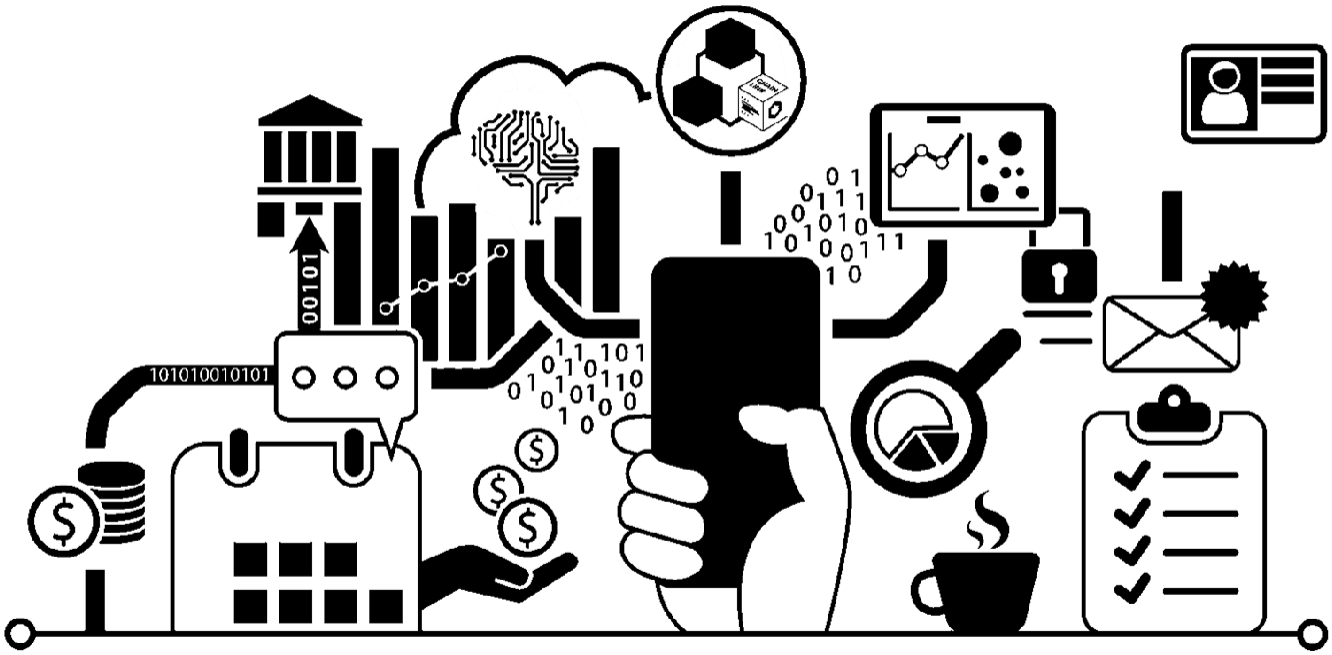
Short Training Courses Designed to Help Address the Current Manufacturing Skills Gap and Plant the Seeds for Industry 4.0.



South Eastern Regional College

Contents

Addressing the current skills gap.

Increasingly manufacturing enterprises struggle to recruit engineers with "experience" into their workforce, since for many years the value of actual "hands on" experience through vocational training and apprenticeships has been de-valued and replaced with the view that academic qualifications alone are enough to recruit and employ qualified engineers and graduates.

Issues arise when problems need to be solved on the production shop floor that require practical skills intervention and manufacturing enterprises realise that few in the organisation have working knowledge of how to practically approach engineering problems or have experience in how to overcome them.

This leads to inefficiencies, unnecessary downtime in production and/or unplanned expenses through the need to utilise external service engineering resources to design, implement, test, maintain or reactively troubleshoot/fault find mechatronic automated plant and equipment.

As part of an Erasmus+ Project- SMART EDU 4.0, the output of which will form a transnational short course industrial training model to aid manufacturing workforce growth, SERC is developing and designing delivery capability to provide upskilling and training for the local manufacturing industry to address the following 3 elements relating to the current skills gap.

The following courses are aimed at Industry 3.0 level skills gaps currently experienced by manufacturers while also planting the seeds for Industry 4.0 smart manufacturing techniques "Mindsets", "Processes" and "Technology".

These short courses are aimed at providing:

1. **Training pathways for the current low skilled manufacturing workforce** bringing them up to at least the minimum skilled standard to enable them to compete in this rapidly technologically advancing industry.

2. **Training pathways for new industry entrants** that is fit for the highly skilled workforce of the future and based on global manufacturing knowledge development.

3. **Development of lifelong training pathways** for existing people in the manufacturing industry that is responsive to continuous technological advancements which will enable them to maintain a competitive edge throughout their career.

The following 15 short courses are being developed by SERC (some are already deliverable) with a view to provide a broad-based knowledge platform to allow attendees to progress further with the essential skills and underpinning knowledge necessary in modern manufacturing enterprises.

15 Short Courses (1-2 Weeks, potential for an academy based multiple week delivery)

1. **Manual/Mechanical Engineering Workshop.** (Bench Fitting, Measurement, Interpreting Engineering Drawings, etc)
2. **Manual Machining Workshop.** (Turning and Milling)
3. **CAD (Computer Aided Design).** (Using Computer Aided Design Software & Techniques)
4. **CAM (Computer Aided Manufacturing).** (Using Computer Aided Manufacturing Software & Techniques)
5. **CNC Advanced Manufacturing Workshop.** (Introduction to CNC machining and advanced manufacturing techniques)
6. **Additive Manufacturing.** (3D Printing & Rapid Prototyping)
7. **Lean Manufacturing, Working in a Team.** (Lean Manufacturing, Continuous Improvement, working as part of a team)
8. **Electronic Engineering Workshop.** (Component Recognition, Circuit Design & Development, Circuit Assembly, Soldering, Fault Finding)
9. **Programming Embedded Systems & Microcontrollers.** (I/O Component Integration, C-Programming, De-Bugging, hardware/software).
10. **Relay Logic Control & Electro-Pneumatic Automation.** (Drawing/reading Schematic Diagrams, Wiring, Relay Logic, Schematic Diagram Navigation, Fault Finding, etc)
11. **PLC Controlled Automation.** (I/O Device Integration, PLC Architecture, PLC Programming Techniques, Trouble Shooting)
12. **Automation & Industrial Robotics** (Overview of Automation and Using/Programming Industrial Robots)
13. **Virtual Engineering/Digital Twin 3D Simulation** (3D Factory Simulation & Factory Flow Layout Planning)
14. **Industry 4.0, IIoT & Digital Transformation.** (Understanding a Smart Factory Eco System & ISA-95 hierarchy - Device Integration, Unified Namespace Architecture, EDGE Gateways & Data-Ops)
15. **Data Analytics, ML & Ai.** (Introduction to real time industrial data analysis)

Training Pathway Map.

The course pathways (fig.1) are designed to scaffold "skills" to provide vocational/practical training, ranging from introductory broad-based engineering subjects through to specialised automation and Industry 4.0 related topics.

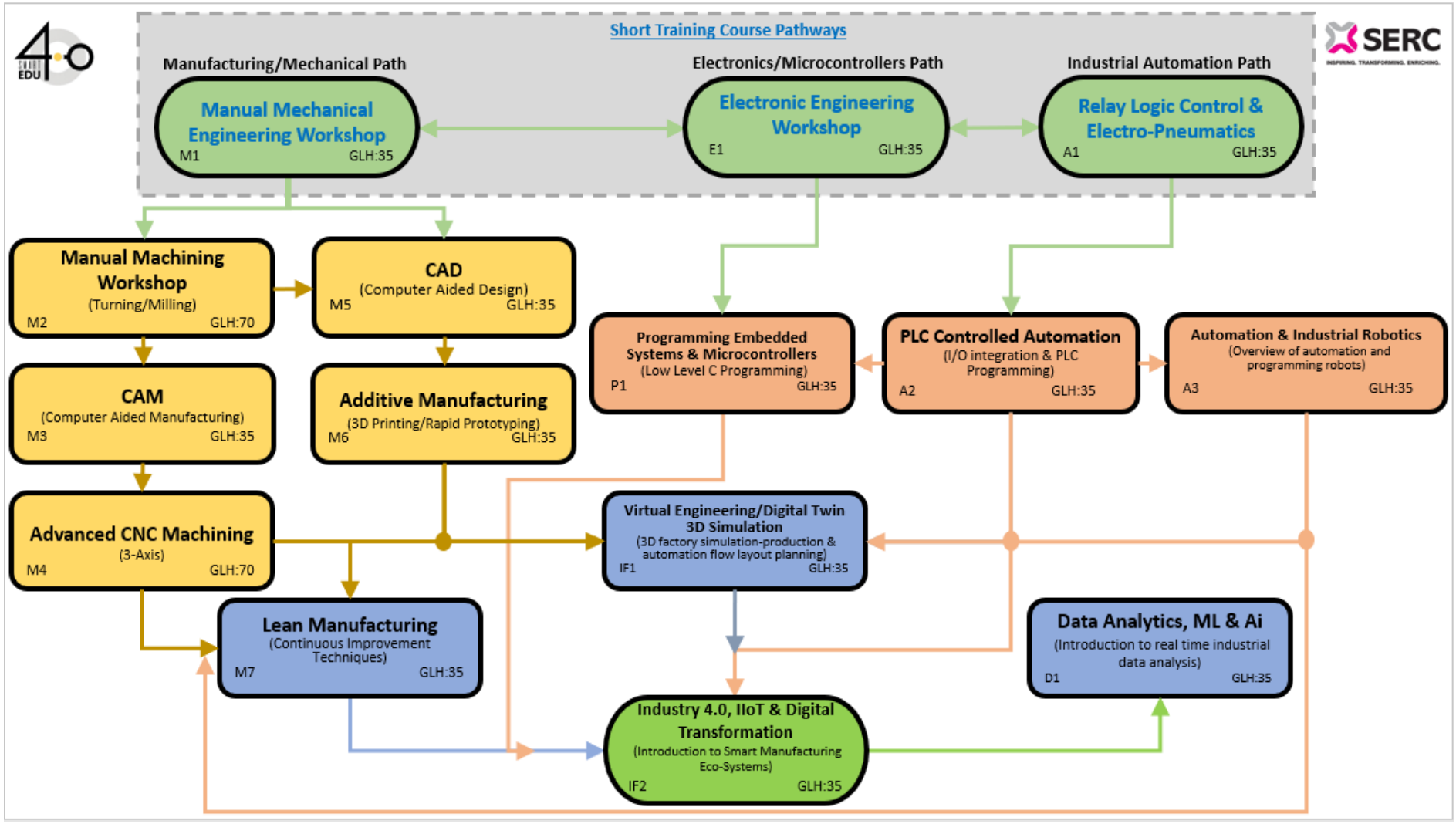


fig.1 *(D Anderson, SERC)*

Mechanical/Manufacturing Training Pathway.

