Advanced Manufacturing:

Investment Opportunities Report

Innovate UK

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An executive summary of the investable opportunity areas within Advanced Manufacturing: AI, Robotics & Digitalisation

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Introduction

This report aims to present the investment opportunities within the UK's Advanced Manufacturing sector, specifically as it pertains to opportunities within AI, Robotics & Digitalisation.

Advanced Manufacturing widely refers to the use of innovative technologies and processes to enhance production efficiency, quality, and flexibility in the manufacturing sector, often incorporating automation, data analytics and advanced materials. It uses new knowledge alongside innovative and cutting-edge technologies such as robotics, 3D printing, artificial intelligence, high-performance computing and modelling, to produce complex products like aeroplanes and medical devices. Advanced Manufacturing applications align with the climate transition as they integrate practices that reduce energy consumption and minimise waste enabling accelerated decarbonisation.

By showcasing select technology areas and business use cases, the report highlights the commercial potential of the various sub-domains within Advanced Manufacturing. This report is in no way intended to be interpreted as investment advice, its purpose is to spotlight key segments within the Advanced Manufacturing sector from which an investor can begin conducting their own research and due diligence.

This report consists of deep-dive research into the sector with the aim of better understanding investable opportunity areas. The research was supplemented by quantitative research using data from Pitchbook and internal Innovate UK databases. Innovate UK would like to thank the **High Value Manufacturing Catapult** for their support and significant contributions to the development of this report and the **Made Smarter Innovation challenge programme** for providing company case studies.

