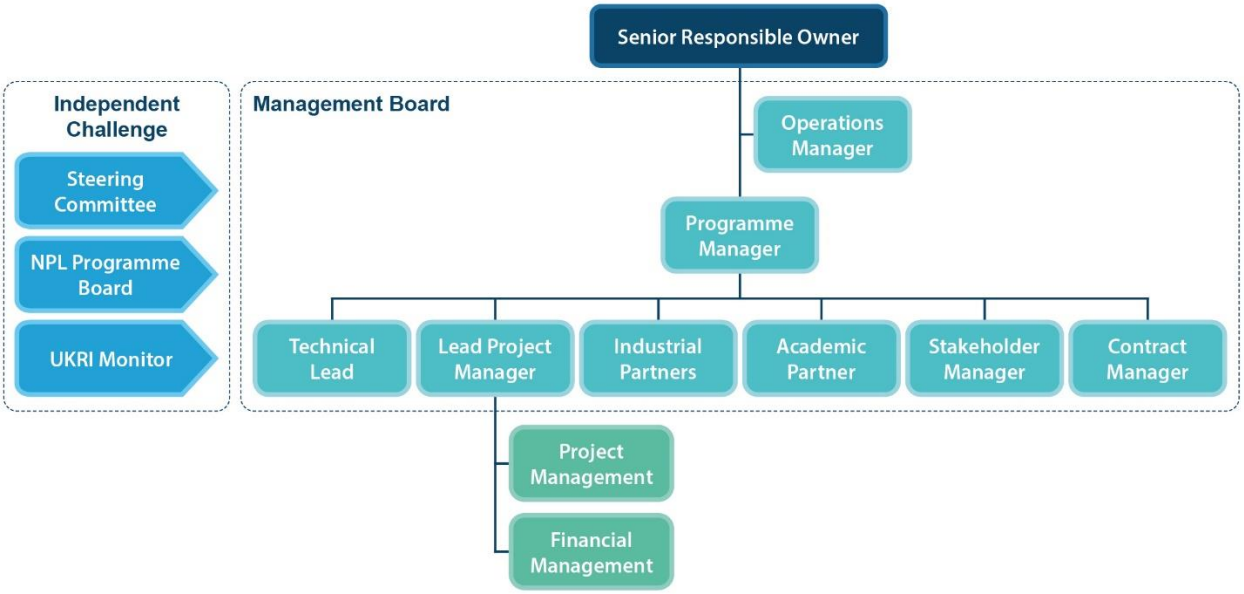
Q7 APPENDIX Project Management and Governance

1. Governance Structure



This programme will be delivered within a governance structure (shown above), which includes the following boards and committees:

- Programme Board: The NPL programme board will provide internal NPL oversight of the delivery of the programme and the realisation of benefits. The Board will support the Programme Manager who is accountable for the successful delivery of the programme. It will provide an escalation route for programme and project risks and issues in advance of the Management Board where programme decisions would be taken.
- Steering Committee: The Steering Committee will provide assurance that the work meets and remains aligned with regional, governmental, industry, academia needs and priorities, specifically requirements associated with innovation-led relative regional growth. It will provide external advice, direction and challenge to the programme on its level of ambition, scope, scale, operation, success factors. The committee members will also champion and raise awareness of the work amongst their stakeholder community. It will also provide advice on mitigating and addressing critical risks and issues impacting on the programme; review expected benefits and their achievement; and encourage the realisation of further benefits. The Committee Chair will be an independent person with a demonstrated track record of successful management of complex programmes. Committee Members will include senior representatives from key stakeholders, including trade associations, industry, academia, the High Value Manufacturing Catapult, local and national government agencies, including GMCA, WYCA and UKRI.
- Management Board: A Management Board will be set up with defined accountability, terms of reference, scopes and members. The purpose of the Management Board is to ensure the programme objectives are delivered according to a detailed delivery plan. The Board will exist to support the Programme Manager who chairs the group and has ultimate accountability for the successful delivery of the programme. It will contain members from each partner organisation with responsibility for delivering specific aspects of the programme, who will each provide resources and commitment to support the delivery of the programme. These partners are listed in the table below:

Acronym	Organisation	Acronym	Organisation
AMP	Advanced Machinery & Productivity Institute	UoH	University of Huddersfield
CRS	Compurent Ltd (trading as C R Solutions)	UoL	University of Leeds
FLL	Fives Landis Ltd	UoM	University of Manchester
NPL	NPL Management Ltd	UoS	University of Salford
PTG	Precision Technologies Group Ltd	WAL	Wayland Additive Ltd
RDA	Rochdale Development Agency		

2. Project Plan

The programme of work is organised according to the work breakdown structure (WBS) illustrated below.