The mechanical/manufacturing course pathways (fig.2) are designed to funnel Industry 3.0 "skills" from introductory broad-based subjects through to specialised topics and provide insights into Industry 4.0 smart manufacturing.

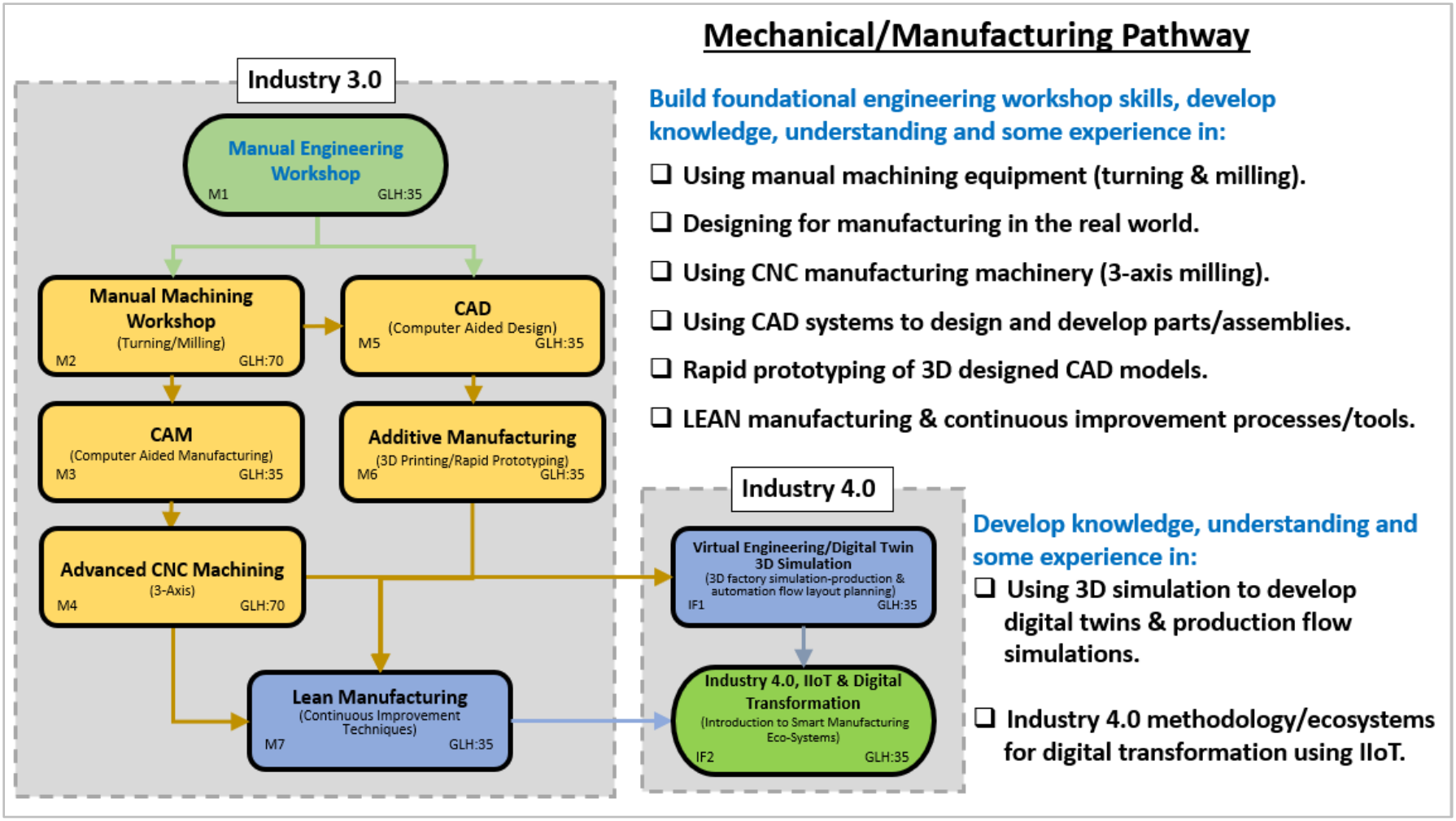


fig.2 *(D Anderson, SERC)*

Electronics & Microcontroller Training Pathway.

The electronics and microcontroller course pathways (fig.3) are designed to funnel Industry 3.0 “skills” from introductory broad-based subjects through to specialised topics and provide insights into Industry 4.0 smart manufacturing.

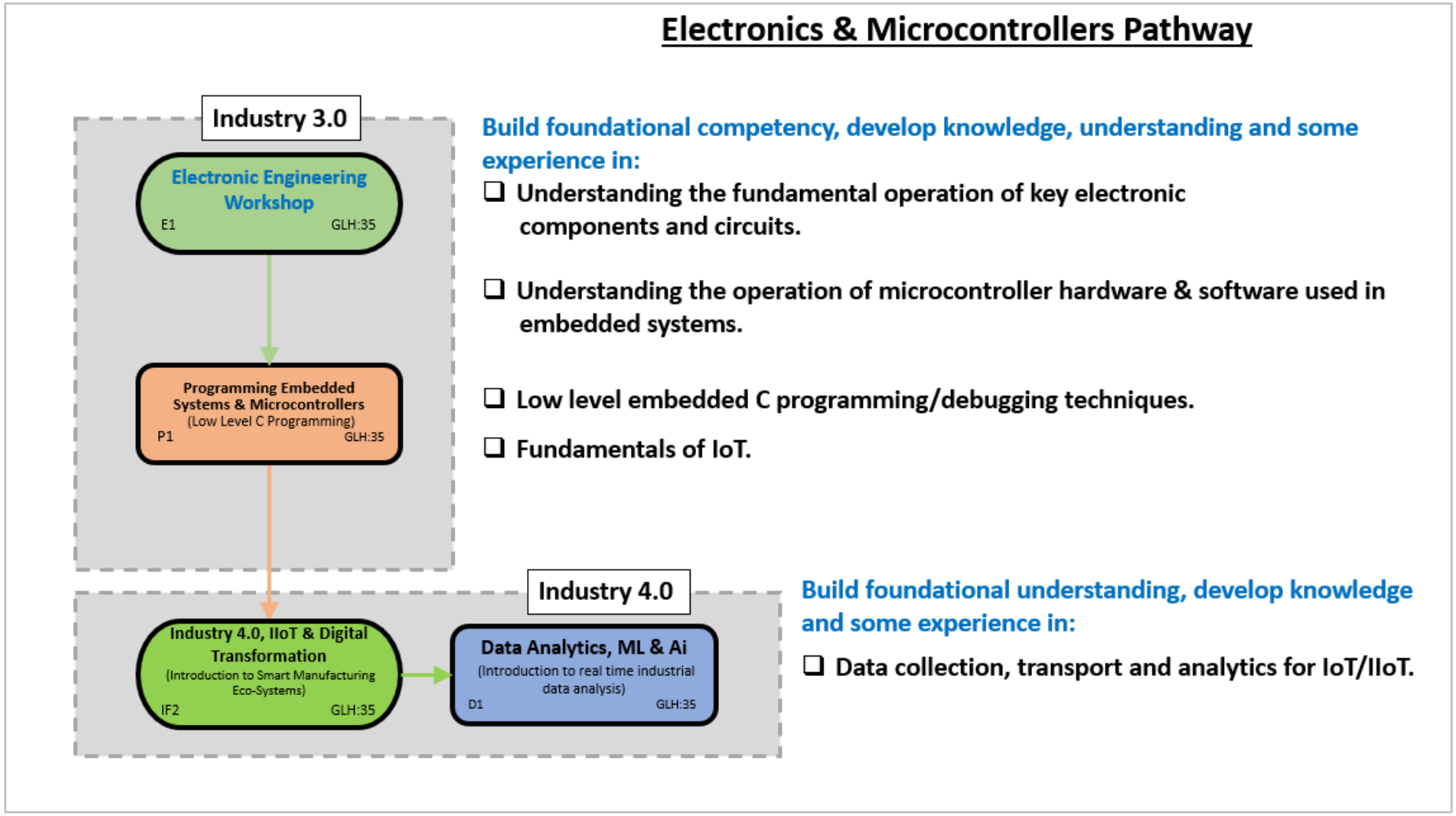


fig.3 *(D Anderson, SERC)*

Industrial Automation Training Pathway.

The industrial automation course pathways (fig.4) are designed to funnel Industry 3.0 “skills” from introductory broad-based subjects through to specialised topics and provide insights and experience of Industry 4.0 smart manufacturing techniques.

