

Digital Mechatronics Programmes @UL

Supporting skills and talent in smart manufacturing for Ireland's factories of the future

Industry Breakfast Showcase

February 8th,
2023



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Agenda

- 8-8.30 – Registration and Breakfast
- 8.30-8.45 – Opening Address by Prof Conor McCarthy
CONFIRM Director
- 8.45-9.15 – New and Existing Mechatronics Courses @UL
– Prof. Conor McCarthy, Dr. Eoin Hinchy
- 9.15-9.45 – SMARTEdu.40 – Prof. Wasif Naeem,
Queens University Belfast
- 9.45-10.00 – UL@Work – Dr Sinead Burke
- 10.00- 10.30 – CONFIRM Tour



Confirm

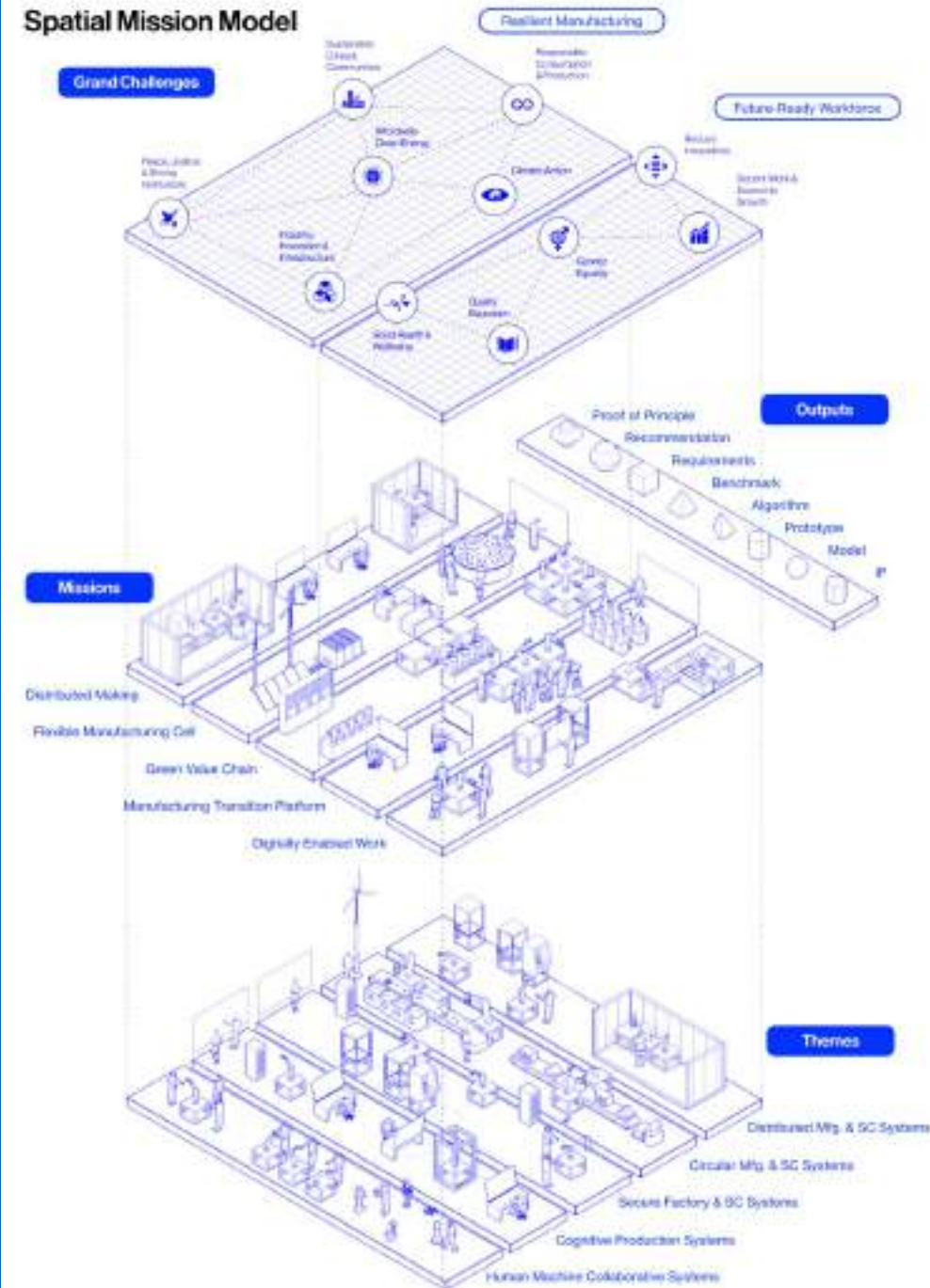
Smart Manufacturing Research

For a Resilient Economy, Society & Environment

Resilient Manufacturing Futures

Confirm Phase 2 (2023-2029)

Spatial Mission Model



Resilience Drivers and their Impact on Manufacturing & SC

- Resilience - develop high robustness in industrial production
 - Resilient strategic value chains, adaptable production capacity, flexible business processes
- Pimenta et al. (2022) identify supply chain resilience capabilities as
 - Visibility
 - Redundancy
 - Flexibility
 - Collaboration
 - Agility
 - Adaptability
 - Sustainability



Covid 19



War on Ukraine



Brexit



Global Trade Wars

CONFIRM - Phase 2

- We define **Manufacturing Resilience** as highly adaptable production & supply chain systems
- Phase 2 Key Focus is on economic, societal and environmental **Resilience**
- Strong links to UN SDG
- Excellent Smart Manufacturing science is at our core!