AMPI Programme	
	WP1 Industry led research portfolio: Five flagship projects to deliver next-generation machinery capability, each led by an industrial partner. Programme agility and inclusivity of further businesses is assured by flexible funding in WP1.6
	WP2 Industry defined academic research portfolio: Nine initial workstreams, each led by an academic partner, with an industrial champion. Discovery- and demand-led agility is assured by flexible funding in WP2.10
	WP3 Innovation for Machinery (I4M): A new industry support scheme to broaden impact to enable short term (<20 days) interactions to solve short-term challenges and facilitate adoption of new innovation
	WP4 Industry engagement: By focussed regional engagement with industry, partners will build a critical mass of supply-chain for machinery producers and of end-users who are the supply chain of the UK's manufacturing base.
	WP5 Programme & financial management: Management, adopting NPL's Project Delivery Framework

The following table shows the main work packages (WP), the lead partner and indication of involved partners, high-level milestones/deliverables (D) and gates (G), whose timings are shown in the Gantt chart. Partner involvement indicates the strong connections between academic and industrial partners across all WPs.

Work packages in this integrated programme have high levels of interdependency, shown in this high level WBS, as "work package linkages".

WP 1.1	**Development of a new concept Friction Stir Welding (FSW) machine**											**Lead: PTG**
Start month	3	**Duration (months)**	24	**WP Linkages** 2.4, 2.3, 2.1, 2.8, 2.9							**Cost**	£ 898,639
Partners		AMP	CRS	FLL	**NPL**	**PTG**	RDA	**UoH**	UoL	**UoM**	UoS	WAL
Aim: To develop a highly innovative, new concept Friction Stir Welding (FSW) machine for production of electric vehicle battery casings and trays. *Obj*: (i) Design using new Virtual Engineering paradigm and adaptable to add outputs from other WPs. (ii) Analyse and quantify clamping and alignment forces, weld forces, mapping of tool torque and axial force, and in-process panel deformation. (iii) Manufacture of fully operational prototype machine with test facilities, sensors & interfaces. (iv) Run extensive trials.												
Gates	**G1.1.1** Results from D1.1.2 to go to build stage (M14); **G1.1.2** Results from D1.1.4 to go to beta release (M26)											
Deliverables	**D1.1.1** Digital twin to simulate process requirements and automation (M11); **D1.1.2** Virtual engineering analysis complete (M14); **D1.1.3** Fully operational prototype machine with test facilities, sensors and interfaces to enable client-factory simulation (M20). **D1.1.4** Report on extensive production trials (M26).											
WP 1.2	**Development of a grinding cell for high-volume production of rolling element bearing rings**											**Lead: FLL**
Start month	1	**Duration (months)**	24	**WP Linkages** 2.4, 2.1, 2.2, 2.6, 2.8, 2.9							**Cost**	£1,409,119
Partners		AMP	CRS	**FLL**	**NPL**	PTG	RDA	**UoH**	**UoL**	UoM	UoS	WAL
Aim: To design manufacture and test a research platform to provide a fundamental understanding of the controlling parameters for the machine and grinding process to be used, ultimately to bring to market a new, fully automated 'Twin Turret Grinder' cell for the high volume production of rolling element bearing rings. This will be essential for electrification of automotive vehicles, food production machinery and Green Energy. *Obj*: (i) parameterisation to enable adaptive control of process parameters in real time (ii) new inverse kinematics (iii) prototype build (iv) pre/post grind metrology techniques compatible with real time adaptive control (v) Artificial intelligence for autonomy and to minimise cycle times.												
Gates	**G1.2.1** Design shown to meet specification before build commences (M6); **G1.2.2** Chosen AI shown to be robust (M18)											
Deliverables	**D1.2.1** Machine design (M6); **D1.2.2** machine inverse kinematics (M7); **D1.2.3** Machine build (M18); **D1.2.4** AI for adaptive control of the bearing grinding process (M18); **D1.2.5** Custom part program editor(M18); **D1.2.6** Report on machining trials (M24)											
WP 1.3	**Development of an integrated free-form AM machine for production of maxillofacial implants**											**Lead: WAL**
Start month	1	**Duration (months)**	24	**WP Linkages** 2.1, 2.3, 2.4, 2.5, 2.8, 2.9							**Cost**	£2,000,000
Partners		AMP	CRS	FLL	**NPL**	PTG	RDA	**UoH**	**UoL**	**UoM**	UoS	**WAL**
Aim: Develop the full end to end machinery required for rapid manufacture (reduce from 6 months to 2 days) of personalised maxillofacial implants with accurate, complex, intricate shape and form. *Obj*: (i) E-beam AM machine (ii) New de-powdering and powder recycling systems (iii) metrology hardware, processing and feedback algorithms produced are key to the new machinery.												
Gates	**G1.3.1-G1.3.12** Each deliverable has a gate between the design, virtual engineering and prototyping stages.											
Deliverables	**D1.3.1** Electron beam AM machine (M6); **D1.3.2** Powder handling, loading & reprocessing equipment (M6); **D1.3.3** Part removal equipment (M9); **D1.3.4** De-powdering machine (M14); **D1.3.5** Geometrical Form & surface finish metrology equipment (M21); **D1.3.6** Electro Chemical Machining & Free-Form Abrasive Processing and Polishing Equipment (M24).											
WP 1.4	**Development of a high-speed delivery feed system for low mass objects in automation**											**Lead: CRS**
Start month	4	**Duration (months)**	24	**WP Linkages** 2.3, 2.3, 2.6, 2.7, 2.9							**Cost**	£509,414
Partners		AMP	**CRS**	FLL	NPL	PTG	RDA	**UoH**	UoL	**UoM**	UoS	WAL
Aim: Produce a prototype servo ball-conveying machine to enable high speed (~220p/min) low mass (<0.05kg), large surface area part feeding. The initial application will be for pharmaceuticals (distributing swabs ready for a robot to pick and pack), but designed for												