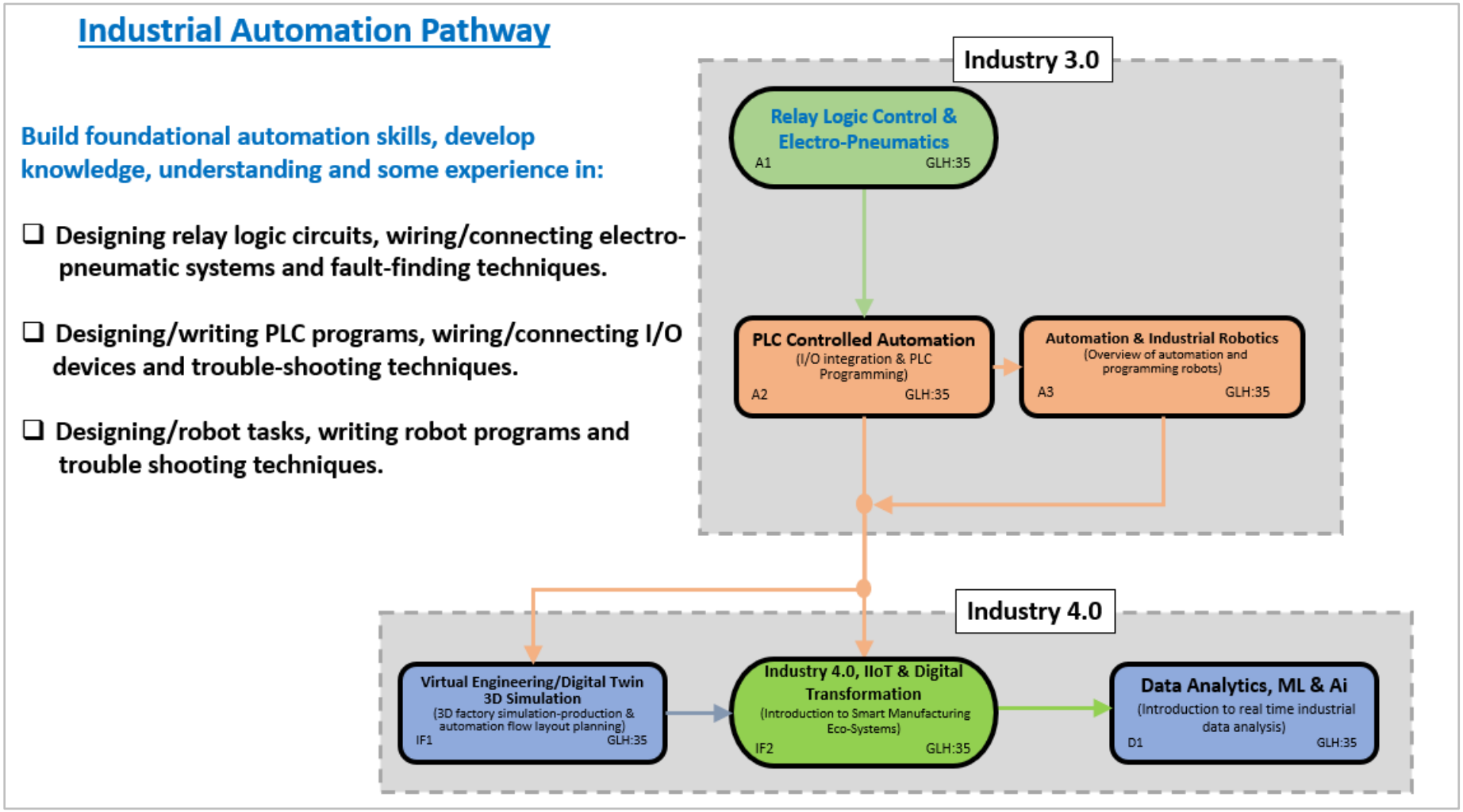


fig.4 *(D Anderson, SERC)*

Figure 1 (Above) lays out Industry 3.0 level vocational training pathways that the afore mentioned groups in the workforce could avail of. These pathways will be further developed to include routes to further Industry 3.0 topics, or delegates could begin with basic engineering subjects and incrementally progress through to higher level Industry 4.0 methodologies and technology. These pathways will target and accommodate learning and training for Low Skilled, Low Qualified and Highly Skilled/Low Qualified workers.

Pick & Mix CPD Training Pathways for the Existing Workforce

The short vocational courses will provide lifelong training pathways aimed at the existing workforce in the manufacturing industry that provides continuous professional development, which is responsive to technological advancements, enabling employees to maintain a competitive edge throughout their career.

The pathways (fig 1) can be used in a "Pick & Mix" format, where the existing workforce can choose the most suitable and relevant course that suits their current upskilling needs, provided they have prior knowledge, experience and understanding of the preceding course subject matter.

Course Pilots

SERC's School of Engineering has been delivering industrial training courses for many years and a few of the new short training courses (below) have already been successfully delivered to local manufacturing companies in 2022 and 2023. As part of this Erasmus KA2 project SERC developed new training courses tailored to suit the needs of manufacturing companies experiencing the current skills gap, the course content is as practical as possible allowing attendees to develop their skills by providing an environment where they have access to the same equipment, they will find in industry with training material designed & delivered by trainers with industrial experience.

Examples:

Existing skilled workforce training

Eight maintenance technicians, employed by a large local milk processing company, have completed the *PLC Controlled Automation* Course, two from the group plus an additional two technicians have also gone through the *Relay Logic & Electro-Pneumatic Course.* The course allowed the technicians to learn new skills, to develop their existing skills, practice using industrial equipment and build confidence without the day-to-day pressures of live production-line maintenance.

New Entrant to the Automation/IIoT Integration Sector

Following a short work experience period with an Automation and IIoT Integration company in Ireland, an individual with Industry 4.0 skills required up-skilling and training on various aspects of Industry 3.0 automation including Relay Logic & Electro-Pneumatics, Microcontroller/Embedded Systems Programming and PLC Programming.

After ten 4hr one to one training sessions the individual gained the underpinning knowledge and skills he needs to progress in his new career in Industrial IIoT and IT/OT Systems Integration.

Industry Evaluation, Feedback and Course Testimonials.

Several local manufacturing companies were asked to rate and evaluate the content of the following courses and provide feedback on:

- *The extent to which these short courses would meet the current skills gaps of you or your existing workforce in relation to Industry 3.0.*
- *The extent to which these short courses would meet the needs of you or your existing workforce in relation to Industry 4.0.*
- *There is a good mix of theoretical and practical activities in these courses.*
- *Would any of these courses be of interest to you/your company as part of an upskilling initiative or an Industry 4.0 digital transformation project?*
- *If you or your employees have previously attended any of these short courses at SERC, what did you/they gain the most from the training and did you/they find it beneficial?*
- *Please list any areas for improvement or comments you feel relate to these short courses.*

The feedback received to date (pages 12-15) is positive with some notes for improvement with regards to specific equipment being added to certain modules, all respondents mention the importance of a "practical hands on" approach to upskilling and training with the majority being very satisfied that there is a good mix of theoretical and practical activities in the proposed courses.
The extent to which the short courses would meet the current skills gaps of the existing workforce in relation to Industry 3.0 was rated very satisfactory and the extent to which they would meet the needs of the existing workforce in relation to Industry 4.0, also very satisfactory.

The course modules have been designed in a way that allows the content to cover a broad range of industries, each of which uses common technologies such as general-purpose PLCs from the most common vendor (Siemens in this case), electro-pneumatics as the fluid power medium as this is more common than hydraulics in most cases. Each course/module could be tailored to specific industry needs if required, obviously within the limits of equipment cost, availability and the existing skill sets and expertise of the industrial training/teaching staff.

Gallarus Industry Solutions (Ireland) –IIoT Special Purpose Technician

COURSE EVALUATION FORM

To assist us with the evaluation process we would appreciate your honest comments which will be treated confidentially.

Your Organisation/Company: Gallarus Industry Solutions

SERC is a partner involved in a project designed to address the current Industry 3.0 skills gap and provide training towards Industry 4.0. As part of this SERC is developing a suite of short courses to upskill the existing workforce.

How would you rate the following:	Very Satisfied	Satisfied	Neither	Dissatisfied	Very Dissatisfied	Not Applicable
The extent to which these short courses would meet the current skills gaps of you or your existing workforce in relation to Industry 3.0.	X					
The extent to which these short courses would meet the needs of you or your existing workforce in relation to Industry 4.0.	X					
There is a good mix of theoretical and practical activities in these courses.	X					

Would any of these courses be of interest to you/your company as part of an upskilling initiative or an Industry 4.0 digital transformation project?

With the wide array of courses available I'm certain that they would be ideal for development of employees. As the courses provide the ability to be hands on with these machines and systems enabling people who undertake them to gain confidence on machines that are commonly used in industry today and will be used into the future.

If you or your employees have previously attended any of these short courses at SERC, what did you/they gain the most from the training and did you/they find it beneficial?

I attended 10 one to one 4-hour sessions and covered parts of the Programming Embedded Systems & Microcontrollers, Relay Logic Control & Electro-Pneumatic Automations, PLC Controlled Automation and Industry 4.0, IIoT & Digital Transformation. These courses gave me a great foundation to move into my role in Industrial automation focused on Industry 4.0. They gave me the ability to gain confidence and be hands on with systems and workflows that I use daily in my current role.

Please list any areas for improvement or comments you feel relate to these short courses.

The only area for improvement I think would be to have more variety of PLC's available to program, while all plc programs operate similarly the differences in connection types and variety within different manufacturers software can prove as a challenging hurdle to overcome which I believe can be alleviated with more exposure to different kinds of PLC's. Legacy PLC's are still used today and some focus time on how these are still useful and can be used in the context of industry 4.0 would be useful in my opinion.

Denroy Group (N'Ireland) –Process Engineer

COURSE EVALUATION FORM

To assist us with the evaluation process we would appreciate your honest comments which will be treated confidentially.