OUR VISION

***“Fundamentally
Transform
Industry to a Smart
Manufacturing
Ecosystem”***

OUR (UPDATED) MISSION

***“Ireland’s Research Centre for
smart manufacturing and
supply chain systems enabling a
resilient economy, society and
environment”***

CONFIRM Phase 2 Core Values are,



Impact



Research Excellence



Creativity & Innovation



Diversity & Integrity



Education & Public Engagement

Confirm
Smart Manufacturing Research

Confirm Investigator Team

- Grown from 40 to 60 Investigators
- Grown from 2.5% to 22% women
- Athena Swan accredited in 2022
- 16 KETs, and growing





Impact

“Through outcomes created as a result of our high-quality research outputs, CONFIRM strives to support manufacturing resilience while delivering strong economic, societal and environmental impact”



Mazzucato, 2018, EC.

CONFIRM Phase 2 - Proposed Grand Challenges in Advanced Manufacturing

UN Sustainability Goals:



Grand Challenges: Heading

Resilient Manufacturing Systems

Future-ready Workforce

Grand Challenges: Description

Creating, developing and enabling the critical infrastructure, flexible supply bases and transparent information flows necessary to embed resilience in sustainable manufacturing ecosystems such that they are responsive to threats and severe disruptions and can answer to rising environmental and social requirements.

Harnessing digitalisation and automation in order to augment workers' capabilities and enhance their roles, while developing the education, skills, know-how and facilities to enable technology diffusion and knowledge absorption capacity and ensuring public awareness and support for digital transformation.

5 Missions defined to respond to these grand challenges

Mission #1: Adaptive Manufacturing Cell



Grand Challenges:
Impact Areas

Resilient Manufacturing

Mission Heading:

Adaptive Manufacturing Cell

What:
Description

Develop modular manufacturing units that can easily be reconfigured in response to new production requirements

How:
Demonstrator

Universal Machine

Why:
Impact

Easily reconfigurable manufacturing processes enable smaller batch sizes and makes production facilities more adaptable to market changes

SFI Impacts:



Impacts	Economic	Societal	Environmental
Beneficiaries	Industry	Consumers/End-users	Society/Industry
Time scales	4-5 Years	5+ Years	5+ Years
Novelty dimension	Flexible manufacturing lines	Personalised Products	Localised energy usage/shorter SCs
Innovation dimension	Feasibility – more agile production	Desirability – tailored products	Sustainability – remanufacturing enabled
Potential Partners	SMEs, MNCs, IMR, AMC, CONNECT, Lero, Insight		

Mission #2: Distributed Making



Grand Challenges:
Impact Areas

Resilient Manufacturing

Mission Heading:

Distributed Making

What:
Description

Enable decentralised local manufacturing

How:
Demonstrator

Factory-in-a-Box, Universal Machine,
Manufacturing Control Tower

Why:
Impact

Producing closer to the end consumer is more sustainable. Regions can also ensure the integrity of their supply by localising some core manufacturing capability.

SFI Impacts:

Economic Impacts	Societal Impacts	Intl. Engage. Impacts	Policy & Public Service Impacts
Health & Wellbeing Impacts	Environmental Impacts	Professional Service Impacts	Human Capacity Impacts



Impacts	Economic	Societal	Environmental
Beneficiaries	Industry/Local Markets	Urban/rural spaces	Society/Industry
Time scales	4+ Years	4-6 Years	5+ Years
Novelty dimension	Distributed manufacturing lines	Local production of tailored products	Localised and highly agile supply chains
Innovation dimension	Viability – platform business models & more agile production	Feasibility – production of essential products at right time/right place	Sustainability – deployable factories for finite timescales
Potential Partners	SMEs, MNCs, IMR, AMC, I-Form, Connect, Lero,		

Mission #3: Green Supply Chain



Grand Challenges:
Impact Areas

Resilient Manufacturing

Mission Heading:

Green Supply Chain

What:
Description

Enable an ethical and environmentally friendly supply chain.

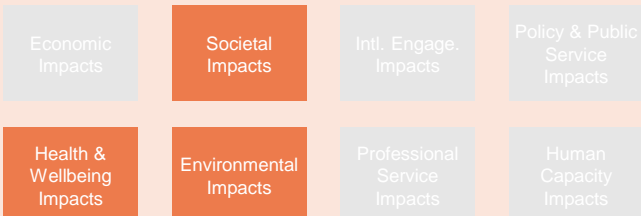
How:
Demonstrator

Circular Production System,
Renewable Energy System.

Why:
Impact

To prevent environmental collapse,
ecological damage and social
exploitation, we must redesign our end-to-
end supply chains.

SFI Impacts:



Impacts	Economic	Societal	Environmental
Beneficiaries	Industry	Society & Workforce	Society/Environment
Time scales	3-5 Years	4+ Years	3-5 Years
Novelty dimension	Circular Production systems	Greener factories and supply chains	Renewable energy systems
Innovation dimension	Economically sustainable production practices	Societal Sustainability – healthier workplaces	Sustainability – green production and supply chains
Potential Partners	SMEs, MNCs, IMR, AMC, I-Form, FMI		

Mission #4: Manufacturing Transition Platform



Grand Challenges:
Impact Areas

Future-ready Workforce

Mission Heading:

Manufacturing Transition Platform

What:
Description

An open platform that leverages physical hubs labs and digital portals in the transfer of knowledge and skills

How:
Demonstrator

Digital Manufacturing Sandbox,
Virtual Cyber Security Sandbox,
Other Mission's Demonstrators

Why:
Impact

Support SMEs and Irelands
Manufacturing workforce in the adoption
of new digital manufacturing technology

SFI Impacts:



Impacts	Economic	Societal	Environmental
Beneficiaries	Industry & Society	Society, Higher Education	Society/Industry
Time scales	2+ Years	2+ Years	5+ Years
Novelty dimension	Open digital platform for best practice	Research and education modules downloadable	Best practice leads to more sustainable industry & society
Innovation dimension	Viability – platform de-risking technology adoption	Desirability – better workplace environments	Viability – platform enables better environmental business decisions
Potential Partners	SMEs, MNCs, IMR, AMC, I-Form, FMI, General Public		

Mission #5: Digitally Enabled Work



Grand Challenges:
Impact Areas

Future-ready Workforce

Mission Heading:

Digitally Enabled Work

What:
Description

Create a collaborative workforce through technology that is human centred and AI powered.