flexibility for food and beverage, aerospace, general manufacturing and Life Science industries. *Obj*: (i) Mechanical, electrical & control design (ii) component procurement, fabrication and assembly (iii) testing for a wide range of applicable products.													
Gates	**G1.4.1** Results from D1.4.1 reviewed and prototype specification agreed (M11), **G1.4.2** Results from D1.4.2 (M23)												
Deliverables	**D1.4.1** Design & virtual engineering analysis (M9), **D1.4.2** Component bench test (M21), **D1.4.3** Prototype machine (M27)												
WP 1.5	**Open Source CNC Control**												**Lead: FLL**
Start month	1	**Duration (months)**	24	**WP Linkages** 2.2, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9								**Cost**	£212,343
Partners		AMP	CRS	**FLL**	**NPL**	PTG	RDA	**UoH**	UoL	**UoM**	UoS	WAL	
Aim: To develop an Open Source computer numerical controller (CNC) that will allow users to implement functionality in high level code within the core of the CNC for any precision manufacturing machinery. This is an enabling technology that will provide UK companies, HVM Catapults and Academic Institutions the ability to design and implement software in high level coding languages in the core of the CNC control for efficient implementation and adoption of new research, including AI, IoT and other methodologies. *Obj*: (i) Define scope from existing controller and intended application (ii) create core functionality (iii) integrate to testbed (iv) test through independent partner (v) Develop open licence framework (e.g. Apache Open Source model).												
Gates	**G1.5.1** Results from D1.5.1 (M3); **G1.5.2** Results from D1.5.2 and D1.5.3 to go to partner trial (M16)												
Deliverables	**D1.5.1** Specification of proposed system (M3); **D1.5.2** Prototype system for 3 axis machining(M14); **D1.5.3** Example code and HMI (M16); **D1.5.4** Demonstrated implementation by a third-party consortium member (M24).												
WP 1.6	**Flexible Industry-led projects**												**Lead: NPL**
Start month	6	**Duration (months)**	50	**WP Linkages** WP2 for each project. Informed by WP3 & WP4								**Grant**	£6,000,000
Partners		**AMP**	CRS	FLL	**NPL**	PTG	**RDA**	UoH	UoL	UoM	UoS	WAL	
Aim: To retain flexibility to respond to in-project foresight and to meet discovery and demand from the existing WPs. *Method:* Through the governance structure, additional projects at different scales (to maximise impact and make accessible to SMEs) will be created to. Two rounds will be called in years 1 & 3. UKRI will be invited to manage the process. Additional sub-WPs will be created for each project, each of which will meet the normal match-funding rules for Innovate UK CR&D projects.													
Gates	**G1.6.1** Proposals review thresholds met for Round 1 (M10); **G1.6.2** Proposals review thresholds met for Round 2 (M22)												
Deliverables	**D1.6.1** Call scope defined and agreed(M8), **D1.6.2** Round 1 projects launched (M11), **D1.6.3** Round 2 projects launched (M23)												