Your Organisation/Company: Denroy

SERC is a partner involved in a project designed to address the current Industry 3.0 skills gap and provide training towards Industry 4.0. As part of this SERC is developing a suite of short courses to upskill the existing workforce.

How would you rate the following:	Very Satisfied	Satisfied	Neither	Dissatisfied	Very Dissatisfied	Not Applicable
The extent to which these short courses would meet the current skills gaps of you or your existing workforce in relation to Industry 3.0.	X					
The extent to which these short courses would meet the needs of you or your existing workforce in relation to Industry 4.0.	X					
There is a good mix of theoretical and practical activities in these courses.	X					

Would any of these courses be of interest to you/your company as part of an upskilling initiative or an Industry 4.0 digital transformation project?

Yes. Of particular interest to myself and my colleagues would be the courses on Relay logic and electro pneumatics, electronic engineering, embedded systems, plc, robotics, additive manufacturing. CAD, industry 4, virtual engineering and data analytics.

If you or your employees have previously attended any of these short courses at SERC, what did you/they gain the most from the training and did you/they find it beneficial? Please list any areas for improvement or comments you feel relate to these short courses.

N/A

Please list any areas for improvement or comments you feel relate to these short courses.

Push as much practical exercises as possible. Provide candidates with list of manuals/books/technical documentation that will progress them even more when introduction courses are completed. Provide certification afterwards so candidates feel like they have achieved something worthwhile. I may have missed it but did not see specific mention of understanding and preparing electrical drawings, needs focus. Provide these courses free if possible.

Glanbia Cheese (N'Ireland) –Automation Engineer

COURSE EVALUATION FORM

To assist us with the evaluation process we would appreciate your honest comments which will be treated confidentially.

Your Organisation/Company: Glanbia Cheese

SERC is a partner involved in a project designed to address the current Industry 3.0 skills gap and provide training towards Industry 4.0. As part of this SERC is developing a suite of short courses to upskill the existing workforce.

How would you rate the following:	Very Satisfied	Satisfied	Neither	Dissatisfied	Very Dissatisfied	Not Applicable
The extent to which these short courses would meet the current skills gaps of you or your existing workforce in relation to Industry 3.0.	☒					
The extent to which these short courses would meet the needs of you or your existing workforce in relation to Industry 4.0.	☒					
There is a good mix of theoretical and practical activities in these courses.	☒					

Would any of these courses be of interest to you/your company as part of an upskilling initiative or an Industry 4.0 digital transformation project?

There are elements of all the courses in my view which are core skills from apprentice, mature apprentice and current skilled men levels which would have benefits from most of the content.

If you or your employees have previously attended any of these short courses at SERC, what did you/they gain the most from the training and did you/they find it beneficial? Please list any areas for improvement or comments you feel relate to these short courses.

Have to say I was impressed with the amount of content regarding the future projects of IoT and IIoT, since I have the knowledge from your classes, to me it is benefit gaining this knowledge and the awareness of how the industry is going to change in coming years and how we should be ready for it.

Please list any areas for improvement or comments you feel relate to these short courses.

Instrumentation, 0 to 10v,4 – 20mA control circuits. Can be built into the PLC/HMI and Pneumatics modules as primarily introduction basis and developed into a separate module as Process control. Introduction to VSDs vs DOL and Star-Delta, different control methods and reasons why VSD is used.

EAE (Electronic Automation Engineers Ltd, N'Ireland) –Automation Director

COURSE EVALUATION FORM

To assist us with the evaluation process we would appreciate your honest comments which will be treated confidentially.

Your Organisation/Company: Electronic Automation Engineers Ltd.

SERC is a partner involved in a project designed to address the current Industry 3.0 skills gap and provide training towards Industry 4.0. As part of this SERC is developing a suite of short courses to upskill the existing workforce.

How would you rate the following:	Very Satisfied	Satisfied	Neither	Dissatisfied	Very Dissatisfied	Not Applicable
The extent to which these short courses would meet the current skills gaps of you or your existing workforce in relation to Industry 3.0.		X				
The extent to which these short courses would meet the needs of you or your existing workforce in relation to Industry 4.0.		X				
There is a good mix of theoretical and practical activities in these courses.		X				

Would any of these courses be of interest to you/your company as part of an upskilling initiative or an Industry 4.0 digital transformation project?

PLC Controlled Automation, Relay Logic Control & Electro-Pneumatics, Automation & Industrial Robotics

If you or your employees have previously attended any of these short courses at SERC, what did you/they gain the most from the training and did you/they find it beneficial? Please list any areas for improvement or comments you feel relate to these short courses.

N/A

Please list any areas for improvement or comments you feel relate to these short courses.

Some really interesting content here Darren. What sort of cost is associated with these?

Short Course Module Content & Intended Learning Outcomes

GHL (Guided Learning Hours) **All Course content is under development and subject to change.**

Course 1) M1: Manual Mechanical Engineering Workshop

The intended aim of this short course is to develop the basic engineering skills, competencies and knowledge required when working in engineering and manufacturing processing environments. Within these environments engineers must be capable of interpreting engineering drawings and use basic conventional hand tools to produce, measure and modify simple components and parts.

The course introduces delegates to a broad range of bench fitting techniques from obtaining all necessary information, interpreting documentation and standards to planning how they intend to carry out the work, select and use the correct tools and equipment, measuring and inspecting the finished part while always adhering to health and safety procedures.

On completion of this course delegates will be able to interpret engineering drawings, select and use the appropriate workshop hand tools needed to produce specified parts, carry out manual bench fitting operations, measure/inspect their own work and be aware of and always follow health and safety procedures.

	1 Week: - Day 1 to 4 – Manual Mechanical Engineering Workshop. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build competence in:** **1. Interpreting engineering information and drawings.** **2. Select and use appropriate hand tools for specific hand fitting operations.** **3. Produce component parts and carryout measurement and inspection operations.** **4. Be aware of, understand and adhere to health and safety procedures.** **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to engineering drawings, manual hand tools, manual bench fitting and measurement/inspection techniques. **Receive workshop H&S induction.**	Typical layout of engineering drawings, standard hand tools used in engineering workshops, typical inspection/measurement devices and H&S procedures.
2	Overview of engineering drawings and standards.	Interpret engineering drawings, part orientation and datum, dimensions, etc.
3	Overview of manual hand material removal and measurement tools.	Tool, equipment, and device selection. What and when to use, etc
4	**Interpret** engineering drawing, **mark out** and **rough-cut** raw material to correct size and dimensions using correct tools.	**Practical**-Mark out and rough-cut raw billet of material as per engineering drawing.
5	**Manually hand file** and **bench fit** to within tolerances of engineering drawing**.**	**Practical**- Use correct tools & techniques to manually bench fit component.
6	**Inspect/measure** component to ensure dimensions are kept within specified tolerances.	**Practical**-Inspect/measure component using correct equipment.
7	**Interpret** engineering drawing, **mark out**, **drill,** and **deburr** holes in the component using correct tools and equipment.	**Practical**-Mark out, select correct tools, drill, and deburr holes in the component using correct equipment.

8	**Interpret** engineering drawing, **mark out**, **drill, deburr** and **tap/thread** holes in the component using correct tools and equipment.	**Practical**-Mark out, select correct tools, drill, deburr and tap/thread holes in the component using correct equipment.
9	**Interpret** engineering **drawing changes** and **modify** the component using correct tools and techniques.	**Practical**-Mark out, select correct tools and modify component as per engineering drawing changes.
10	**Inspect** completed component using correct equipment and techniques.	**Practical**- Select correct tools and equipment to inspect component.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Interpreting** engineering drawings. ○ **Selecting** correct tools and equipment. ○ Bench fitting **techniques.** ○ **Measurement** and inspection.	Practical using correct tools and equipment.

Course 2) M2: Manual Machining Workshop

1 week of Turning Workshop and 1 week of Milling Workshop *(can be delivered stand-alone)*

The intended aim of these two short courses is to further develop and build on previous *M1-Mechanical Engineering Workshop* skills, knowledge, and competencies as within manufacturing and processing environments it is beneficial for engineers to have an appreciation for, and some experience of the underpinning skills required to produce complex components and parts with the use of manual machining techniques using conventional lathes and milling machines.

These two courses introduce delegates to both turning and milling techniques, they will obtain all necessary information, interpret documentation and plan how they intend to carry out the work by selecting and using the correct tools and equipment, measuring, and inspecting the finished parts while always adhering to health and safety procedures.

On completion of this course delegates will be able to interpret engineering drawings, select and use the appropriate turning and/or milling tools and procedures required to produce specified parts, carry out manual turning and/or milling operations, measure/inspect their own work and be aware of and always follow health and safety procedures.

	Week 1 of 2: - Day 1 to 5 – Introduction to using Manual Lathes. (Theory & Practical) **GLH: Practical Workshop 35hrs** **(Wk. 1 of 2)** **Intended Learning Outcomes for day 1 to 5 are to upskill and build confidence in:** • **Understand the dangers and required H&S aspects of manual turning.** • **Interpreting engineering information and drawings.** • **Produce component parts using correct tools and procedures.** • **Carryout measurement and inspection operations**.	
1	Overview of manual lathes and turning operations.	Introduction to lathes, turning operations, capabilities and typical parts produced.
2	Introduction to manual lathes-**Receive turning H&S induction.**	Typical layout, operation of and H&S aspects of manual lathes.
3	Overview of engineering drawings and standards.	Interpret engineering drawings.
4	**3-Jaw Chuck-** Selection and setup procedures.	**Practical-** correct tool selection and set up.
5	**3-Jaw Chuck-**Speed & Feed selection.	**Practical-** calculating correct speeds, feeds and effects on different materials.
6	Produce various parts using the above.	**Practical-**Produce various parts using the above.
7	**4-Jaw Chuck-** Selection and setup procedures.	**Practical-** correct tool selection and set up.
8	**4-Jaw Chuck-**Speed & Feed selection.	**Practical-** calculating correct speeds, feeds and effects on different materials.
9	Produce various parts using the above.	**Practical-**Produce various parts using the above.
10	**Inspect** completed components using correct equipment and techniques.	**Practical-** Select correct tools and equipment to inspect component.

