;
IP Issues	This project has IP potential
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/ facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is

required. The student can only start the research once all the issues raised in the form have been resolved.

A Novel Metered Dose Inhaler with Spacer for Effective Delivery of Drugs to treat COPD

Project Proposer:	Prof. Ing. Philip Farrugia, *philip.farrugia@um.edu.mt, Department of Industrial & Manufacturing Engineering (DIME), Faculty of Engineering*
Supervisor(s):	Prof. Ing. Philip Farrugia, *philip.farrugia@um.edu.mt, DIME, Faculty of Engineering*
Co-supervisor[5]:	Dr Cynthia Farrugia Jones, cynthia.farrugia-jones@um.edu.mt, Faculty of Medicine & Surgery
Problem Background	Metered Dose Inhalers (MDIs) equipped with spacers play a pivotal role in inhalation therapy, serving as a primary method for delivering medication effectively. These devices are fundamental in treating conditions such as asthma and Chronic Obstructive Pulmonary Disease (COPD). Nevertheless, the proper use of MDIs is essential to ensure the medication is delivered efficiently. The challenge of using inhaler devices is particularly pronounced among elderly patients, who may encounter difficulties in handling these devices correctly. This can lead to significant errors, adversely affecting the delivery of medication to the lungs and, consequently, the overall effectiveness of the treatment. In light of these challenges, this project proposes the development of an innovative metered dose inhaler with a spacer designed specifically for elderly individuals suffering from COPD. This new design aims to facilitate easier and more effective inhalation of prescribed medications, ensuring that patients can manage their condition more effectively.
Project Objective(s):	• To carry out a literature review of the state-of-the-art MDI solutions (including a patent search) • To compile a product design specification (PDS) • To develop a number of working principles of the MDI solution • To generate the CAD models of the selected working principle and the corresponding detailed engineering drawings • To evaluate the proposed solution with a number of stakeholders.
Project Resources	• Budget: N/A
Industrial Partners:	• No industrial partners involved
Expected Project Deliverables:	• Deliverable 1: A literature review and PDS as described above • Deliverable 2: At least two different working principles • Deliverable 3: 3D CAD model and detailed engineering drawings of the final design solution developed • Deliverable 4: Evaluation results
Student background / interest:	• Medical devices, engineering design, CAD, prototyping
IP Issues	X The project has patent possibilities.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line. The student must then download the filled-in form as pdf, and send a copy to her/his supervisor and another copy to research-ethics.eng@um.edu.mt. The supervisor must send an email to research-ethics.eng@um.edu.mt to confirm that the student has filled in the form correctly. If no issues are

[5] Only one co-supervisor per project, if any.

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A Modular Test Jig for Smart Packaging Solutions

Project Proposer:	Prof. Ing. Philip Farrugia, *philip.farrugia@um.edu.mt, Department of Industrial & Manufacturing Engineering (DIME), Faculty of Engineering*
Supervisor(s):	Prof. Ing. Philip Farrugia, *philip.farrugia@um.edu.mt, DIME, Faculty of Engineering*
Co-supervisor[6]:	
Problem Background	The packaging market is projected to be valued at USD 1.14 trillion in 2024, with anticipated growth to USD 1.38 trillion by 2029, exhibiting a Compound Annual Growth Rate (CAGR) of 3.89% from 2024 to 2029, as per the forecast[7]. Smart packaging enables transparency by instantly allowing the tracking and tracing of a product's precise location within the supply chain, utilising distinctive barcodes, QR codes, or RFID technology. Smart packaging dealing with food and pharmaceutical contents must be rigorously tested to adhere with the relevant industrial standards. Innovative smart packaging solutions are bring designed as part of the *SMARTSPACK* project, coordinated by DIME. In this context, this project proposes the development of a modular jig through which a number of smart packaging solutions, developed in SMARTSPACK, can be tested.
Project Objective(s):	• To carry out a literature review of the state-of-the-art testing jigs specifically employed in packaging testing, standards and regulations • To understand the main functions of the smart packaging solutions developed in the *SMARTSPACK* project and the specifications it should meet in the testing phase • To develop a number of working principles of how the device can be tested to mimic its use by the respective target user, in a modular test jig • To generate the CAD models of the test jig and detailed engineering drawings • To fabricate the test jig • To evaluate the design solution through testing of prototype packaging solutions.
Project Resources	• Budget: Eur from the *SMARTSPACK* project
Industrial Partners:	• No industrial partners involved
Expected Project Deliverables:	• Deliverable 1: A literature review of similar jigs as described above. • Deliverable 2: A PDS of the test jig • Deliverable 3: At least two different working principles • Deliverable 4: 3D CAD model and detailed engineering drawings of the final design solution developed • Deliverable 5: A functional test jig • Deliverable 6: Testing results
Student background / interest:	• Packaging design, engineering design, CAD, prototyping
IP Issues	X The project has patent possibilities.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line. The student must then download the filled-in form as pdf, and send a copy to