How:
Demonstrator

Digital Environment for Collaborative Design, Cobot Ecosystem,

Why:
Impact

To empower people and teams in the world of work as technology advances and automation replaces menial tasks

SFI Impacts:



Impacts	Economic	Societal	Environmental
Beneficiaries	Industry & Society	Consumers/End-users	Society/Industry
Time scales	4-5 Years	4+ Years	5+ Years
Novelty dimension	Remote control & maintenance of production systems	Flexible & distributed work practices	Commuting & business travel optimised
Innovation dimension	Viability – distributed & connected workforce underpins new business models	Desirability – talent acquisition & retention through flexible work	Sustainability – flexible work practices invigorate cities & rural regions
Potential Partners	MNCs, SMEs, Worker representative groups, Public, ICT & Tech Sectors		

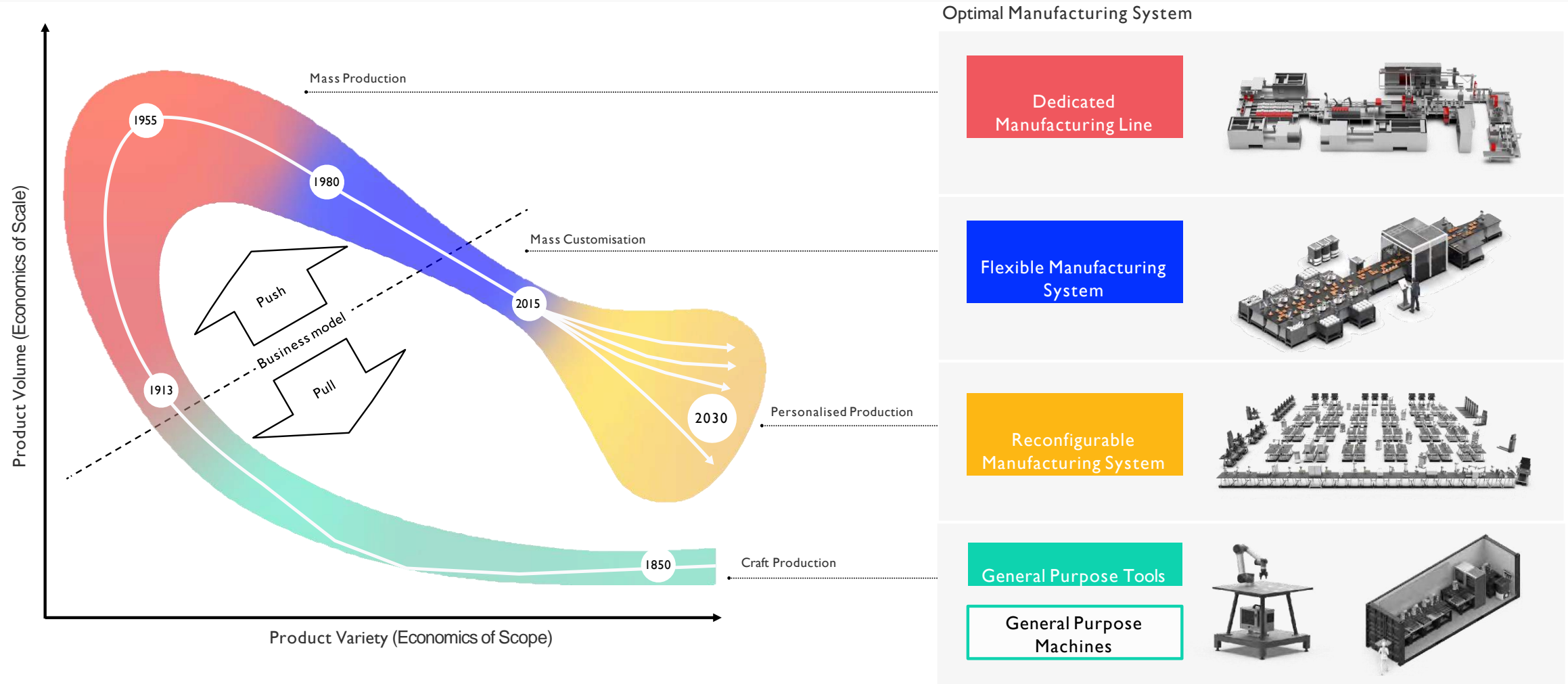


Research Excellence

“We strive to excel in cyber-physical manufacturing systems and digital supply chains research, and place a strong emphasis on high quality research outputs in high impact journals and conferences”

Multi-Modal Manufacturing Big Picture Trajectory

For the first time since the Industrial Revolution, the world is regaining the ability to deliver personalised production at scale