WP 2.1	**Dynamic resilient machines and fabrication technologies**												**Lead: UoL**
Start month	3	**Duration (months)**	53	**WP Linkages** 1.3, 1.4, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8								**Cost**	£2,242,932
Partners		AMP	**CRS**	**FLL**	NPL	PTG	RDA	UoH	**UoL**	**UoM**	**UoS**	**WAL**	
Aim: To design highly physically modular, reconfigurable, low cost, Intelligent and self-adapting machine technologies beyond state-of-the art. We will investigate the combination of soft, lightweight materials, muscular actuation, sensing skins, fabrication technologies. *Obj* (i) Development of a lightweight modular low cost robotic manipulator, using a combination of actuation units, that is rapidly reconfigurable based on the task request; (ii) Reconfigurable dexterous end effectors for unknown object and tasks (iii) Design and control of high speed lightweight machines (iv) Smart robotic machines for additive manufacturing													
Gates	**G2.1.1** Results from D2.1.1 (M20); **G2.1.2** Results from D2.1.3 (M38)												
Deliverables	**D2.1.1** Smart machine 3D manufacturing platform created, commissioned & demonstrated (M20). **D2.1.2** A demonstration of mobile smart machine platform operating in dynamic environments forces (e.g. during re-machining) (M38). **D2.1.3** Universal adaptable end effector demonstrated and delivered (M38). **D2.1.4** Demonstration of reconfigurable lightweight manipulator using the combination of the multi-drive systems units (M53)												
WP 2.2	**Human-machine interaction systems**												**Lead: UoS**
Start month	3	**Duration (months)**	53	**WP Linkages** 1.5, 2.1, 2.3, 2.6, 2.7								**Cost**	£700,403
Partners		AMP	**CRS**	**FLL**	NPL	PTG	RDA	**UoH**	**UoL**	UoM	**UoS**	WAL	
Aim: To develop control architecture for HRI that implements the coordination of actions as a dynamic and flexible process that integrates teaching by demonstration, compliant architecture and advanced motor behaviours. The architecture will consist of three main layers (i) learning of elementary tasks; (ii) hierarchical combinations of tasks; (iii) decentralized motor control structure responsible for torque/ position trajectory tracking (iv) integration to the compliant manipulator (D2.1.4) for testing of the skill through kinaesthetic teaching.													
Gates	**G2.2.1** Results from D2.2.1 (M36)												
Deliverables	**D2.2.1** Development of a user-friendly Multimodal HM robotics Pal interface (M36); **D2.2.2** Control architecture completed and tested (M50). **D2.2.3** Demonstration directly in the compliant manipulator's workspace (M56).												
WP 2.3	**Materials, surface engineering and coatings for sustainable, productive advanced machinery**												**Lead: UoM**
Start month	1	**Duration (months)**	36	**WP Linkages**								**Cost**	£456,132
Partners		AMP	CRS	FLL	**NPL**	PTG	RDA	UoH	**UoL**	**UoM**	UoS	WAL	
Aim: This WP will investigate (i) Lightweight materials and structures, especially for high-speed machinery requiring reductions in inertial forces & reduction in energy demand; (ii) Improved machinery longevity through selectively hardened surfaces; (iii) Tool life extension and reduced machine excitation through advanced ceramic coatings for cutting tools, and lubricious coatings for forming dies and moulds; (iv) Materials developments for advanced fixtures and robotic grippers.													
Gates	**G2.3.1** define components for lightweighting (M8), **G2.3.2** define components for tools for hardening (M12), **G2.3.3** define components for tools for coating (M12), **G2.3.4** define components for gripper system requirements (M12).												
Deliverables	**D2.3.1** Optimise surface treatment performance in model tests (M20),**D2.3.2** Demonstrator parts (M20-36), **D2.3.3** Provide hardened components (M24), **D2.3.4** Provide coated tools (M24), **D2.3.5** Trials on gripper material (M36)												