[6] Only one co-supervisor per project, if any.
[7] https://www.mordorintelligence.com/industry-reports/global-packaging-market

her/his supervisor and another copy to research-ethics.eng@um.edu.mt. The supervisor must send an email to research-ethics.eng@um.edu.mt to confirm that the student has filled in the form correctly. If no issues are highlighted in the filled-in UREC form, then the form is just filed and the student can start her/his research. If not, FREC reviews the form and proceeds according to the issues raised. The student can only start once all the issues raised in the form have been resolved.

Recycling of Polymers for Sustainable 3D Printing

Project Proposer:	Prof. Ing. Paul Refalo
Supervisor:	Prof. Ing. Paul Refalo - paul.refalo@um.edu.mt Department of Industrial and Manufacturing Engineering
Co-supervisor:	Prof. Arif Rochman – arif.rochman@um.edu.mt Department of Industrial and Manufacturing Engineering
Problem Background:	Recycling of polymers closes the lifecycle loop of plastics and could create industrial symbiotic relationships. This reduces the use of natural resources, and decreases landfilling and incineration of waste, with an additional positive end-result on the financial and social pillars. Meanwhile, additive manufacturing, also known as 3D printing, is a very popular and versatile polymer manufacturing process. There are various 3D printing techniques such as Fused Filament Fabrication (FFF) and Fused Granular Fabrication (FGF). The former uses raw material in filament form, while the latter uses pellets. The scope of this project is to identify and assess the technical suitability, and environmental and financial sustainability of 3D printing using recycled polymers such as PET. An analysis of the use of resources (such as energy and materials) and product quality will help to improve the efficiency of the process and reduce the impacts on the environment.
Project Objectives:	• To assess the technical suitability and environmental and financial sustainability of 3D printing using recycled polymers • To compare the sustainability impacts of different 3D printing techniques, when using recycled polymers
Project Resources:	• Budget: € • Source of funds: Internal Research Grants • Equipment: Filament maker FFF 3D printer FGF 3D printer Power logger
Industrial Partners:	• N/A
Expected Project Deliverables:	• Review of relevant literature • Outline factors affecting sustainability and resource efficiency of FFF and FGF 3D printing using recycled polymers • Design of experiment • Collection and analysis of experimental data • Recommendations for resource-efficient 3D printing
Student background / interest:	• Sustainable Manufacturing • Polymer Engineering, particularly 3D Printing
IP Issues	☐ The project has patent possibilities;
Ethical and Data Protection Issues	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form online available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Development of a Sustainable Pneumatic Monitoring and Control System

Project Proposer:	Prof. Ing. Paul Refalo
Supervisor:	Prof. Ing. Paul Refalo - paul.refalo@um.edu.mt Department of Industrial and Manufacturing Engineering
Co-supervisor:	Prof. Ing. Emmanuel Francalanza – emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering
Problem Background:	Compressed air is widely used in industry typically for pneumatic automation systems. Despite their advantages, these systems are frequently susceptible to faults, compromising their sustainable performance. A monitoring and control system intended to mitigate the effects of different sources of inefficiency in compressed air systems has been developed. Like any other equipment, such a system would have its own environmental and financial impacts. This project aims to assess the environmental and financial sustainability of the developed monitoring and control system from a lifecycle perspective and improve its design accordingly.
Project Objectives:	• To assess the environmental and financial sustainability of a Pneumatic Monitoring and Control System, • To compare the sustainability impacts of different pneumatic monitoring and control scenarios • To develop a Sustainable Pneumatic Monitoring and Control System
Project Resources:	• Budget: N/A • Source of funds: N/A • Software: Ansys Granta EduPack SimaPro • Equipment: Pneumatic Monitoring and Control System
Industrial Partners:	• AIM Enterprises Ltd
Expected Project Deliverables:	• Review of relevant literature, • Outline factors affecting the sustainability of pneumatic monitoring and control systems, • Technical, financial and environmental assessment of pneumatic monitoring and control systems, • Development of a Sustainable Pneumatic Monitoring and Control System
Student background / interest:	• Sustainable Manufacturing • Life Cycle Assessment
IP Issues	☐ The project has patent possibilities;
Ethical and Data Protection Issues	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form online available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research

	Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

5-Axis CNC Machining Process of a Vehicle Upright

Project Proposer:	Dr Ing. Emmanuel Francalanza – emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering
Main Supervisor:	Dr Ing. Emmanuel Francalanza – emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering
Co-supervisor:	None
Problem Background:	Vehicle uprights are complex products with three dimensional features made of aluminium alloys and typically manufactured using 5-axis machines. This complex type product requires to be manufactured to very high precision, and therefore is manufactured on CNC machines. Ideally also the fabrication of this component makes use of the smallest number of setups, in order to avoid misalignment within the different faces of the component. This project will investigate what are the best approaches and process plans in order to manufacture such a complex component. This will include first of all an analysis of the material, design and product information as well as the preparation processes. The focus of this work will be on the simulation of the CNC process as well as the necessary CNC programming required for use with the new 5 axis CNC machine at the Department of Industrial and Manfuacturing laboratory.
Project Objective(s):	• To carry out a literature review on various process improvement methodologies, CNC manufacturing, digital manufacturing tools; • To analyse the existing CNC manufacturing process flow and capabilities at the IME labs in order to determine the system's function and requirements. • To develop and analyse using CNC simulation programs a set of potential improvements to the CNC manufacturing process. • To manufacture and measure a vehicle upright using the 5-Axis CNC at the IME labs.
Project Resources:	• Manufacturing Equipment at the Department of Industrial and Manufacturing Engineering Laboratories • Autodesk FUSION
Industrial Partners involved:	• None
Expected Project Deliverables:	• Review of relevant literature. • An in-depth information flow, and process analysis of the CNC manufacturing process required for an Vehicle Upright. • A simulation of the CNC manufacturing process for a Vehicle Upright • The manufacture and detailed measurement of a Vehicle Upright at the IME labs.
Student background / interest:	• Process Improvements • CNC Manufacturing • Digital Manufacturing
IP Issues	☐ The project is IP sensitive;
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee

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Designing Safe and Collaborative Robotic Experiences in Manufacturing Environments

Project Proposer:	Dr Ing. Emmanuel Francalanza – emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering
Main Supervisor(s):	Dr Ing. Emmanuel Francalanza – emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering
Problem Background	Collaborative robotics are changing the way in which manufacturing operations are designed, especially when it comes to the possibilities of automating processes which require a human contribution. Collaborative robots open up new opportunities for automation due to their fast implementation times and capabilities. These opportunities bring about also a number of challenges, such as how to design the safe interaction between humans and robotic cells in order to provide an enhanced experience for the operator whilst remaining operationally feasible. Furthermore, this aspect has to also be considered when retrofitting or updating existing manufacturing systems to Industry 4.0 paradigms especially to determine the optimal safety interface for the operation of the equipment.
Project Objectives:	• To carry out a literature review on state of the art in the design of collaborative robotic cells which employ human-robot interactions. • To understand the typical problems encountered when implementing collaborative robots within legacy automation systems (retrofitting); • To design a safe and cost-effective case study for the use of a collaborative robot interactive experience;
Project Resources	• Industrial Sponsor
Industrial Partners involved:	ST Microelectronics Ltd.
Expected Project Deliverables:	• A literature review on state of the art design of collaborative robotic cells and human-robot and human-computer interfaces; • An investigation into different approaches to retro-fit or implement collaborative robot experiences within existing automation systems; • A set of conceptual designs for a collaborative robotic experience in a manufacturing environment; • Simulation of feasible human-robot experience;
Student background / interest:	Automation and Robotics Digital Manufacturing Simulation Design CAD/CAM
IP Issues	☐ The project has patent possibilities; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The

	student can only start the research once all the issues raised in the form have been resolved.
Ethical and Data Protection Issues	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line. The student must then download the filled-in form as pdf, and send a copy to her/his supervisor and another copy to **research-ethics.eng@um.edu.mt**. The supervisor must send an email to **research-ethics.eng@um.edu.mt** to confirm that the student has filled in the form correctly. If no issues are highlighted in the filled-in UREC form, then the form is just filed and the student can start her/his research. If not, FREC reviews the form and proceeds according to the issues raised. The student can only start once all the issues raised in the form have been resolved.