Phase 2 – Excellent Science - Five Core Research Themes

Theme #1

Cognitive Production Systems



Foundations:
Key Enabling
Technologies



Theme #2

Distributed SC & Manufacturing Systems

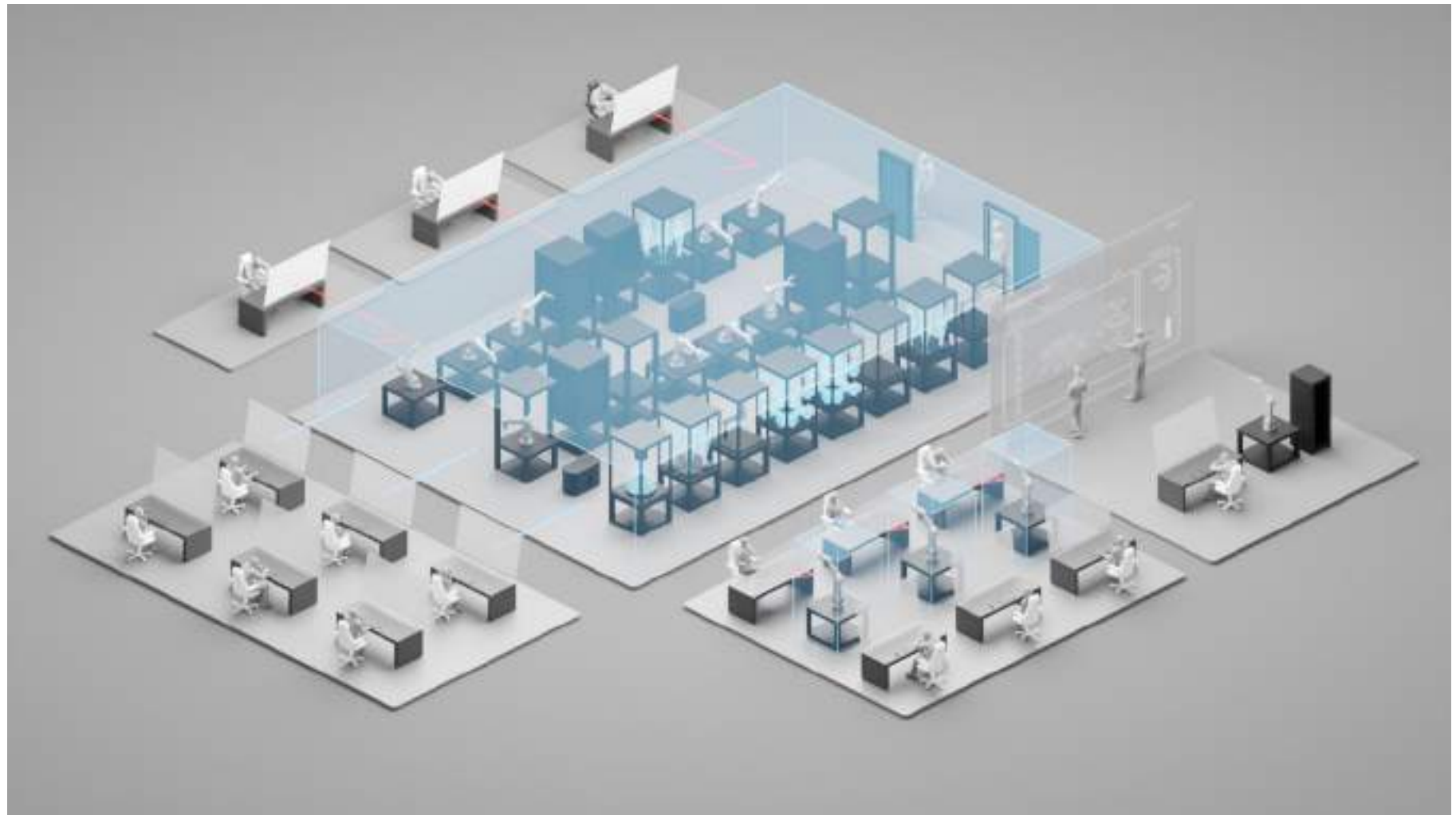


Foundations:
Key Enabling
Technologies

- Business Models
- Modelling & Simulation
- HCI, SW & Integration
- Advanced Robotics
- Big Data & Analytics
- Advanced Sensing
- Materials Processing
- Artificial Intelligence
- Advanced Materials
- Augmented & Virtual Reality
- Cloud Computing
- Cyber Security
- Autonomous Vehicles
- Internet of Things
- Circular Systems
- Process Control