	Week 2 of 2: - Day 1 to 5 – Introduction to using Manual Milling Machines. (Theory & Practical) **GLH: Practical Workshop 35hrs (Wk. 2 of 2)** **Intended Learning Outcomes for day 1 to 5 are to upskill and build confidence in:** **1) Understand the dangers and required H&S aspects of manual milling.** **2) Interpreting engineering information and drawings.** **3) Produce component parts using correct tools and procedures.** **4) Carryout measurement and inspection operations**.	
1	Overview of manual milling operations.	Introduction to mills, milling operations, capabilities and typical parts produced.
2	Introduction to manual lathes-**Receive milling H&S induction.**	Typical layout, operation of and H&S aspects of manual mills.
3	Overview of engineering drawings and standards.	Interpret engineering drawings.
4	Alignment, setup and securing of workpiece vice.	**Practical-** Manually align, setup and securing of vice.
5	Loading, unloading tools in/out of spindle.	**Practical-** Manually load and unload tools in spindle.
6	X, Y & Z axis datum setup.	**Practical-** Manual setup of XYZ datums.
7	Speed & feed selection.	**Practical**- calculating correct speeds, feeds and effects on different materials.
8	Climb milling & upcutting.	**Practical-** Produce various parts using the above techniques.
9	**Debur** and finish parts produced.	**Practical-** Manually debur and finish parts produced.
10	**Inspect** completed components using correct equipment and techniques.	**Practical**- Select correct tools and equipment to inspect component.

Course 3) M3: CAM (Computer Aided Manufacturing)

The intended aim of this short course is to further develop and build on previous *M2-Manual Machining (Milling)* skills, knowledge, and competencies to further progress and enhance experience needed to produce computer aided manufacturing drawing and produce the machine programs required to manufacture complex components and parts with the use of advanced CNC machining techniques.

The course introduces delegates to CAM software 2D & 3D drawing techniques, they will obtain all necessary information, interpret documentation and plan how they intend to carry out the work by selecting and using the correct procedures and steps to produce simulations of CNC machining processes and post processing techniques.

On completion of this course delegates will be able to create basic 2D shapes & use 3D modelling techniques using CAM software to select and simulate tools, stock material behaviour and tool paths required to produce specified components.

	1 Week: - Day 1 to 5 – CAM (Computer Aided Manufacturing) (Theory & Practical) **GLH: Practical Workshop 35hrs (1 Week)** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** **1. Understand the dangers and required H&S aspects of CNC machining.** **2. Interpreting engineering information and drawings.** **3. Produce component parts using correct tools and procedures.** **4. Carryout measurement and inspection operations**.	
1	Overview of CAM software.	Introduction to CAM software.
2	Understand origins in the software environment**.**	**Practical-** Familiarisation of CAM software and the need for origins.
3	2D drawing of basic shapes.	**Practical-** Using CAM software to produce basic shapes/components.
4	3D modelling techniques.	**Practical-** Using CAM software to model basic 3D shapes/components
5	Selecting and assigning stock material to the CAM software model.	**Practical-** Assigning various stock material to the CAM software model.
6	Selecting and assigning correct tools to the CAM software model.	**Practical-** Selecting and assigning correct tools to the CAM software model.
7	X, Y & Z axis and datum setup.	**Practical-** Setup of XYZ axis and datums within the CAM software.
8	Creating and simulating tool paths.	**Practical-** Creating and simulating various tool paths within the CAM software.
9	Post processing.	**Practical-** Producing post processing code for CNC machining.
10	**Inspect** completed simulated components and post processing code.	**Practical**- Inspect completed simulated components and post processing code.

Course 4) M4: CNC- Advanced CNC Machining

The intended aim of this short course is to further develop and build on previous *M2-Manual Machining (Milling)* & *M3-CAM* skills, knowledge, and competencies to further enhance experience of the underpinning skills required to produce complex components and parts with the use of advanced CNC machining techniques.

The course introduces delegates to CNC milling techniques, they will obtain all necessary information, interpret documentation and plan how they intend to carry out the work by selecting and using the correct tools and equipment, measuring, and inspecting the finished parts while always adhering to health and safety procedures.

On completion of this course delegates will be able to interpret engineering drawings, select and use tools and procedures required to produce specified parts, carry out CNC machine operations, measure/inspect their own work and be aware of and always follow health and safety procedures.

	2 Weeks: - Day 1 to 10 – CNC Advanced Machining (Theory & Practical) **GLH: Practical Workshop 70hrs (2Weeks)** **Intended Learning Outcomes for day 1 to 10 are to upskill and build confidence in:** **1) Understand the dangers and required H&S aspects of CNC machining.** **2) Interpreting engineering information and drawings.** **3) Produce component parts using correct tools and procedures.** **4) Carryout measurement and inspection operations**.	
1	Overview of manual milling operations.	Introduction to mills, milling operations, capabilities and typical parts produced.
2	Introduction to CNC milling machines-**Receive CNC H&S induction.**	Typical layout, operation of and H&S aspects of CNC mills.
3	Overview of engineering drawings and standards.	Interpret engineering drawings.
4	Tool selection, gripping tool in collect, correct tool to carousel alignment and required safety.	**Practical-** Select correct tools, correctly grip tool in collet and correct tool placement in carousel.
5	Alignment, setup and securing of workpiece vice.	**Practical-** Manually align, setup and securing of vice.
6	X, Y & Z axis and datum setup.	**Practical-** Setup of XYZ axis and datums.
7	Uploading and downloading of machine programs.	**Practical-** Correct procedures for uploading and downloading of machine programs.
8	Controlling a CNC machine.	**Practical-** Controlling a CNC machine, slow speeds, taking manual control/safety.
9	**Debur** and finish parts produced.	**Practical-** Manually debur and finish parts produced.
10	**Inspect** completed components using correct equipment and techniques.	**Practical**- Select correct tools and equipment to inspect component.

Course 5) M5: CAD (Computer Aided Design)

The intended aim of this short course is to develop basic CAD skills, competencies and knowledge required to produce 3D models of components, parts and assemblies. Within modern engineering environments it is beneficial for engineers to have a basic understanding of how to produce basic 3D models using CAD software.

The course introduces delegates to a range of 3D CAD modelling techniques from obtaining all necessary information, interpreting documentation, planning how they intend to carry out the design, select and use the correct modelling software tools, measurement/inspection techniques and visualisation of required parts.

On completion of this short course delegates will be able to select and use the appropriate 3D CAD software tools and techniques to produce 3D design models of specified parts.

	1 Week: - Day 1 to 4 – CAD (Computer Aided Design) (Theory & Practical) **GLH: Practical Workshop 35hrs (1 Week)** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** **1. Using Computer Aided Design software.** **2. Create basic sketches and Produce 3D models of component parts using CAD software.** **3. Modify 3D models of component parts and using measurement and inspection tools.** **4. Apply textures and renders to 3D models for visualisation of 3D modelled objects.** **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to CAD software.	Typical layout of CAD software, navigation of the software environment, etc.
2	Creating/drawing basic 2D sketches.	**Practical –** Drawing basic 2D shapes.
3	Creating/drawing basic 3D component/part models.	**Practical –** Drawing basic 3D models, extruding, creating fillets/chamfers, etc, using available drawing tools.
4	Adding/modifying dimensions and using measurement/inspection tools.	**Practical –** Adding/modifying dimensions, using measurement/inspection tools.
5	Adding construction planes to the 3D modelling environment.	**Practical –** Adding construction planes to the 3D modelling environment using available drawing tools.
6	Working with bodies, components and assemblies.	**Practical –** Adding construction planes to the 3D modelling environment using available drawing tools.
7	Adding canvases to 3D component/part models.	**Practical –** Adding canvases to 3D component/part models using available drawing tools.
8	Adding textures and renders to 3D component/part models.	**Practical –** Adding textures and renders to 3D models using available drawing tools.
9	Creating simple joints and joint limits.	**Practical –** Creating simple joints and joint limits using available drawing tools.
10	Creating visualisation and simple assembly animations.	**Practical –** Creating visualisation and simple assembly animations using available drawing tools.

	Day 5 – Practice & Experimentation (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Using Computer Aided Design software.** ○ **Create basic sketches and Produce 3D models of component parts using CAD software.** ○ **Modify 3D models of component parts and Carryout measurement and inspection.** ○ **Apply textures and renders to 3D models for visualisation of 3D modelled objects**.	Practical using CAD software.

Course 6) M6: Additive Manufacturing (3D Printing/Rapid Prototyping)

The intended aim of this course is to develop the skills, knowledge and experience required to use 3D printing technology to produce rapid prototypes of parts and components. The course further develops the skills gained on the previous *M5-CAD (Computer Aided Design)* course to 3D print real world objects modelled in CAD software environments.
The course aims to develop an understanding of the benefits and limitations of 3D printing technology and progressively develop the skills, knowledge, and experience of rapidly prototyping new designs for parts, temporarily replacing existing damaged components and producing physical objects from initial ideas.

On completion of this course delegates will appreciate the use cases for 3D printing in an engineering/manufacturing environment, be able to design small parts/components using CAD software, use slicing software to convert, prepare & optimise 3D designs into STL/G-Code and produce 3D printed objects using additive manufacturing technology.