WP 2.4	Design and optimisation through virtual tools											Lead: UoH
Start month	1	Duration (months)	56	WP Linkages 1.1, 1.2, 1.3, 1.4, 1.5, 2.1, 2.3, 2.6, 2.7, 2.8							Cost	£1,300,000
Partners	AMP	CRS	FLL	NPL	PTG	RDA	UoH	UoL	UoM	UoS	WAL	
Aim: Create simulation tools for key machinery and processes most relevant to the industrial partners and future demands. *Obj:* (i) parameter identification from quality metrics to ensure model development captures sensitive design variables (ii) determine the best CAE tool and integration of optimisation methods that enable rapid model development (iii) prototype virtual tools (software and methods) for partner testing.												
Gates	**G2.4.1** virtual tool preliminary model performance is design capable (M36), **G2.4.2** Virtual tools usability feedback (M54)											
Deliverables	**D2.4.1** Detail of identified machinery and performance parameters (M12), **D2.4.2** virtual tool model definitions (M30), **D2.4.3** Prototype software/methods for partner design trials (M50). **D2.4.4** Virtual tool trials results reported (M56)											
WP 2.5	**Metrology for ultra-precision dynamic process capability**											**Lead: NPL**
Start month	1	Duration (months)	56	WP Linkages 1.1, 1.3, 1.5, 2.3, 2.6, 2.7, 2.8, 2.9							Cost	£1,100,000
Partners	AMP	CRS	FLL	NPL	PTG	RDA	UoH	UoL	UoM	UoS	WAL	
Aim: To create the necessary instrumentation to support advanced machines in carriable environments. *Obj*: (i)Develop a dynamic infra-red, optical-based coordinate metrology system, forming a key component of future closed-loop factory-wide digital tracking environments used for dynamic control. (ii) Develop an ultra-high accuracy one-dimensional instrument to enable the traceable verification of high accuracy components and high precision manufacturing machines.												
Gates	**G2.5.1** Hardware procured and commissioned - team trained (M8), **G2.5.2** Hardware procured (M8), **G2.5.3** Instrument built and tested to basic requirements (M14)											
Deliverables	**D2.5.1** Protocol for self-calibration routine of robot using static target measurement demonstrated (M26), **D2.5.2** Target spec tested and proven in simulated environment (M26), **D2.5.3** Target spec tested and proven in representative environment (M35), **D2.5.4** Self-correction of single robot demonstrated using dynamic measurements (M44), **D2.5.5** Self-correction of multiple, connected robots demonstrated using dynamic measurements (M56)											
WP 2.6	**Cyber-Physical interoperability of machinery and subsystems**											**Lead: UoH**
Start month	4	Duration (months)	36	WP Linkages 1.4, 1.5, 2.1, 2.2, 2.4, 2.5, 2.7, 2.8							Cost	£1,206,132
Partners	AMP	CRS	FLL	NPL	PTG	RDA	UoH	UoL	UoM	UoS	WAL	
Aim: A framework for mechanical, electrical and control descriptors will be derived to allow interoperability between machines and between subsystems of machines. The conflict between standardisation and flexibility needs to be resolved to avoid suppressing innovation of OEM system development. *Obj*: (i) defined standardised APIs for open- and closed-source systems, (ii) inclusion of rapid reconfigurability, drive optimisation and the various compensations in WP2.8 (iii) embedding metrology data transfer (iv) Real-time optimisation of drives for criteria such as energy use, output quality indices and fault mitigation with the system-level combination of data and co-ordinating control across multiple drives (v) energy efficient, self-optimising multi-drive systems for machinery.												
Gates	**G2.6.1** Cyber-Physical framework applied to MDoF control\ system (M29), **G2.6.2** Standard interface evaluation (M33)											
Deliverables	**D2.6.1** Drive and subsystem type selection (M11). **D2.6.2** C-P framework design, with optimisation (M23). **D2.6.3** Performance validation against MDoF AMPI machinery, using standard interface (M29). **D2.6.4** Energy optimised drive demonstrator (M33). **D.2.6.5** Fault mitigation algorithms (M39).											
WP 2.7	**Autonomous manufacturing machines**											**Lead: UoH**
Start month	1	Duration (months)	56	WP Linkages 2.9, 2.6, 2.4, 2.3, 2.1, 2.2, 1.5, 1.2							Cost	£875,000
Partners	AMP	CRS	FLL	NPL	PTG	RDA	UoH	UoL	UoM	UoS	WAL	
Aim: To deduce the necessary data and knowledge streams (demands, commands, sensors, etc.) and algorithms to allow manufacturing machinery to operate autonomously by design. *Obj*: (i) physical, sampling and data structure definitions for embedded awareness (ii) application of self-learning and cognitive tools (iii) fidelity of data and decision-making, with metric for confidence and uncertainty												
Gates	**G2.7.1** Decision on extra resource needed after D2.7.1 (M12), **G2.7.2** Deployment based on D2.7.4 (M52)											
Deliverables	**D2.7.1** Report on information streams for machinery builders and available algorithms (M10) **D2.7.2** Toolkit of information streams, including output from D2.9.2 (M23) **D2.7.3** Algorithms tested and evaluated (M42) **D2.7.4** Demonstration on manufacturing machine (M50).											
WP 2.8	**Advanced error correction and compensation**											**Lead: UoH**
Start month	4	Duration (months)	52	WP Linkages 1.1, 1.2, 1.3, 1.5, 2.1, 2.3, 2.4, 2.6, 2.8							Cost	£571,564
Partners	AMP	CRS	FLL	NPL	PTG	RDA	UoH	UoL	UoM	UoS	WAL	
Aim: This WP will focus on reducing significant spatially and temporally variant errors affecting standard and reconfigurable machinery including thermal, dynamic, and static finite stiffness. This requires research into three main areas (i) robust error modelling (ii) rapid measurement (minimum downtime) and cost-effective embedded sensing (iii) methods for real-time compensation integration into partner machinery control systems.												
Gates	**G2.8.1** Partner agreed machinery errors identified (M15), **G2.8.2** Prototype compensation systems installed at sites (M51)											
Deliverables	**D2.8.1** Reference modelling methods for error compensation (M19) **D2.8.2** Measurement methods for reduced downtime (M27) **D.2.8.3** Embedded dynamic error detection (M39) **D2.8.4** Machinery controller interfaces and validation (M55).											
WP 2.9	**Dynamic monitoring of intelligent machining systems**											**Lead: NPL**
Start month	1	Duration (months)	56	WP Linkages 2.8, 2.3, 2.5, 2.6							Cost	£750,500
Partners	AMP	CRS	FLL	NPL	PTG	RDA	UoH	UoL	UoM	UoS	WAL	