Theme #3

Secure Future Factory & SC Systems



Foundations:
Key Enabling
Technologies



Business Models

Modelling & Simulation

HCI, SW & Integration

Advanced Robotics

Big Data & Analytics

Advanced Sensing

Materials Processing

Artificial Intelligence

Advanced Materials

Augmented & Virtual Reality

Cloud Computing

Cyber Security

Autonomous Vehicles

Internet of Things

Circular Systems

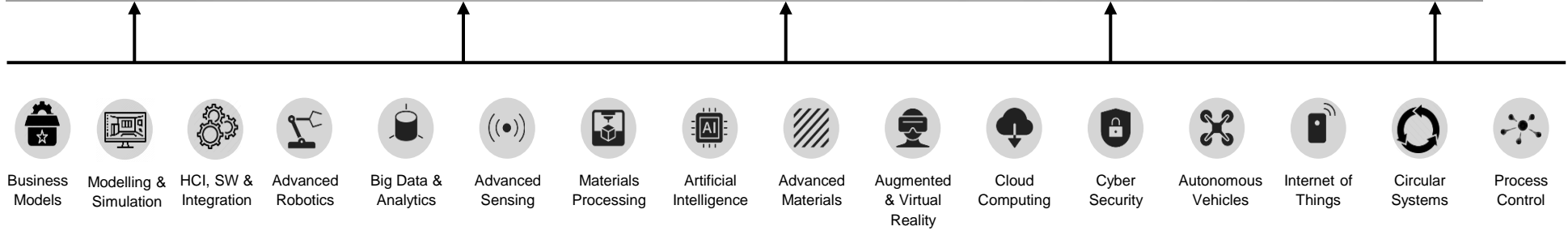
Process Control

Theme #4

Human-Machine Collaborative Systems

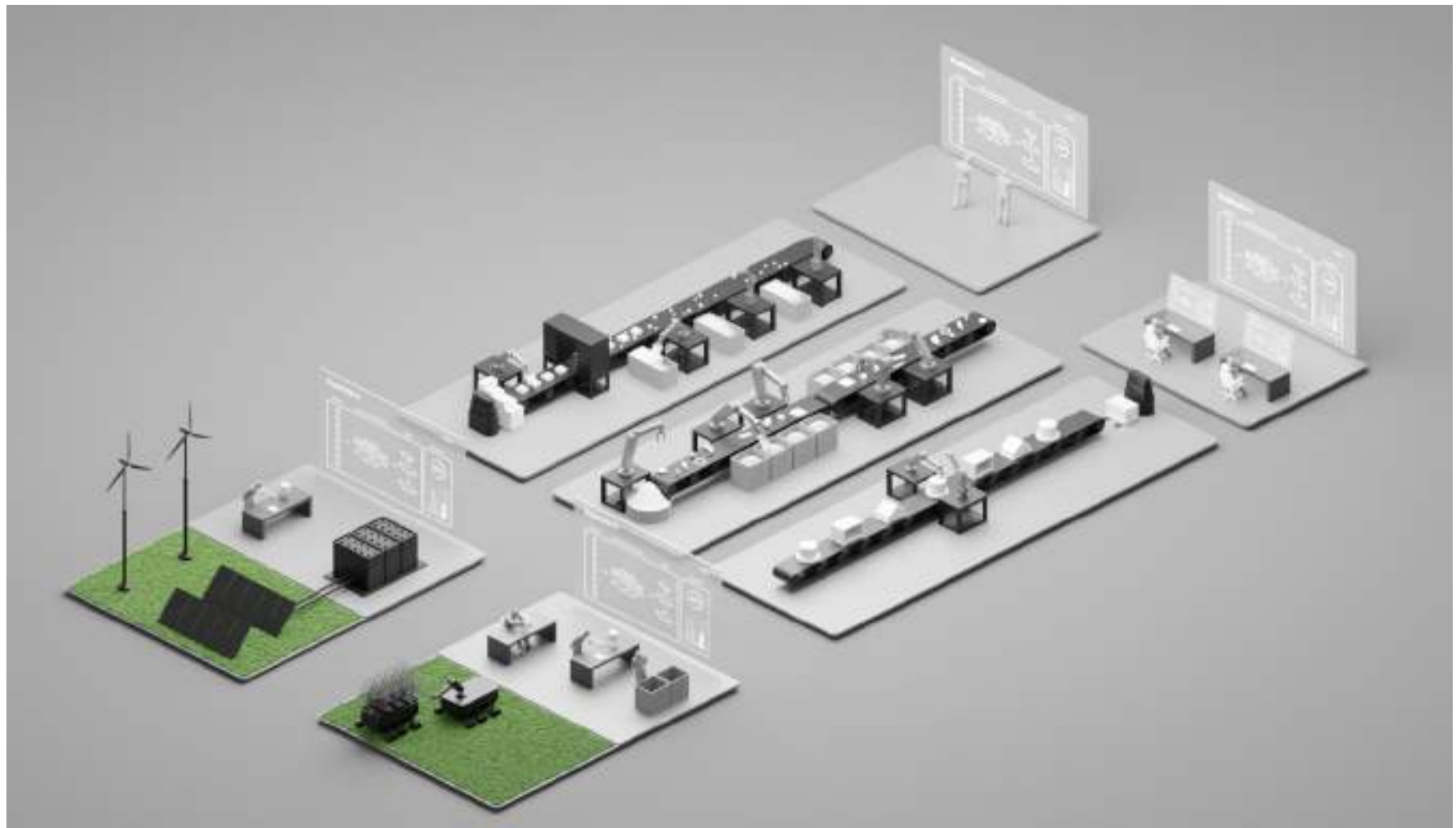


Foundations:
Key Enabling
Technologies

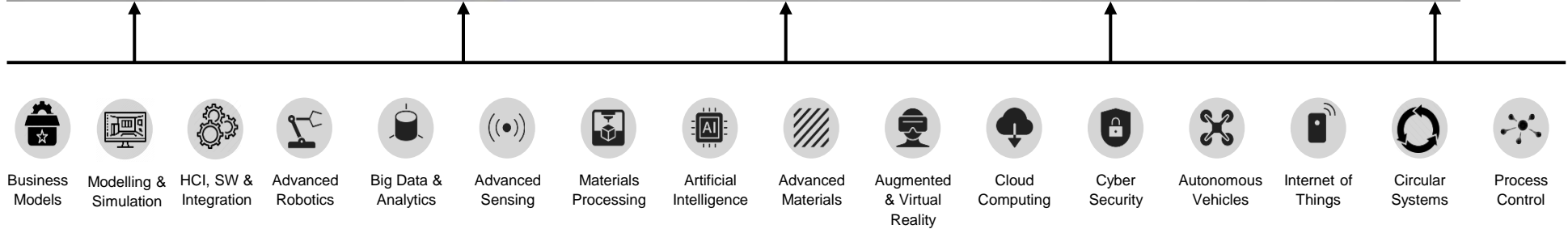


Theme #5

Circular Manufacturing & SC Systems



Foundations:
Key Enabling
Technologies



- Business Models
- Modelling & Simulation
- HCI, SW & Integration
- Advanced Robotics
- Big Data & Analytics
- Advanced Sensing
- Materials Processing
- Artificial Intelligence
- Advanced Materials
- Augmented & Virtual Reality
- Cloud Computing
- Cyber Security
- Autonomous Vehicles
- Internet of Things
- Circular Systems
- Process Control

Phase 2 Research Programme - Mission-based Approach

UNSDGs:
Macro Goals



Grand Challenges:
Impact Areas

EPE -
Targeted -
Platform -

Resilient Manufacturing Future-ready Workforce

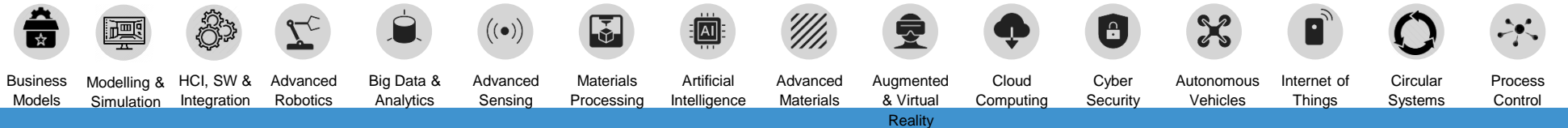
Missions:
Impact
Demonstrators

Flexible Manufacturing Cell Distributing Making Green Supply Chain Manufacturing Transition Platform Digitally Enabled Work