Logistics Simulation of a Fabrication Facility

Project Proposer:	Dr Ing. Emmanuel Francalanza – emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering
Main Supervisor(s):	Dr Ing. Emmanuel Francalanza – emmanuel.francalanza@um.edu.mt Department of Industrial and Manufacturing Engineering
Problem Background:	Fabrication facilities necessitate careful and detailed planning in order to organize their organizational layout in terms of the movement of material and resources. This flow of material is typically difficult and complex to visualize using traditional pen and paper techniques, or with the use of standard CAD packages. Digital manufacturing tools such as plant logistics simulation and virtual and augmented reality allow us to both optimize the material flow, as well as visualize better the solutions being developed. This project will begin by analyzing the material flow in an existing fabrication and warehousing facility in order to understand the system requirements. This will then be modelled in a logistics simulation package in order to visualize and optimize the facility layout to improve productivity and the utilization of space.
Project Objective(s):	• To carry out a literature review on logistics simulation methods for the optimization and visualization of material flow. • To analyze an existing fabrication and warehousing facility in order to determine the system's function and requirements. • To develop an approach for implementing simulation and visualization techniques for material handling planning and facility layout. • To implement the developed simulation and visualization approaches on an existing fabrication and warehousing facility.
Project Resources:	• Logistics Simulation Software
Industrial Partners involved:	• Yes
Expected Project Deliverables:	• Review of relevant literature. • An in-depth material flow and layout analysis of an existing fabrication and warehousing facility. • Visualization of the material flow in the facility in augmented or virtual reality. • An improved material flow solution and facility layout for the application being considered.
Student background / interest:	• Facility Planning • Simulation • Digital Manufacturing • CAD
IP Issues	☐ The project is IP sensitive;
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee

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Combining Additive Manufacturing and Laser Machining for the Fabrication of Polymer Inserts for Micro Injection Moulding

Project Proposer:	Dr. Ing. Pierre Vella, *pierre.vella@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Main Supervisor(s):	Dr. Ing. Pierre Vella, *pierre.vella@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Co-supervisor (if any):	Prof. Arif Rochman *arif.rochman@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Problem Background:	Microinjection molding (MIM) of thermoplastic polymers is one of the most promising methods for the accurate replication of components with micro features such as micro channels and chambers. However, the tooling cost associated with this manufacturing process remains relatively high. Within this context, it is necessary to investigate the feasibility of utilising polymer inserts for prototype tooling in micro injection moulding that can reduce both product development time and costs associated with the design and testing of micro products/components prior to mass fabrication.
Project Objective(s):	Specifically, the project will experimentally investigate the feasibility of using additive manufacturing (AM) technology and laser machining for the fabrication of the abovementioned polymer inserts; and also to evaluate the performance of the polymer inserts when used in injection moulding process.
Project Resources:	Budget: € Indicate source of funds: Internal Research Grant Equipment/Software/Literature: DLP 3D printer, laser micromachining system, dimensional measurement & polymer characterization equipment at DIME's ERIL labs.
Industrial Partners involved:	• Not applicable
Expected Project Deliverables:	***Deliverable 1:*** A critical literature review of the state-of-the-art on AM processes and their respective capabilities, AM equipment, polymer laser processing, potential candidate high temperature polymer material(s), etc. ***Deliverable 2:*** Identification of a suitable high temperature polymer material and the corresponding additive manufacturing process to be used to fabricate the case study polymer inserts. ***Deliverable 3:*** The design of a number of case study polymer inserts and corresponding set of experiments to be used to quantitatively evaluate the performance of the: (i) 3DP and laser machining processes for the fabrication of the polymer inserts using the polymer identified in Deliverable 2; and (ii) the polymer inserts when used in the injection moulding process ***Deliverable 4:*** Execution of a set of experiments and their respective characterization tests defined in Deliverable 3. ***Deliverable 5:*** Proposed future work.
Student background / interest:	Laser machining, polymer materials, characterization techniques, injection molding, additive manufacturing

IP Issues	The project is IP sensitive: The project could have patent possibilities.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.