CATAPULT
High Value Manufacturing

Advanced Manufacturing

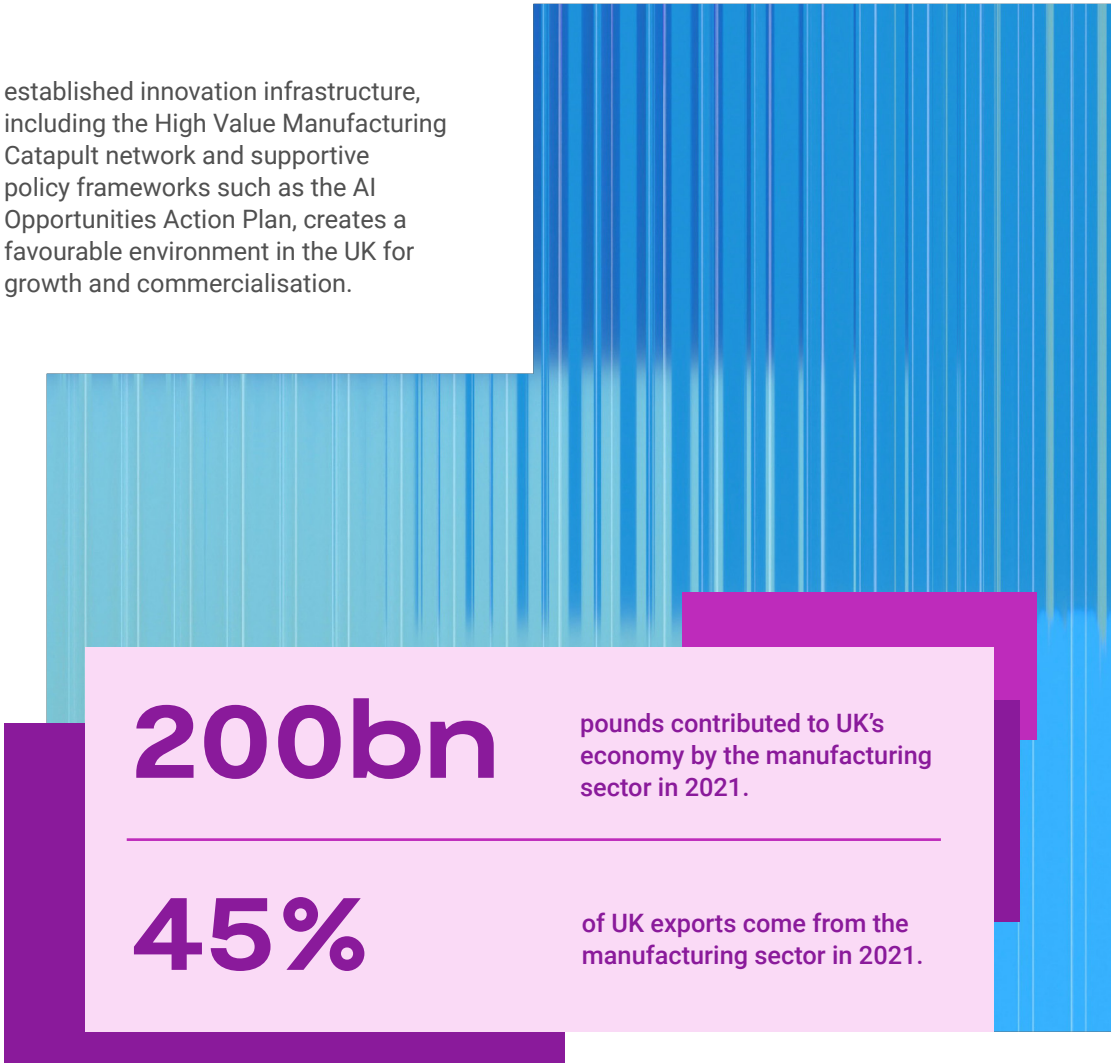
Sector Overview

The UK maintains its position as one of the world's largest manufacturing nations, with the sector **contributing approximately £200 billion to the economy** in 2021 and accounting for roughly 45% of UK exports. This substantial economic footprint, combined with a significant productivity gap—UK productivity currently lags 16% below the G7 average—creates a compelling investment thesis for digital transformation in manufacturing. The adoption of advanced AI, robotics, and digitalisation solutions represents one of the most significant investment opportunities in the UK industrial landscape today.

Currently positioned 24th–25th globally in industrial robot density with approximately **100 robots per 10,000 workers** (compared to Germany's 429 and South Korea's 1,012), the UK's relative underinvestment in automation technologies represents untapped potential in a sector employing nearly 3 million people.

Recent market signals indicate accelerating technology adoption: **annual robot installations grew to 2,534 units** in 2022, with 2023 witnessing a record 51% year-on-year increase following the implementation of tax incentives. This surge demonstrates UK manufacturers' readiness to embrace digital transformation when supported by appropriate financial catalysts—a promising indicator for investors considering entry into this market.

The UK possesses exceptional academic research strengths in robotics and AI, supported by strong aerospace, automotive, food and drink, and defence sectors that serve as early technology adopters. A growing startup ecosystem focused on industrial AI, robotics and digitalisation, complemented by established innovation infrastructure, including the High Value Manufacturing Catapult network and supportive policy frameworks such as the AI Opportunities Action Plan, creates a favourable environment in the UK for growth and commercialisation.



200bn

pounds contributed to UK's economy by the manufacturing sector in 2021.

45%

of UK exports come from the manufacturing sector in 2021.

The skills gap in digital, AI and robotics across UK manufacturing sector – particularly acute among the SMEs that comprise 99% of UK manufacturing firms – is not only a challenge but also a prime market opportunity for investors. Innovators offering easy-to-adopt digital technologies and practical training solutions can unlock massive value as these small manufacturers embrace digital tools and boost their productivity.

The market opportunity stems from projected productivity gains that could

over a decade, adding approximately 3% to annual growth. Emerging technologies are democratising access and lowering adoption barriers for automation for enterprises of all sizes. Implementation of digital thread technologies enables supply chain optimisation, and certification by analysis approaches are reducing physical testing costs and time-to-market. Fast-evolving developments in AI such as Large Language Models and wider Generative applications are also driving new opportunities while Net Zero targets are driving demand for efficiency technologies, and reshoring trends present additional opportunities for advanced manufacturing solutions.

Strategic Investment Opportunities

The digital transformation of manufacturing presents several distinct investment categories with compelling risk-return profiles. AI and IoT enabled decision making solutions represent another high-growth segment leveraging the UK's research excellence and deploying practical implementation in factories. Innovative companies in this space are developing industry-specific AI applications for predictive maintenance, quality control, and process optimization that deliver measurable ROI within months rather than years—an attractive value proposition for manufacturers facing competitive pressure and skills shortages.