Themes:
Systems Type &
Innovation Area



Foundations:
Key Enabling
Technologies



Impact

Excellence Science

Digital Mechatronics Programmes @UL

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Industry Breakfast Showcase

February 8th, 2023 @ CONFIRM Centre, RSVP to Sinead.a.Mellett@ul.ie

8:00-10:30am

Registration/Breakfast

BE/ME Digital Mechatronics, UL@Work

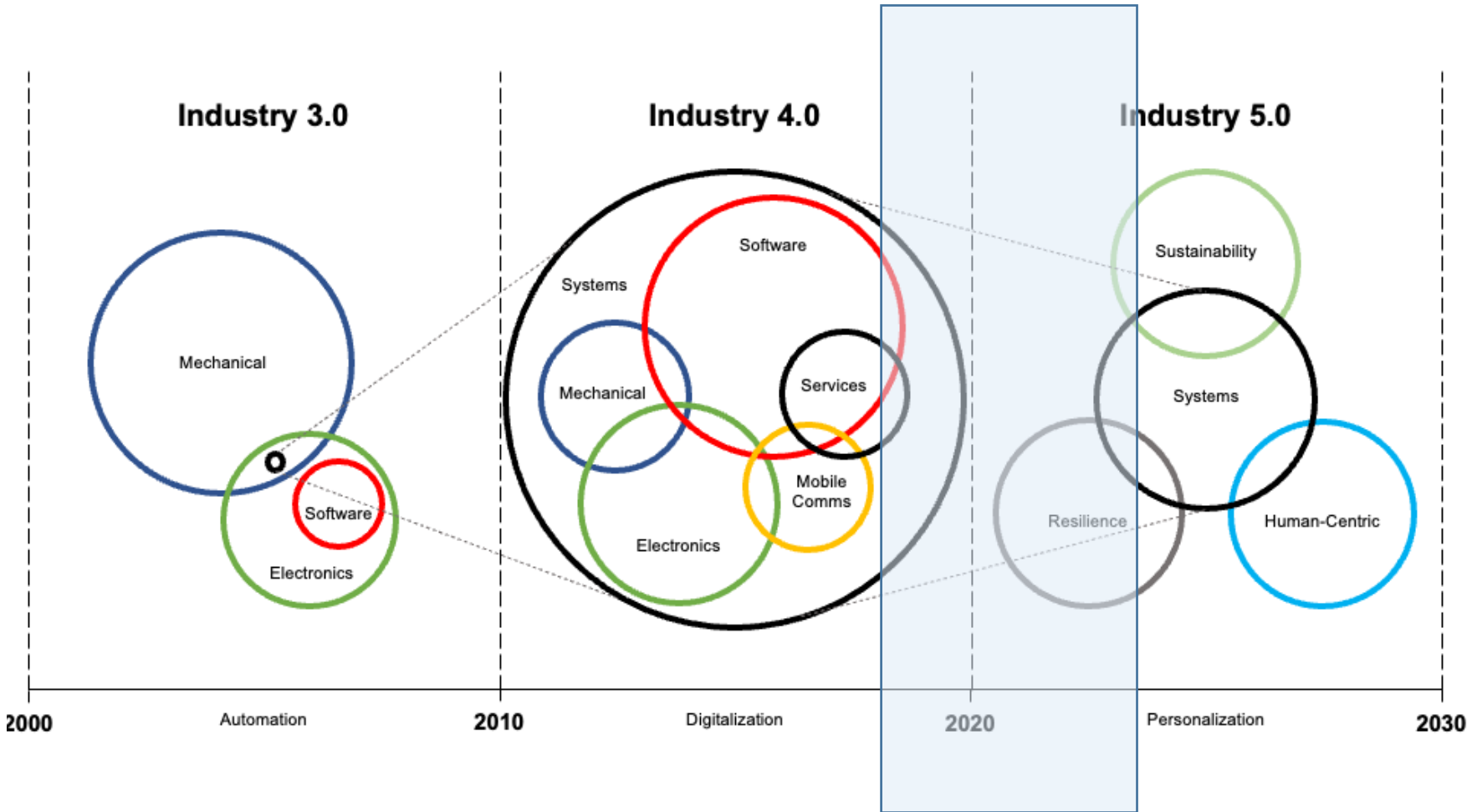
International Digital Mechatronics Erasmus+ Programme SMARTEdu4.0

Tour of the CONFIRM Centre for Smart Manufacturing Research

CONFIRM - Park Point | Dublin Road | Castletroy | Limerick | V94 C928



Advancing Digital Talent in S+E @ UL



Some highlights

- Mechatronics M.Eng.
- PD-Eng in Principal Engineering
- Industrial Masters in Equipment Systems Engineering
- Confirm's Structured PhD programme
- MSCA co-fund SMART 4.0
- Erasmus+ SmartEdu4.0 programme
- Over 70 undergraduate and postgraduate programmes nationally
- All-Island Digital Manufacturing PhD programme white paper
- SALI Chair in Digital Engineering
- Chair in Advanced Manufacturing

Advancing Talent @ UL

NEW

(1)

Chair in Advanced Manufacturing

NEW

(1)

SALI Chair in Digital Engineering

NEW
(30)