	1 Week: - Day 1 to 4 – Additive Manufacturing (3D Printing/Rapid Prototyping) (Theory & Practical) **GLH: Practical Workshop 35hrs (1 Week)** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Understanding the uses cases for and the benefits/limitations of 3D printing.** • **Creating/Drawing 3D CAD models for 3D printing.** • **Using slicing software to prepare and optimise 3D models for 3D printing.** • **Use additive manufacturing 3D printing machines to produce parts/components**. **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Overview of additive manufacturing technology and 3D printing processes.	Introduction to additive manufacturing, 3D printing capabilities, typical materials used, and parts produced.
2	Introduction to FDM 3D printers and required safety precautions**.**	Demo of FDM 3D printers, H&S, polymer materials used, component parts of 3D printers and their operation.
3	Creating CAD models suitable for 3D printing.	**Practical**-Use CAD software to create simple 3D model suitable for 3D printing.
4	Convert 3D CAD models to STL format suitable for optimisation in 3D printing slicer software.	**Practical-** Convert models to STL format for optimisation in 3D printing slicer software.
5	Preparing 3D printing machine for additive manufacturing.	**Practical-** Preparation, calibration and set-up of 3D printing machines.
6	Produce 3D printed object, part removal and quality testing.	**Practical-** Produce 3D printed object, remove part safely and test quality.
7	Modify 3D model parameters and re-optimise 3D printer settings to improve part quality.	**Practical-** Modify 3D model and further optimise 3D printer settings and reprint part.
8	Improving 3D printed part strength.	**Practical-** Improving 3D printed part strength through design modifications and reprint part.
9	Optimising, balancing and refining print time against quality.	**Practical-** Optimising, balancing and refining print time against quality.
10	Testing 3D printed parts in the real world, design for manufacture.	**Practical**- Overview of design for manufacture, are your prototype 3D printed parts fit for purpose, will the final actual component work as intended.

	Day 5 – Practice & Experimentation (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Understanding the uses cases for and the benefits/limitations of 3D printing.** ○ **Creating/Drawing 3D CAD models for 3D printing.** ○ **Using slicing software to prepare and optimise 3D models for 3D printing.** ○ **Use additive manufacturing 3D printing machines to produce parts/components**.	Practical using CAD software, slicer software and 3D printer.

Course 7) M7: LEAN Manufacturing (Continuous Improvement Techniques)

The intended aim of this course is to develop knowledge, understanding and experience of applying Lean manufacturing tools and techniques and the benefits of a continuous improvement mindset. Lean manufacturing processes can be used to improve efficiency, increase productivity, reduce wasted resources and wasted time.
The course examines the fundamentals of traditional manufacturing processes and Lean manufacturing processes to allow delegates to develop their skills, knowledge, and experience of using Lean manufacturing tools and develop a continuous improvement mindset.

On completion of this course delegates will understand the difference between traditional manufacturing processes versus Lean manufacturing processes while appreciating the benefits of a continuous improvement approach and how Lean thinking can Increase product quality, improve production efficiency, reduce wasted resources and nurture innovation.

	1 Week: - Day 1 to 5 – Lean Manufacturing (Continuous Improvement Techniques) (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Understanding Lean tools and continuous improvement.** • **Recognising value added and non-value-added processes.** • **Using Lean tools to reduce waste and increase efficiency.** • **Working in a team to continuously improve manufacturing processes**. **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Overview and introduction to Lean manufacturing continuous improvement.	What is Lean manufacturing, Kaizen and why do we need them compared to traditional manufacturing processes.
2	What are the different types of waste in manufacturing.	Examination of different types of waste: over production, motion, waiting, transportation, defects, rework.
3	What is TPS (Toyota Production System), where did it come from and what are the benefits and barriers of employing it.	What is TPS, the lean tools used, the benefits it brings, and the barriers met while trying to implement continuous improvement projects.
4	Team manufacturing exercise.	**Practical-**Work as part of a team to manufacture/assemble a simple product using traditional processes.
5	Review team manufacturing exercise outputs.	**Practical-**Short team presentations- how did your team perform; where is the waste, how can the processes be improved; do you need different skills sets.
6	Using lean tools to improve (Kaizen).	Overview of available Lean tools that can be used to improve a process: 5S, Value Stream Mapping, Kanban, Poke Yoke, etc.
7	Team manufacturing exercise.	**Practical-**Work as part of a team using predetermined lean tools to manufacture/assemble the simple product using TPS tools/processes.

8	Review team manufacturing exercise outputs.	**Practical-**Short team presentations- how did your team perform; was the manufacturing process improved, how and why.
9	Team manufacturing exercise.	**Practical-**Work as part of a team using lean tools to improve the manufacturing/assembly of the simple product using TPS tools/processes.
10	Review team manufacturing exercise outputs.	**Practical-**Short team presentations- how did your team perform; was the manufacturing process improved, how and why.

Course 8) E1: Electronic Workshop

The intended aim of this course is to develop skills, knowledge, and experience of low level discrete electronic components and circuits. All automated equipment within engineering and manufacturing environments contains electronics in some degree, it is essential that those working with this type of equipment understand basic electronic engineering.

The course introduces delegates to a broad range of electronic devices, components, and circuits from obtaining all necessary information, interpreting circuit diagrams and data sheets to planning how they intend to carry out the work, select and use the correct tools and components, breadboarding circuit prototypes, soldering & de-soldering components to create stripboard circuits, testing and measuring the finished circuit while always adhering to health and safety procedures.

On completion of this course delegates will be able to create & interpret electronic circuit diagrams, select components and use the appropriate electronic workshop tools needed to produce specified circuits, carry out testing/measuring of circuit operation, inspect their own work and be aware of and always follow health and safety procedures.

	1 Week: - Day 1 to 4 – Basic Control Circuits. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Understanding key electronic component operation.** • **Creating/Drawing electronic circuit diagrams interpreted from a basic brief of required system operation and select correct/suitable components.** • **Breadboarding/Soldering electronic components to create basic electronic circuits.** • **Fault-Finding** and **Trouble Shooting electronic circuits.** **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to Electronics.	Where are electronics used, typical layout of electronic circuits. ISO standard symbols.
2	Overview of key electronic components, devices and circuits used.	I/O components, resistors, capacitors, diodes, PSUs, etc. Including underpinning fundamental operation of each and H&S.
3	Overview of underpinning electronic component theory.	Ohms Law, resistor colour codes, basic diode theory, etc. Essential basic mathematical theory and calculations.
4	Basic practical electronic circuit building on breadboard.	**Practical–** introduction to building simple prototype circuits on breadboard.
5	**Reading/Following** basic electronic circuit diagrams, selecting correct components, and wiring circuits on breadboard.	**Practical–** interpreting circuit diagrams to build simple prototype circuits on breadboard.
6	**Drawing/Creating** circuit diagrams using electronic CAD software.	**Practical–** using electronic CAD software to draw, create, simulate, and test electronic circuits.

7	**Soldering/De-Soldering** techniques, building/testing electronic circuits on copper stripboard.	**Practical**- using soldering/de-soldering techniques.
8	**Design, Drawing and testing** of electronic circuits from initial concept, CAD software testing to breadboard prototype build and copper stripboard soldered circuit.	**Practical**- using software design/test, breadboarding and soldering/de-soldering techniques.
9	Electronic circuit **Fault-Finding** techniques.	**Practical–** electronic fault-finding techniques and equipment, multi-meters, oscilloscopes, etc.
10	Overview of PCB design and production.	Introduction to electronic PCB design and production.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned through:**	
	○ **Designing electronic circuits using CAD software.** ○ **Building electronic circuit prototypes on breadboard.** ○ **Soldering/De-soldering and Fault-Finding electronic circuits.**	Practical using correct tools and equipment.

Course 9) P1: Programming Embedded Systems & Microcontrollers

The intended aim of this short course is to further develop the introductory skills, knowledge, and competencies in devising electronic circuits from the previous *E1-Electronic Engineering Workshop* by interfacing electronic hardware devices, sensors, and actuators with microcontrollers to form embedded systems while learning low level C programming skills.

The course uses both embedded system software simulation tools and practical microcontroller I/O interfacing and programming to allow delegates to progressively develop their skills, knowledge, and experience of interfacing various I/O devices, electronic hardware, fault finding, writing low level programs, using the C programming language, and debugging their own code.

On completion of this course delegates will be aware of the features of common microcontrollers, be able to design and build small electronic circuits that interface with a microcontroller and write/debug structured C programs to create small embedded systems.

	1 Week: - Day 1 to 4 – Programming Embedded Systems & Microcontrollers. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build competence in:** • **Interface electronic circuits and I/O devices with microcontrollers.** • **Write structured C code programs.** • **Fault find hardware circuits and debug code/program errors.** • **Modify, adapt, and improve microcontroller programs**. **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to embedded systems and microcontrollers.	What are embedded systems & microcontrollers, where are they used and discussion on IoT.
2	Using simulation software to build small "hello world" microcontroller based embedded system: interfacing electronic circuit I/O with microcontroller.	**Simulation software based practical.** Connect an LED to an O/P pin and write code to switch on LED. Following systems to include LCDs, buttons, sensors, servo motors, potentiometers, etc.
3	Overview of microcontroller **program operation** and **structure**.	**Practical-** Writing/coding typical C programs, construction/layout, variables, initialisation, and main functions.
4	Overview of **debugging code** when program compilation errors occur.	**Practical-** rectification of typical C program compilation errors as they occur.
5	Building/programming of small embedded systems, repeating the software simulated exercises above.	**Practical-** building small "hello world" microcontroller based embedded systems by interfacing electronic circuit I/O with microcontroller.
6	Progressively **Modify** program complexity as far as using function call & return within code.	Each program introduces new functionality and progressively builds on the previous code.