Certification by Analysis technologies enable manufacturers to replace costly and time-consuming physical testing with computational techniques, dramatically accelerating product development cycles and reducing time-to-market. Companies developing these solutions are positioned to capture significant value as regulatory bodies increasingly accept digital evidence for certification, creating a clear pathway to commercialization.

The Digital Thread concept is evolving from theoretical to essential infrastructure, with technologies supporting cross-supply chain collaboration and data sharing becoming critical components of modern manufacturing. Solutions that maintain traceability and provide a single source of truth throughout product lifecycles solve fundamental challenges in industrial digitalization, offering substantial value creation opportunities for investors able to identify scalable platforms in this space.

Sector-specific applications tailored for the UK's manufacturing landscape offer focused investment opportunities with well-defined value propositions. The automotive sector provides a compelling example, with EV manufacturing driving a 300% increase in robot orders in 2023. Similarly, pharmaceutical manufacturing stands to increase output by approximately 25% through automation by 2025, according to industry analyses. These sector-specific plays benefit from clear ROI metrics and established customer demand, reducing market risk for specialized solutions. This is particularly relevant for research-intensive, tightly regulated industries like pharmaceuticals, where the cost of product development is the main capital outlay and there is a need to trace the integrity and performance of the product across its entire lifecycle (e.g. from drug discovery to pharmacovigilance during commercialization).

Net Zero & Circular Economy Contributions

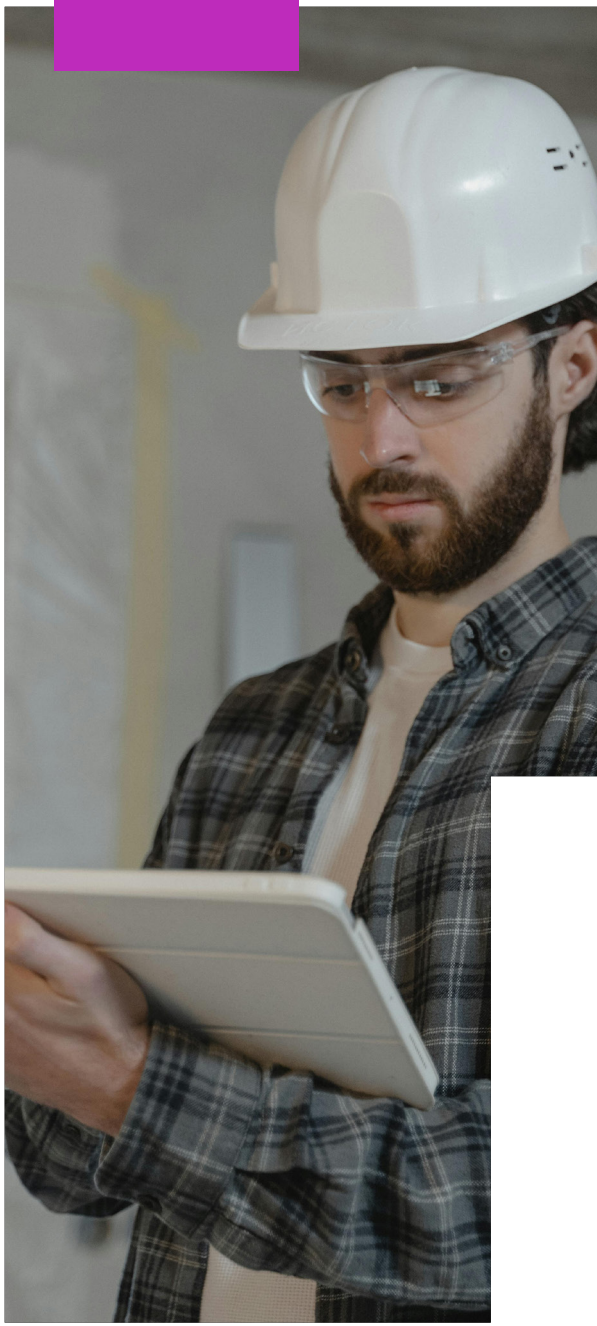
Increasing investment in AI, robotics, and digitalisation solutions presents an opportunity to simultaneously increase productivity, foster economic growth, achieve NetZero and address workforce development—a powerful combination of financial, environmental and societal returns.