Aim: To define IoT sensor swarms with traceability and quantified accuracy suitable for embedding in machinery for through-life monitoring. *Obj*: (i) establish a specification of digital requirements for integrating metrological process data and process-related metadata. (ii) Determine the specification and development of the technology required to implement IoT swarms with traceability and quantified accuracy. (iii) Design and build a prototype to applied to a suitable demonstrator within the consortium. (iv) Short-term experiments and medium-term data capture and analysis.	
Gates	**G2.9.1** Prototype of traceable IoT sensor array conforms to specification (M26), **G2.9.2** Analysis of extracted data from demonstrator system (M41), **G2.9.3** Review of practical implementation of IoT system at end of project (M41), **G2.9.4** Review of practical implementation of IoT system at end of programme (M56).
Deliverables	**D2.9.1** Specification of digital requirements (M8), **D2.9.2** Prototype of traceable IoT sensor array (M23), D2.9.3 Specification for demonstration of prototype (applied) (M29), **D2.9.4** Developed demonstrator system (applied prototype) (M38), **D2.9.5** Practical implementation of IoT system (M56).

WP 2.10	**Flexible research portfolio**											**Lead: NPL**
Start month	6	**Duration (months)**	50	**WP Linkages**							**Grant**	£1,250,000
Partners		**AMP**	CRS	FLL	**NPL**	PTG	**RDA**	**UoH**	UoL	UoM	UoS	WAL
Through the governance structure, additional projects will be created to meet discovery and demand. As well as the response to the programme determined by the review process, two rounds will be called (in years 2 and 3) to refresh the portfolio with externally-driven project ideas. If appropriate, UKRI will be invited to manage the process, which will follow the agreed cost model of the programme.												
Gates	**G2.10.1** Proposals review thresholds met for Round 1 (M10); **G2.10.2** Proposals review thresholds met for Round 2 (M22)											
Deliverables	**D2.10.1** Scope defined and agreed, (M8) **D2.10.2** Round 1 projects launched (M11), **D2.10.3** Round 2 projects launched (M23)											

WP 3	**Innovation for Machinery (I4M) scheme**											**Lead: NPL**
Start month	1	**Duration (months)**	56	**WP Linkages** WP2 & 4 & WP1.6							**Cost**	£1,040,000
Partners		**AMP**	CRS	FLL	**NPL**	PTG	**RDA**	UoH	UoL	UoM	UoS	WAL
NPL will launch and administer a new industry support scheme called 'Innovation for Machinery' (I4M). Under this scheme, UK manufacturing companies will be able to apply for up to 20 days of consultancy and/or short-term measurement, design and technology foresighting projects free of charge, to help accelerate the development of new advanced manufacturing products in the UK. This scheme will help bridge the gap from a technology prototype to an industry-ready, innovative new product or service. It follows the methodology, though broadens the offering, from the very successful Analysis for Innovators (A4I) and Measurement for Recovery (M4R) programmes.												
Gates	**G3.1** after soft launch assess process for effective delivery and efficiency and make any adjustment prior to full launch (M11); **G3.2** assess early outcomes and evaluation impact through Business Success Interviews (M17).											
Deliverables	**D3.1 - D3.5** annual reports on outcomes and impact.											