Throughout the above exercises the following topics will be introduced, discussed, and practiced.		
7	Examine and understand the internal architecture and elements of typical MCUs.	-Function of MCU main elements. -Microcontroller internal architecture. -The CPU clock. -CPU-Fetch Decode Execute Cycle. -Memory- RAM/ROM. -Data, Address & Control Busses.
8	Explaining basics of Binary, Bits, Bytes, Hexadecimal, Integers, and float data types, etc. Conversion between decimal, binary and hex.	-Binary, Bits and Bytes. -What are Data types? -Different number systems.
9	Examine and understand digital devices (pull up/down resistors) and analogue devices including ADC, raw value scaling and resolution.	-Difference between Digital & Analogue devices. -ADC (Analogue to Digital Conversion) -Resolution
10	Awareness and appreciation of the broad scope use of MCUs and IoT in Smart Devices.	Examination & discussion- where are MCUs used both commercially, domestically and in industry, **Introduction to IoT**.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Interface** electronic circuits and I/O devices with microcontrollers. ○ **Write** structured C code programs**.** ○ **Fault find** hardware circuits and **debug** code/program errors**.** ○ **Modify**, **adapt**, **and improve** microcontroller programs.	**Practical** building/programming of small embedded systems

Course 10) A1: Relay Logic Control & Electro-Pneumatics

The intended aim of this course is to develop skills, knowledge, and experience of working with equipment controlled by relay logic without a software-based controller within engineering and manufacturing environments.

The course uses electro-pneumatics as the fluid power system controlled through hardwired relay logic circuits, delegates will progressively develop their skills and knowledge by interpreting schematic diagrams, selecting the correct components, and wiring/testing the practical circuit and resolving encountered faults.

On completion of this course delegates will be able to design appropriate relay logic/electro-pneumatic schematic diagrams as interpreted from the requirements for small electro-pneumatic systems and confidently navigate circuit diagrams when fault finding and troubleshooting on manufacturing equipment.

	1 Week: - Day 1 to 4 – Basic Relay Logic Control. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Reading schematic diagrams.** • **Creating/Drawing schematic diagrams interpreted from a basic brief of required system operation and select correct/suitable components.** • **Wiring/Building relay logic circuits to control electro-pneumatic components.** • **Fault-Finding** and **Trouble Shooting**. **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to Electrical Control Schematics.	Typical layout of schematic diagrams, ISO standard symbols, typical control circuit schematic layout.
2	Overview of machine control panels and typical components used.	PSUs, I/O components, relays, contactors, etc.
3	Overview of relay logic and I/O devices.	What is a relay, how do they work and why are they used?
4	Basic relay circuit design and practical connection.	Practical – introduction to using a relay logic training board.
5	**Reading** relay logic schematic diagrams and **Wiring** circuits.	**Practical**- using a relay logic training board.
6	Overview of pneumatic/electro-pneumatics, typical components used, typical control circuit schematic layout and how electrical control circuit schematics relate to electro-pneumatic schematics (navigating basic drawings)	Cylinders, Valves (3/2, 5/2, etc). Typical layout of schematic diagrams, ISO standard symbols.
7	**Reading** relay logic and electro-pneumatic schematic diagrams and **Wiring/Building** circuits.	**Practical**- using a relay logic/pneumatic training board.

8	**Creating** relay logic and electro-pneumatic schematic diagrams and **Wiring/Building** circuits.	**Practical**-Drawing/Amending schematics based on a short "brief". Practical using a relay logic/pneumatic training board.
9	Overview of **typical digital switches/sensors** used.	Proximity sensors (Inductive, Capacitive, Optical, etc), Reed switches, etc.
10	Relay logic and electro-pneumatic **Fault-Finding** and **Trouble Shooting**.	Practical using a relay logic/pneumatic training board.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Designing/creating** electro-pneumatic circuit schematics. ○ **Building/wiring** the circuits. ○ **Fault finding** & trouble shooting. ○ **Modifying** & **Amending schematics**, updating documentation.	Practical using and electro-pneumatic equipment.

Course 11) A2: PLC Controlled Automation

The intended aim of this course is to develop skills, and confidence in using PLCs, understand their applications within engineering and manufacturing and gain experience in programming them for typical small automated systems.

The course builds on previous skills and knowledge by using PLCs to control electro-pneumatic systems, utilising various I/O devices and typical PLC ladder logic programming techniques. Delegates will progressively develop their skills, knowledge, and experience by selecting the correct components, wiring, programming, and testing the practical PLC circuit and resolving encountered hardware faults and coding errors.

On completion of this course delegates will be able to select and connect appropriate I/O hardware devices to a PLC as interpreted from the requirements for small electro-pneumatic automated systems and confidently write, compile, download and test their own ladder logic programs.

	Day 1 to 4 – Introduction to PLCs. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Using and working around PLCs.** (Demystifying the "Black Box") • **PLC theory, practical programming, and automation.** • **Wiring/Building PLC controlled electro-pneumatic systems.** • **Fault-Finding and Trouble Shooting**. **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to PLCs.	What is a PLC, where did they come from, why do we need them? Types of PLCs- Unitary, Modular, Rack, RTU, etc.
2	**Introduction to TIA Portal V16.0.** **Wiring** and **programming** a basic PLC controlled circuit.	Practical using PLCs (S7-1200)- Opening TIA Portal, adding a device, online connection, HW config. Writing 1st simple program, compiling, downloading to PLC and testing circuit, etc.
3	**Reading/interpreting** a PLC based electro-pneumatic circuit schematic. **Wiring** devices to PLC I/O, **programming PLC, testing operation, fault-finding & trouble shooting, using monitor mode, tag/watch tables, etc.**	Practical using PLCs (S7-1200)- writing/amending increasingly complex programs using Ladder programming.
4	-Introduction to **HMIs** and data visualisation? - **Creating**, **programming,** and **connecting** basic PLC/HMI controlled circuits. *This topic is not essential and is dependent on time and delegate's progress.*	-What is an HMI, why do we need them? - Practical using PLCs and HMIs (S7-1200 & KTP700 Basic)- adding an HMI to a project, online connection. Creating 1st simple visualisation HMI program, compiling, downloading, and testing circuit.

	Throughout/during the above exercises the following topics will be introduced, discussed, and practiced.	
5	What is inside a PLC and how do they work?	I/P module & opto-isolators, O/P module & internal PLC relays. Relationship between CPU, memory, and the scan cycle, call hierarchy, addressing, etc
6	-What are Data types? -Different number systems.	Explaining basics of Bits, Bytes, Words, Endian, conversion between decimal, binary, hex, and BCD.
7	What are Tags, symbolic and absolute addressing?	Explanation and practice. Importance of using "meaningful" tag names that relate back to schematic diagrams, etc. Different naming conventions. (CamelCase, etc)
8	What are Memory Bits, Memory Words and using Data Blocks?	Explanation and practice. Re-enforce understanding of bits, bytes, addressing by discussing optimised and non-optimised Data Blocks.
9	**Displaying** data on an HMI. *This topic is not essential and is dependent on time and delegate's progress.*	Creating HMI accessible data in a data block and visualisation.
10	**Inputting** data from an HMI to manipulate a PLC program. *This topic is not essential and is dependent on time and delegate's progress.*	Control O/P devices using HMI buttons, switches, etc.

	<u>Day 5 – Practice & Experimentation.</u> <u>(Theory & Practical)</u> **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Designing/creating** small PLC controlled electro-pneumatic circuit schematics. ○ **Building/wiring** the circuits. ○ **Programming** the PLC. ○ **Testing**. ○ **Fault finding** & trouble shooting. ○ Adding an **HMI,** *dependent on progress.* ○ Fault finding & trouble shooting. ○ **Modifying** & **Amending schematics**, hardware components, software program, HMI visualisation and updating documentation.	Practical using PLCs an HMIs (S7-1200 & KTP700 Basic) and electro-pneumatic equipment.

Course 12) A3: Automation & Industrial Robotics

The intended aim of this course is to further the skills, knowledge and understanding of industrial automation and gain an appreciation for the uses of industrial robotics and gather some experience of offline/online programming industrial robots to perform simple tasks.

The course provides delegates with an appreciation for the benefits and limitations of automation in manufacturing environments while developing their skills, knowledge, and experience of the uses for offline/online programming of industrial robots.

On completion of this course delegates will understand how or when to automate processes and the use cases for different types of industrial robots, EOAT, safety measures and requirements when working around automated manufacturing environments.

	1 Week: - Day 1 to 4 – Automation & Industrial Robots. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Understanding the benefits and limitations of automation in manufacturing processes.** • **Understanding of different types of industrial robots, EOAT and associated safety requirements.** • **Designing and writing offline simulated robot programs to perform simple tasks.** • **Designing and writing online practical robot programs to perform simple tasks**. **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	**Understanding** Industrial automation - **when**, **why**, **where**, **what** and **who** should be involved.	Overview and understanding of when and where to automate in a manufacturing process, why not/why should you automate, what devices/systems to use for automation and who should be involved in the process.
2	Understand different types of industrial robots and their use cases.	Types of robots; multi axis articulated arm, SCARA, Delta, Cartesian, mobile, etc.
3	Understand different types of industrial robots and their use cases.	Types of EOAT, sensors, actuators, etc and associated use cases.
4	Understand the safety systems used in automation and industrial robots.	Understanding of safety systems used with industrial automation, robotics, robot cells and how to assess risk.
5	**Assess, Design,** and **Improve** non-automated and existing automated manufacturing processes. existing automated systems through industrial robot integration.	Accessing existing manufacturing processes with a view to improvement through automation. Simulation software workshop, case study/discussion.
6	**Assess, Design,** and **Improve** non-automated and existing automated manufacturing processes with industrial robot integration.	Accessing existing manufacturing processes with a view to improvement with industrial robot integration. Simulation software workshop, case study/discussion.