For example, AI-optimized manufacturing processes can **reduce energy consumption by 10–20%** through continuous adjustment of operational parameters, delivering both cost savings and emissions reductions. These technologies directly support the UK's legally binding targets to reduce emissions by 78% by 2035 compared to 1990 levels.

Material optimization through digital systems minimizes waste through precise material usage and defect reduction. Advanced vision systems combined with AI can identify quality issues earlier in production processes, reducing scrap rates and associated material and energy waste. These technologies offer manufacturers attractive returns through operational cost reductions while addressing increasing regulatory and consumer pressure for sustainable manufacturing.

Product lifecycle management technologies enable design for automation, repair, and disassembly, extending product lifespans and supporting circular economy principles. The development of technologies facilitating easier disassembly and material recovery creates new business opportunities at the end of traditional product lifecycles. Investors in this space benefit from the emerging regulatory framework promoting extended producer responsibility and the increasing value of recovered materials.

Digital and AI-based solutions are revolutionizing supply chain design, optimization, and management, offering manufacturers enhanced efficiency, reduced costs, and improved decision-making capabilities. These technologies enable predictive analytics for demand forecasting, real-time inventory management, and proactive risk mitigation, leading to more resilient and responsive supply chains. The market for AI in supply chain management is experiencing significant growth, with projections estimating an **increase from USD 9.15 billion in 2024 to USD 40.53 billion** by 2030, representing a compound annual growth rate (CAGR) of 28.2%. Companies commercializing these AI-driven solutions present compelling investment opportunities, as the escalating demand underscores the transformative impact of AI on supply chain operations and the potential for substantial returns in this rapidly evolving sector.



Investment Outlook

The convergence of necessity (productivity challenges, skills shortages, NetZero compliance) and opportunity (technology maturation, government support) creates an advantageous environment for early investors in UK advanced manufacturing technologies. The Advanced Manufacturing Plan, providing **£4.5 billion in targeted funding** over five years from 2025, creates a favourable context for private investment by signalling long-term public sector commitment to sector development and reducing policy risk for investors with multi-year horizons.

Skills development initiatives focusing on technical capabilities through apprenticeships and specialized education programs are beginning to address key barriers to technology adoption, gradually improving implementation capacity across the sector. The growing recognition that the UK cannot maintain global competitiveness without significant increases in automation and digitalisation creates demand pull that complements technology development, creating favourable market conditions for solution providers.

Companies enabling the transformation of UK manufacturing through AI, robotics, and digitalisation stand to capture substantial returns as the UK strives to improve its competitive position in the global manufacturing landscape. For investors with the vision to bridge the gap between the UK's research excellence and its implementation challenges, the advanced manufacturing sector offers a compelling opportunity to generate both financial returns and meaningful industrial transformation in one of the economy's most vital sectors.

This report has been segmented into key value propositions of the technologies within scope. Within each segment we have provided use case examples within one deployment model and one business model such as they align with the value proposition being showcased.

We are also spotlighting case studies of companies supported by the Innovate UK Made Smarter Innovation programme to demonstrate the real-life commercial applications and business model potential within these Advanced Manufacturing value propositions.

Cost Reduction Solutions

Cost reduction is a value proposition which includes **solutions and technologies** aimed at lowering production expenses while maintaining or improving product quality and efficiency. These solutions can range from automation, implementing lean manufacturing principles and adopting advanced materials which minimise materials costs and lead times.

Deployment Model: Integrated Production Systems

These systems **exemplify the advanced integration of multiple technologies**, including robotics and AI, to streamline the entire manufacturing process. They can significantly reduce waste and operational costs by optimising workflows and minimising downtime.