WP 4	**Industry Engagement**											**Lead: UoH**
Start month	1	**Duration (months)**	56	**WP Linkages** WP1, 2 & 3							**Cost**	£641,665
Partners		**AMP**	CRS	FLL	**NPL**	PTG	**RDA**	**UoH**	UoL	UoM	UoS	WAL
The UoH Business Growth and Productivity Service run two local LEP programmes around Supply Chain, Manufacturing Growth and Technology Adoption. We will work with RDA and NPL to offer a service to local industrial partners, strengthening regional supply-chains to support the new technologies/machinery being developed across the programme. This WP will manage the regular engagement between programme partners and key industrial stakeholders. This essential function will ensure that the technical research programme matches the needs of, and maximises the impact to, local & UK industry through the advanced machinery sector. We will engage with networks like CKMA, BAMA and Make UK to ensure the support from AMPI is well communicated across the industry partners.												
Gates	**G4.1.1 – G4.1.4** Annual reviews of industry engagement activities											
Deliverables	**D4.1.1** Revised industry engagement plan (M30)											

WP 5	**Programme management**											**Lead: NPL**
Start month	1	**Duration (months)**	56	**WP Linkages** All							**Cost**	£2,613,818
Partners		**AMP**	**CRS**	**FLL**	**NPL**	**PTG**	**RDA**	**UoH**	**UoL**	**UoM**	**UoS**	**WAL**
NPL's management processes are ISO 9001 accredited. A robust project management procedure (QPNPL/B/004 NPL Project Delivery Framework) will ensure an appropriate level of management and oversight of all work. This programme will be supported by NPL's Project Management Office (PMO) whose role is to manage NPL's portfolios of projects funded by a range of public and private sector bodies. A dedicated lead project manager will be assigned from the PMO, who will manage delivery of this programme on a day-to-day basis. NPL will manage the programme budget and distribution of funds to its consortium partners, using its existing finance team, structures and systems. The finance team will work closely with the programme management team to prepare accurate payment schedules, monitor delivery against these schedules and ensure that all claimed costs are eligible under UKRI guidelines.												
Gates	**G5.1.1** Mid-term review (M28); **G5.1.2** transfer of responsibility to AMPI Ltd (M56).											
Deliverables	**D5.1.1** Consortium agreement signed by all parties (M1); **D5.1.2** Detailed project plans (M6) **D5.1.3** Quarterly reports to UKRI.											