7	**Designing** and offline **programming** of an industrial robot to carry out simple tasks.	**Practical-** 6-axis articulated robot offline programming using simulation software.
8	**Understand** robot movements and programming instructions/commands.	**Practical-** Use various movements and instructions, Joint moves, Linear moves, velocity, TCP, position tolerances/accuracy, working envelope, etc.
9	**Designing** and online **programming** of an industrial robot to carry out simple tasks.	**Practical-** 6-axis articulated robot online programming.
10	**Understand** robot movements and programming instructions/commands.	Use various movements and instructions, Joint moves, Linear moves, velocity, TCP, position tolerances/accuracy, working envelope, etc.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Designing robot tasks.** ○ **Writing robot programs.** ○ **Testing and using robots.**	Practical using industrial robots.

Course 13) IF1: Virtual Engineering & Digital Twin 3D Simulation

The intended aim of this course is to develop knowledge & understanding of digital twin simulation technology, the benefits of using 3D factory simulation software and experience in developing virtual shopfloor production environments to visualise manufacturing production flow.

The course uses digital twin factory simulation software to allow delegates to progressively develop their skills, knowledge, and experience of developing 3D factory operations/production floor layouts, simulating manufacturing processes in real-time, perform virtual commissioning, process flow improvements, and connect cyber physical systems to simulated 3D machines.

On completion of this course delegates will be able to plan, design, simulate and improve virtual 3D digital twin factory production environments and understand the benefits that such technology can bring to an industry 4.0 compliant smart factory.

	Day 1 to 4 – Virtual Engineering & Digital Twin 3D Simulation. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Digital Twin Technology types & uses.** • **Using Digital Twin 3D simulation & virtual engineering software tools.** • **Planning, Designing, Building and Simulating real-time factory production 3D simulations.** • **Improving factory production/process flow environments using 3D simulation**. **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to Digital Twin technology, Virtual Engineering, and 3D Factory Simulation.	What is a Digital Twin, types and uses. What is Virtual Engineering and use cases for 3D factory simulation environments.
2	Overview of digital twin 3D simulation software package.	Opening the 3D software environment, tour of the IDE, component library and tools.
3	Planning, Designing, Building, and Simulating a simple factory production line.	**Practical-** first basic factory simulation. Part feeders, conveyor belts, virtual machines, etc
4	Using virtual human operators to carryout basic production line processes.	**Practical–** Adding virtual human operators to a simulated production process. Creating flow connections, altering workflows, speeds & feeds, etc.
5	Using and Altering processing parameters within production line flows to simulate and test real-time processes.	**Practical–** using and altering processes to improve and test real-time simulations, continuous improvement testing.
6	Importing and changing production parts within simulated production flows and processes.	**Practical–** Changing simulated part sizes/shapes in production flows and importing existing CAD models into simulated factory environment.
7	Creating realistic factory environments and recording/sharing videos of factory simulations.	**Practical–** Using realistic real-time factory simulation video recordings to onboard stakeholders and share ideas.

8	Extract data and statistics from real-time simulations and produce dashboards for analysis of production and process improvement strategy.	**Practical–** Create informative dashboards using data from real-time factory simulations for use is process improvement projects.
9	Overview of digital twin 3D simulation connection to cyber physical systems.	The benefits of digital twin and CPS real-time links using IIoT data-ops. OPC-UA connections.
10	Connect and test digital twin 3D simulation to real world cyber physical systems (PLCs).	**Practical–** Connect and test digital twin 3D simulation to a real-world PLC using OPC-UA.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Designing/creating** real-time 3D factory production simulations. ○ **Improving** factory simulated processes. ○ **Modifying** factory simulated production layouts and processes for continuous improvement.	Practical using digital twin 3D factory simulation software.

Course 14) IF2: Industry 4.0, IIoT and Digital Transformation

The intended aim of this short course is to develop knowledge of and to understand industrial digital transformation in the context of Industry 4.0 & Smart Manufacturing and how IIoT technology can be used to collect real time data from production processes and provide informational insights with a view to improve a manufacturing businesses overall operation.

The course examines sensors, PLCs, microcontrollers, IIoT data transport protocols and data-ops software platforms to allow delegates to enhance their skills, knowledge, and experience of existing automation technology and develop an "Industry 4.0" methodology mindset.

On completion of this course delegates will understand the difference between Industry 3.0 and Industry 4.0 while appreciating the benefits of digital transformation using modern IIoT techniques and how to select and connect sensors to build small/simple IIoT projects and create small ecosystems capable of data collection, data transportation, timeseries data base storage and insightful visualisation dashboards.

	Day 1 to 4 – Industry 4.0, IIoT & Digital Transformation. (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Understand the key differences between Industry 3.0 & Industry 4.0.** • **Understand industrial digital transformation and IIoT manufacturing ecosystems.** • **Connect, Collect, Transport, Store and Visualise real time sensor data with IIoT open-source platforms using a UNS (Unified Name Space).** • **Understand digital transformation strategy and improvement projects.** **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction to IoT, Industry 4.0, IIoT and Digital Transformation.	What impact did/do industrial revolutions have on manufacturing (key disruptors), what is the difference between IoT & IIoT and what are the benefits of digital transformation.
2	Overview of a typical Industry 3.0 factory.	Current ISA-95 automation level hierarchy. How is data currently collected and used.
3	Overview of an Industry 4.0 smart factory of the near future.	ISA-95 automation hierarchy using a Unified Name Space.
4	The What, Why, When, Where, Who and How of industrial data collection.	What data should be collected, Why do we need it, When should we get it, Where should we get it from, Who needs to see it and how can it be used. The need for data context.
5	Overview of IIoT data-ops.	OPC-UA, MQTT (Pub/Sub), data normalisation tools, real time data brokers (MQTT), Time Series Data bases and data visualisation tools. Local, EDGE and/or Cloud based computing.
6	**Connect** sensors and **Collect** data in real time.	**Practical-** Connect sensors to microcontrollers/PLCs, write programs to send the data to local low code flow-based software tools and visualise data.

7	**Create** and **use** an MQTT Broker (UNS) and Publish/Subscribe data to and from flow-based software platform.	**Practical-** Use an MQTT broker to manage publishing and subscription of real time data, using flow-based software tool for data normalisation and visualisation.
8	**Create** and **Use** a Time-Series data base and query the data collected from sensors/controllers.	**Practical-** Use a Time-Series data base to store/query real time data.
9	**Create** an insightful dashboard providing contextualized information from the collected data.	**Practical-**Use a Visualisation software tool to visualise the collected data with graphs, charts, gauges, etc.
10	**Produce** auto-generated reports & alerts based on collected data.	**Practical-** use reporting and alert tools to provide useful information from real time data.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Connecting sensors**. ○ **Writing programs, using low-code software tools**. ○ **Using software data visualisation tools to provide information from data**.	Practical using software and hardware.

Course 15) D1: Data Analytics, ML & Ai (Intro to real time industrial data analysis)

The intended aim of this short course is to further develop and build knowledge and skills gained on the previous *IF1-Industry 4.0, IIoT & Digital Transformation* course in the context of analysing real time data to provide meaningful insights using data analytics, machine learning and artificial intelligence to discover patterns and trends in raw data.

The course uses existing and real time data sets gathered from data-ops software platforms to allow delegates to enhance their skills, knowledge, and experience of the use cases for data analytics, machine learning and artificial intelligence and understand various data analysis tools.

On completion of this course delegates will understand the capabilities and use cases for various industrial data analysis approaches such as, descriptive, diagnostic, predictive and prescriptive analytics.

	1 Week: - Day 1 to 4 – Data Analytics, ML & Ai **(Intro to real time industrial data analysis)** (Theory & Practical) **GLH: Practical workshop 35hrs** **Intended Learning Outcomes for day 1 to 4 are to upskill and build confidence in:** • **Understand data analytics.** • **Understand ML & Ai use cases in IIoT manufacturing ecosystems.** • **Connect, Collect and analyse data sets using ML & Ai.** • **Visualise data analysis results and use various data analytical tools.** **Day 5 is used to re-enforce learning by providing time for delegates to practice and experiment.**	
1	Introduction/recap on IoT, Industry 4.0, IIoT and Digital Transformation.	Difference between IoT & IIoT and what are the benefits of industrial digital transformation.
2	Introduction to Industrial Data analytics, ML and Ai.	What is data analytics where it is used, how can it be used in a manufacturing environment to improve operations.
3	Overview of how a typical Industry 3.0 factory uses data from the shopfloor compared to a smart Industry 4.0 factory of the near future.	How is industrial data typically used in "your" factory; if at all, what are the latest data analytical tools currently available?
4	The What, Why, When, Where, Who and How of industrial data collection.	What data should be collected, Why do we need it, When should we get it, Where should we get it from, Who needs to see it and how can it be used. The need for data context.
5	Analysis of existing data sets.	**Practical**- Analysis of existing data using software tools to find trends and anomalies.
6	Analysis of real time data sets.	**Practical**- Analysis of data using software tools to find trends/patterns and spot anomalies.
7	Using data analytics for diagnostics.	**Practical**- Using real time data for diagnostics.
8	Analysis/comparison of existing data sets and real time data.	**Practical**- Analysis/comparison of existing data sets and real time data using software tools to find trends/patterns and predict anomalies.

9	Analysis/comparison of existing data sets and real time data.	**Practical**- Analysis/comparison of existing data sets and real time data using software tools to find trends/patterns, predict anomalies and prescribe potential solutions.
10	Reporting, alarming and alerting based on collected data.	**Practical**- use reporting, alarming and alerting tools to provide useful information from data analysis.

	Day 5 – Practice & Experimentation. (Theory & Practical) **Intended Learning Outcome for day 5 is to re-enforce learning by providing time for delegates to practice and experiment with the equipment they have been using and theory they have learned.**	
	○ **Understand data analytics.** ○ **Understand ML & Ai use cases in IIoT manufacturing ecosystems.** ○ **Connect, Collect and analyse data sets using ML & Ai.** ○ **Visualise data analysis results and use various data analytical tools.**	Practical using data analytics, ML and Ai software tools.