Integrated BE/ME in Digital Mechatronic Engineering



130+

PhDs via CRT Foundations of Data Science



120

PhDs via CRT in Artificial Intelligence

70

Structured PhDs in Digital Manufacturing

18

L9 courses

30

L8 courses

17

L7 courses

160+

Postdocs & PhD Graduates

16

SMART 4.0 Marie-Curie Research Fellows

20

Industry Fellows PDEng Apprenticeship



120

PhD via CRT in Advanced Networks for Sustainable Societies

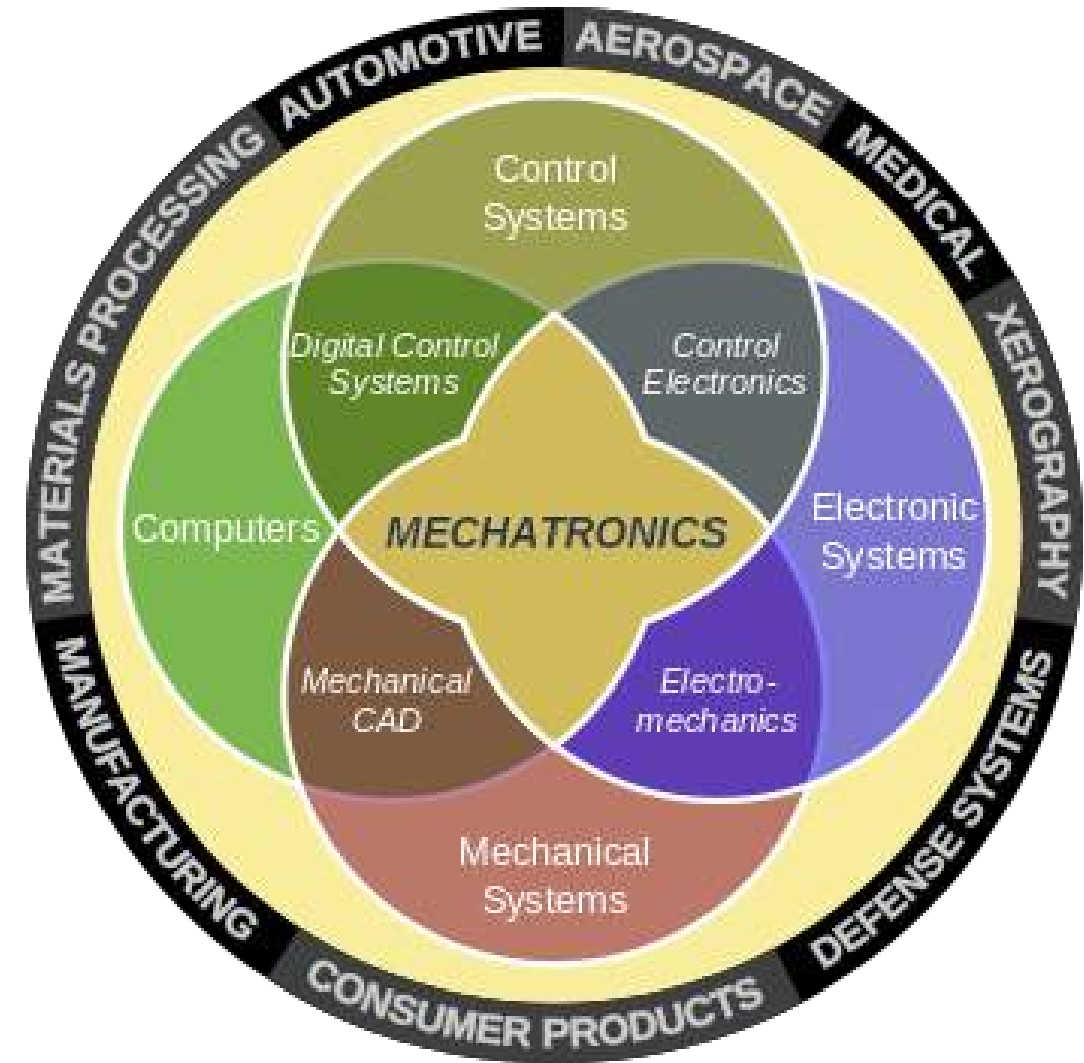
BE/ME Digital Mechatronic Engineering

A SoE/ECE Inter-departmental Enhanced Workplace based BE/ME Programme

Faculty of Science + Engineering

BE/ME Digital Mechatronic Engineering

- Combination of mechanical, electronic, robotic and software engineering systems
- Underpins many sectors (as shown right)
- Used extensively in modern manufacturing industries
- Becoming one of the fastest growing career areas
- Manufacturing sector in Ireland employs over 260,000 people directly and a further 230,000 indirectly
- Responsible for 34.5% GDP in 2020



Manufacturing in Ireland by the numbers

260,000

260,000 people -
12% of total employment

€12.5 billion

€12.5 billion in wages and
employment taxes annually

150,000

Irish manufacturers employ
150,000 people abroad; 60,000
in the US and 25,000 in the UK.

€1.7 billion

€1.7 billion of tangible
investment

28.8%

28.8%, or over €4.4 billion
of corporation tax

€20 billion

€20 billion spent each year
on goods and services from
suppliers in the Irish economy

90%

Irish owned manufacturing
exporters grew sales by over
80% between 2010 and 2021

64%

Inward FDI manufacturers
grew their exports by 64%
in the same period

€165.2bn

The state exported a record €165.2
billion worth of goods in 2021

Manufacturing in Ireland 2022 - Today, Tomorrow and Beyond

10

BE/ME Digital Mechatronic Engineering - Programme Design Team



Dr. Eoin Hinchy



Dr. Alan Ryan



Dr. Sinead Mellett



Dr. Ciaran Eising



Dr. Mark Halton



Dr. Ger Dooly



Dr. Sinead Burke



Prof. Martin Hayes



Dr. Ronan O'Higgins



Prof. Colin Fitzpatrick



Prof. Conor McCarthy

Co-Designed and delivered by School of Engineering & Dept. of Electronic & Computer Engineering

BE/ME Digital Mechatronic Engineering - Programme Outline

- Integrated BE/ME (4/5 Year, May Finish)
- Workplace Based (extended 12/13 Month Co-Op Placement)
- 270/330 ECTS Credits
- Common Entry through LM116 Engineering (Common Entry)
- Start-of-the Art Labs (Mechatronics M.Eng, UL @ Work, Confirm Centre)
- Strong links to Industry
- Strong links to R&D
- Will seek accreditation through *Engineers Ireland*