3. Project Schedule

Ref No.	Activity Description	Lead Partner	2021 Q3	2021 Q4	2022 Q1	2022 Q2	2022 Q3	2022 Q4	2023 Q1	2023 Q2	2023 Q3	2023 Q4	2024 Q1	2024 Q2	2024 Q3	2024 Q4	2025 Q1	2025 Q2	2025 Q3	2025 Q4	2026 Q1	2026 Q2
	Key:				Activity				Deliverable						Gate							
			AMPI ISCF Strength in Places Wave 2 Programme																			
WP1	**Industry Led Research Portfolio**	**NPL**																				
1.1	**New concept Friction Stir Welding machine**	PTG																				
1.1.1	Digital twin to simulate process reqs & automation	PTG				D1																
1.1.2	Virtual engineering analysis & reporting	PTG					D2	G1														
1.1.3	Build & test fully operational prototype	PTG							D3													
1.1.4	Trial prototype	PTG									D4	G2										
1.2	**Twin Turret Grinder Cell**	FLL																				
1.2.1	Design machine	FLL			D1	G1																
1.2.2	New machine inverse kinematics	FLL			D2																	
1.2.3	Machine build	FLL							D3													
1.2.4	AI for adaptive control of bearing grinding	FLL							D4	G2												
1.2.5	Custom part program editor	FLL							D5													
1.2.6	Write report on machining trials	FLL									D6											
1.3	**Print machine for maxillofacial implants**	WAL																				
1.3.1	Develop electron beam AM machine	WAL					G1		G2		D1	G3										
1.3.2	Develop powder processing equipment	WAL	G4	G5	D2	G6																
1.3.3	Develop part removal equipment	WAL	G7		G8	D3	G9															
1.3.4	Develop de-powdering machine	WAL	G10		G11		D4	G12														
1.3.5	Develop form & surface finish metrology equipment	WAL				G13		G14		D5	G15											
1.3.6	Develop ECM & abrasive processing/polishing Equipment	WAL					G16		G17		D6	G18										
1.4	**High-speed delivery feed system**	CRS																				
1.4.1	Design & virtual engineering analysis	CRS				D1	G1															
1.4.2	Component bench test	CRS								D2	G2											
1.4.3	Prototype machine	CRS										D3										
1.5	**Open source CNC control**	FLL																				
1.5.1	Specification of proposed system	FLL		D1	G1																	
1.5.2	Prototype system for 3 axis machining	FLL					D2	G2														
1.5.3	Example code and HMI;	FLL						D3	G3													
1.5.4	Demonstrated implementation by TP consortium member	FLL									D4											
1.6	**Flexible Projects**				D1	D2	G1			D3	G2											
WP2	**Industry Defined Academic Research Portfolio**	**UoH**																				
2.1	**Dynamic resilient machines and fabrication technologies**	UoS							D1	G1					D2/D3	G2				D4		
2.2	**Human-machine interaction systems**	UoS													D1	G1		D2			D3	
2.3	**Materials, surface engineering & coatings for machinery**	UoM				G1		G2-G4		D1/D2	D3/D4				D4							
2.4	**Design and optimisation through virtual tools**	UoH					D1						D2			G1			D3		D4	G2
2.5	**Ultra-Precision Dynamic Process Capability**	NPL		G1/G2			G3			D1/D2			D3			D4					D5	
2.6	**Cyber-Physical interoperability of machines and**	UoH				D1				D2		D3	G1	D4	G1	D5						
2.7	**Autonomous manufacturing machines**	UoL				D1		G1		D2							D3		D4		G2	
2.8	**Advanced error correction and compensation**	UoH						G1	D1			D2				D3				G2	D4	
2.9	**Dynamic monitoring of intelligent machining systems**	NPL			D1					D2	G1	D3			D4		G2/G3				D5	G4
2.10	**Flexible Research Portfolio**	NPL			D1	D2	G1			D3	G2											
WP3	**Innovation for Machinery (I4M) Scheme**	**NPL**																				
3.1	**Set up scheme**	NPL																				
3.2	**Soft launch of pilot scheme**	NPL																				
3.3	**Assess process for effective delivery & efficiency**	NPL				D1	G1															
3.4	**Promote full scheme**	NPL							G2													
3.5	**Launch and operate full scheme**	NPL								D2			D3					D4			D5	
3.6	**Assess early outcomes and evaluation impact**	NPL																				
WP4	**Industry Engagement**	**UoH**																				
4.1	**Develop & maintain industry engagement plan**	UoH											D1									
4.2	**Industry engagement activities & events**	UoH					G1				G2				G3				G4			
WP5	**Programme & Financial Management**	**NPL**																				
5.1	**Establish consortium agreement**	NPL	D1																			
5.2	**Develop detailed project plans**	NPL			D2																	
5.3	**Set up finances and raise partners' P/Os**	NPL																				
5.4	**Manage finances and process claims (quarterly)**	NPL											G1								G2	
5.5	**Programme Boards (quarterly)**	NPL								D3 = Quarterly reports												
5.6	**Management Board meetings (quarterly)**	NPL																				
5.7	**Steering Committees (six-monthly)**	NPL																				

Accompanying notes

- Due to space constraints, the deliverable and gate numbers are displayed on the Gantt (figure 2) without their task suffixes (e.g. deliverable D1.6.2 under task 1.6 is displayed as 'D2').
- Innovation for manufacturing (I4M) Scheme: gateway reviews will be undertaken at two points in the scheme's lifecycle: (1) after the soft launch of the programme (for a small select number of companies), before full launch, to assess the process for effective delivery and efficiency, and make any adjustment prior to full launch; (2) approximately 5 months after the promotion and launch of the full programme, to assess the effectiveness of the promotion and review early outcomes seen through Business Success Interviews.
- Industry Led Research Portfolio: the projects already defined (WP1.1 through 1.5) are forecast to complete by the end of 2023, but further flexible projects (WP1.6) will be defined in the early stages of the programme, which will continue through to 2026.
- Industry Led Research Portfolio: the industrial partners are accelerating development of new products to maximise their early impact. Each partner is committed to further R&I activities in the second half of the programme to embed the outcomes from WP2. Detailed plans for this will be defined at the mid-term review.
- Programme and Financial Management: the collaboration agreement will be finalised and signed by all consortium partners in the initial project start-up phase.
- Programme and Financial Management: detailed project plans will be developed for each of the constituent projects and tasks, and approved by the management board, within 6 months of project start.

- This integrated programme has multiple cross-dependencies throughout all work packages (see Project Plan) which cannot be clearly displayed on the Gantt Chart.