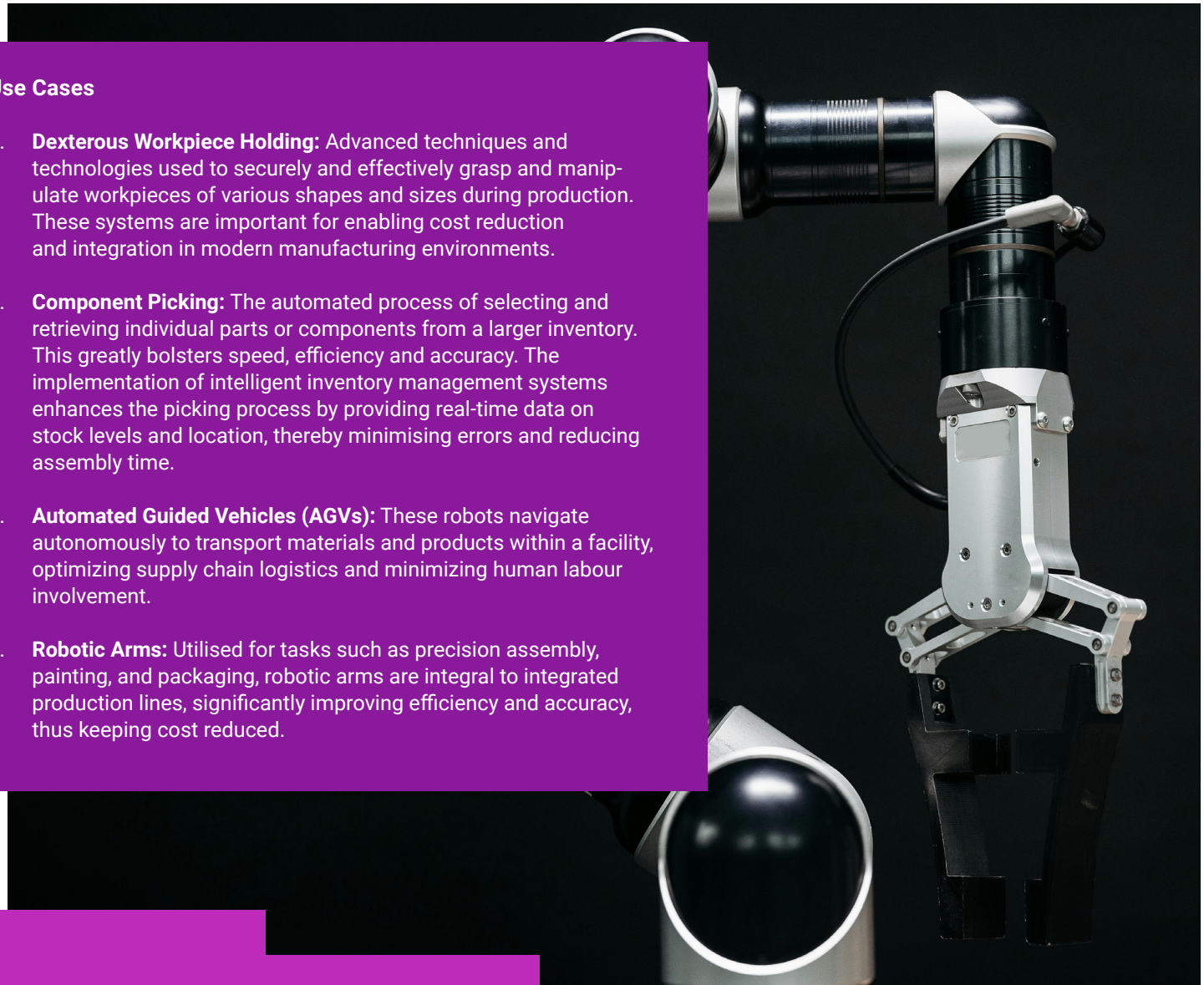
Use Cases

1. **Dexterous Workpiece Holding:** Advanced techniques and technologies used to securely and effectively grasp and manipulate workpieces of various shapes and sizes during production. These systems are important for enabling cost reduction and integration in modern manufacturing environments.

2. **Component Picking:** The automated process of selecting and retrieving individual parts or components from a larger inventory. This greatly bolsters speed, efficiency and accuracy. The implementation of intelligent inventory management systems enhances the picking process by providing real-time data on stock levels and location, thereby minimising errors and reducing assembly time.

3. **Automated Guided Vehicles (AGVs):** These robots navigate autonomously to transport materials and products within a facility, optimizing supply chain logistics and minimizing human labour involvement.

4. **Robotic Arms:** Utilised for tasks such as precision assembly, painting, and packaging, robotic arms are integral to integrated production lines, significantly improving efficiency and accuracy, thus keeping cost reduced.