Year 1 - LM116 Common Entry Engineering

Semester 1			Semester 2		
Core			Core		
Code	Title	ECTS	Code	Title	ECTS
ME4001	Introduction to Engineering	3	MA4002	Engineering Mathematics 2	6
MA4001	Engineering Mathematics	6	ME4111	Engineering Mechanics 1	6
ME4121	Engineering Science 1	6	ME4412	Fluid Mechanics 1	6
EE4001	Electrical Engineering 1	6	MT4002	Materials 1	6
EE4011	Engineering Computing 1	6	-	<i>Choose One of three Electives Below</i>	
CH4001	Chemistry for Engineers	3			
Electives : None			Electives : Choose 1		
Code	Title	ECTS	Code	Title	ECTS
			ME4042	Introduction To Design For Manufacture	6
			ME4032	Structural Engineering Design	6
			ID: 8002	Introduction to Digital Mechatronics	6

Year 2 – B.E. Digital Mechatronic Engineering

Semester 3			Semester 4		
Core			Core		
Code	Title	ECTS	Code	Title	ECTS
MA4003	Engineering Maths 3	6	MA4004	Engineering Maths 4	6
ME4112	Engineering Mechanics 2	6	DM4004	Plant Automation	6
ME4213	Mechanics of Solids 1	6	ME4113	Applied Mechanics	6
ET4013	Communications Networking Fundamentals	6	EE4214	Control 1	6
CE4703	Computer Software 3	6	EE4524	Digital Systems 3	6

Year 3 – Extended Co-Op Option (12/13 month Placement)

Summer			Semester 5			Semester 6		
Core			Core			Core		
Code	Title	ECTS	Code	Title	ECTS	Code	Title	ECTS
CO4230	COOPERATIVE EDUCATION 1	30	ID:8194	COOPERATIVE EDUCATION 2A	15	ID:8195	COOPERATIVE EDUCATION 2B	15
			<p style="color: green; text-align: center;">Students on Extended Co-op: The five modules below are taken in blended format to garner 30 ECTS Credits in place of a standard Semester 6</p>					
			Semester 5 (Electives None)			Semester 6 (Electives None)		
			Code	Title	ECTS	Code	Title	ECTS
			ID:8039	Critical Problem Solving*	6	ID:7979	Introduction to Machine Learning for Engineers*	6
			AU4043	LEAN THINKING / LEAN TOOLS*	6	AU3131	INTRODUCTION TO QUALITY MANAGEMENT*	6
			ID8316	Enhanced Placement Engineering Portfolio 1*	3	ID:8096	Enhanced Placement Engineering Portfolio 2*	3

* Delivered in a blended format

Year 3 – Standard Co-Op Option

Summer			Semester 5			Semester 6		
Core			Core			Core		
Code	Title	ECTS	Code	Title	ECTS	Code	Title	ECTS
CO4230	COOPERATIVE EDUCATION 1	30	CO4310	COOPERATIVE EDUCATION 2	30	MF4756	Product Design & Modelling	6
						DM4016	Product Automation	6
						EE4044	Communication & Network Protocols	6
						ET4224	Robotics 1: Sensors and Actuators	6
						ID:7979	Introduction to Machine Learning for Engineers	6

Year 4 : Semester 7 - B.E. Digital Mechatronic Engineering

Core			BE/ME Option (Choose 1)		
Code	Title	ECTS	Code	Title	ECTS
EE4003	The Engineer as a Professional	6	ID:8097	Project 1 Digital Mechatronic Engineering <i>(only if BE path chosen)</i>	6
ET4031	Electrical Automation	6	ET4023	Introduction to Security & Cryptography <i>(only if ME path chosen)</i>	6
CE4051	Intro to Data Engineering & Machine Learning	6			
Streams : Choose 1 Stream					
1. Digital Robotic Engineering			2. Digital Manufacturing Engineering		
Code	Title	ECTS	Code	Title	ECTS
CE4041	Artificial Intelligence	6	DM4017	Simulation Modelling & Analysis	6

Year 4 : Semester 8 - B.E. Digital Mechatronic Engineering

Core			Electives : BE/ME Option (Choose 1)		
Code	Title	ECTS	Code	Title	ECTS
RE4002	Spatial Robotics	6	ID:8098	Project 2 Digital Mechatronic Engineering <i>(only if BE path chosen)</i>	12
RE4012	Machine Vision	6	IE4248	<i>Project Planning & Control</i> <i>(only if ME path chosen)</i>	6
			EE4042	Master of Engineering Project Preparation <i>(only if ME path chosen)</i>	6
Streams : Choose 1 Stream					
1. Digital Robotic Engineering			2. Digital Manufacturing Engineering		
Code	Title	ECTS	Code	Title	ECTS
EE4216	Control 2	6	DM4006	Engineering Design	6

Year 5 : Semester 1 - M.E. Digital Mechatronic Engineering

Core (Semester 1)					
Code	Title	ECTS	Code	Title	ECTS
ID:8100	Research Project 1 (ME Digital Mechatronic Engineering)	9	DM6011	Automated System Design	6
ET4021	Electronics Life Cycle Engineering	6	ME6051	Advanced Technical Communication for Engineers	3
Streams : Choose 1 Stream					
1. Digital Robotic Engineering			2. Digital Manufacturing Engineering		
Code	Title	ECTS	Code	Title	ECTS
CE5002	Computer Vision Systems	6	DM6031	Automation & Control	6

Year 5 : Semester 2 – M.E. Digital Mechatronic Engineering

Core (semester 2)					
Code	Title	ECTS	Code	Title	ECTS
ID:8101	Research Project 2 (ME Digital Mechatronic Engineering)	12	DM6022	System Integration	6
EE5052	Robotic Sensing & Perception	6			
Streams : Choose 1 Stream					
1. Digital Robotic Engineering			2. Digital Manufacturing Engineering		
Code	Title	ECTS	Code	Title	ECTS
EE5042	Robotic Planning, Mapping & Manipulation	6	EE6452	Digital Control	6