Rapid Fabrication of Microfluidic Devices Using AM Technologies

Project Proposer:	Dr. Ing. Pierre Vella, *pierre.vella@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Supervisor(s):	Dr. Ing. Pierre Vella, *pierre.vella@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Co-supervisor[1]:	Prof. Arif Rochman *arif.rochman@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Problem Background	Microfluidics is an expanding field, enabling a wide range of biomedical applications such as cancer screening, high-throughput drug testing, and point-of care diagnostics. However, fabrication of microfluidic devices is often complicated, time consuming, and requires expensive equipment and sophisticated cleanroom facilities. With the recent advancements in additive manufacturing (AM) technologies, highly complex microfluidic devices can be fabricated rapidly and cost-effectively in a few process steps, making them more accessible to users.. Different AM technologies (FFF, FGF, SLA and DLP) are available at the Department of Industrial and Manufacturing Engineering (DIME). However, although these machines have been used to generate normal sized components, their capability in fabricating miniature components such as microfluidic devices has not yet been fully explored.
Project Objective(s):	In view of the above , this project aims at designing and performing a number of experiments on some of these machines in order to evaluate their performance and effectiveness in using them to fabricate microfluidic devices.
Project Resources	• Budget: € from IRG for fabrication and testing of case study parts. AM equipment and test equipment available at DIME's ERIL labs
Industrial Partners:	• N/A
Expected Project Deliverables:	• ***Deliverable 1***: A critical literature review of the state-of-the-art on AM processes and their respective capabilities, characterization of AM processes and equipment, test artefacts and standards for the characterization of AM processes and equipment, etc. • ***Deliverable 2*****:** A set of typical functional features found in microfluidic devices. • ***Deliverable 3:*** Based on Deliverable 2, design a test artefact(s) and corresponding set of experiments to be used to quantitatively evaluate the performance of two AM machines/processes for the fabrication of microfluidic devices. • ***Deliverable 4:*** Sets of parameters for the experiments to assess the capability of two AM systems for the fabrication of microfluidic devices. • ***Deliverable 5:*** Manufacture and assemble two microfluidic devices (one for each AM technology) • ***Deliverable 6****:* An evaluation and comparison of the performance of the machines. • ***Deliverable 7:*** Proposed future work
Student background / interest:	• Additive manufacturing technologies and equipment, testing, characterization, polymer materials, biomedical applications
IP Issues	• The project has no patent possibilities.

[1] Only one co-supervisor per project, if any.

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3D Printing of Metal Components through Fused Filament Fabrication (FFF) – A Feasibility Study.

Project Proposer:	Dr. Ing. Pierre Vella, *pierre.vella@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Main Supervisor(s):	Dr. Ing. Pierre Vella, *pierre.vella@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Co-supervisor (if any):	Prof. Arif Rochman *arif.rochman@um.edu.mt, Department of Industrial & Manufacturing Engineering, Faculty of Engineering*
Problem Background:	The fused filament fabrication (FFF) process is widely used in both industrial and private applications. Reasons for this are simple handling, the wide range of polymer materials, a cost-effective system technology and uncomplicated maintenance. Recently OEM of 3D printers have expanded the material range to metals, thus enabling the flexible production of individual or a small series of metal parts such as gears, edm electrodes, micro injection mould inserts, medical components, etc. The Ultimaker S5 with an Metal Expansion kit enables one to 3D print metal parts . Some typical advantages of using this technology are: no handling of loose powder, closed cavities and internal channels are possible (without residual powder inside) and nearly 100% material utilization. A literature search has revealed that the capabilities of this technique has not been fully explored yet.
Project Objective(s):	Consequently, this project will endeavor to experimentally investigate the feasibility of the FFF process for the successful fabrication of metal components with multiple length scale features.
Project Resources:	• Budget: € • Indicate source of funds: Internal Research Grant • Equipment/Software/Literature: FFF 3D printer with a metal expansion kit, dimensional measurement & characterization equipment at DIME's ERIL labs
Industrial Partners involved:	• Not applicable
Expected Project Deliverables:	• ***Deliverable 1:*** A critical literature review of the state-of-the-art on AM processes and their respective capabilities, metal FFF, metal FFF systems, potential candidate metal filament (s) etc, • ***Deliverable 2:*** Identification of at least one candidate metal filament material(s). • ***Deliverable 3:*** The design of a number of case study parts / artefacts and corresponding set of experiments to be used to quantitatively evaluate the performance of the Ultimaker S5 FFF system for the fabrication of metal parts using the metal filament identified in Deliverable 2. • ***Deliverable 4:*** Execution of the set of experiments and their respective characterization tests to assess /analyze the performance of the Ultimaker S5 when using the selected metal filament material(s) in order to produce the metal parts with the required quality (e.g. dimensional, surface roughness, etc). • ***Deliverable 5:*** An evaluation of the performance of the Ultimaker S5 (strengths and weaknesses). • ***Deliverable 6:*** Proposed future work.

Student background / interest:	• Advanced manufacturing processes, fused filament fabrication, characterization techniques, additive manufacturing.
IP Issues	• The project is IP sensitive; please specify.
Ethical and Data Protection Procedure	Before the start of any research project at the University of Malta, including final-year projects, a student must fill in the UREC form on-line available at: https://www.um.edu.mt/eng/students/facultyresearchethicscommittee This form is reviewed by the Faculty Research Ethics Committee (FREC) and a decision of whether further investigation or referral to the University Research Ethics Committee (UREC) is required. The student can only start the research once all the issues raised in the form have been resolved.