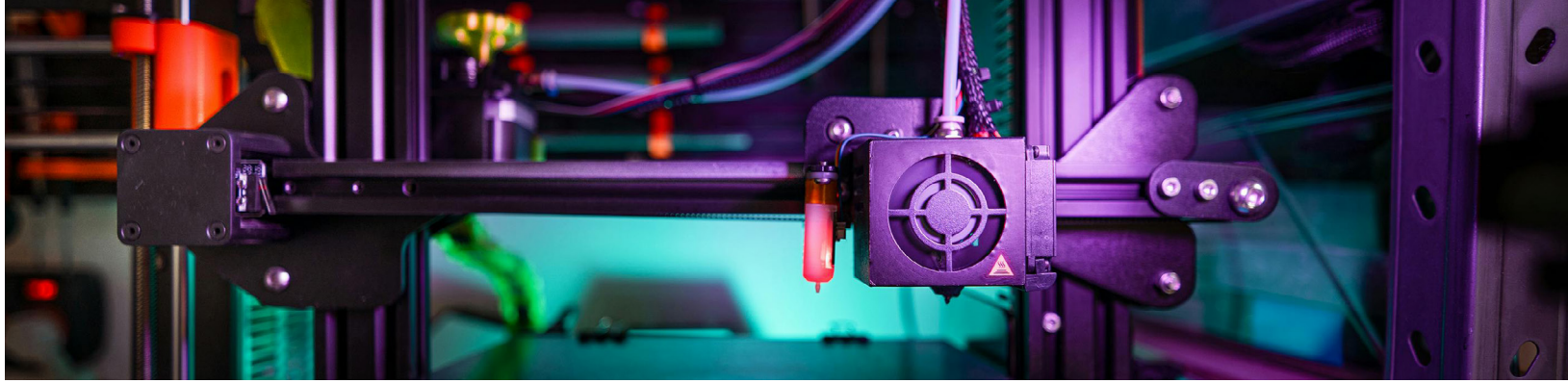


Business Model: Software-as-a-Service (SaaS)

Software-as-a-Service (SaaS) with tiered subscription levels based on facility size or production volume, and outcome-based pricing tied to cost reduction targets. This business model **exemplifies the kind of innovative deployment and flexible financial model** that can sustain cost reduction.

Use Cases

1. **AI-Powered Predictive Maintenance:** Software that uses machine learning to predict equipment failures before they occur, reducing downtime and maintenance costs by 15-30%.
2. **Digital Process Twin:** Virtual models with real time data feed that simulate manufacturing processes to identify optimization opportunities without disrupting production.
3. **AI Supply Chain Optimization:** Systems that dynamically adjust procurement and inventory levels based on real-time supply risk data and production needs.



Company Example — Raplas

Raplas, manufacturer of **3D printing technologies** has produced a new automated solution to enable the sand-casting industry to rapidly produce more complex components cheaper, quicker and more efficiently.

Raplas, headquartered in London with a manufacturing facility in South Wales, partnered with FMS, a foundry machinery expert based in Walsall, and Northumbria University, to develop a new solution for rapid sand-casting production.

3D printing emerged as the solution to improve the process, allowing more complex and higher quality components to be manufactured quicker.

Raplas joined forces with Northumbria University, and FMS, and the consortium explored a variety of system elements including printheads, print fireboards, software, the sand delivery system and post printing processes.

The outcome was the creation of a smaller, modular 3D printing system which can be manufactured bespoke to customer requirements and easily integrated into existing foundries. The system can be fully automated or manually operated to suit all sizes of foundry. It uses off-the-shelf printheads, which are cheaper and easier to replace, with currently a furane binder, with the aim to introduce a phenolic binder which is more environmentally friendly than what is currently used. Meanwhile, the re-coater system, which deposits a fine layer of sand across the build platform before the printhead function, manipulated existing technology used to make agricultural seeds and powders. It also uses an Integra operating system, a software used on Raplas's current resin SLA systems, to give high reliability and on-line maintenance access to reduce machine downtime.

The result is a new, more affordable solution which can be made bespoke to a customer, with lower running costs because the machine is smaller and uses less energy and uses cheaper print heads which are more available and easily replaced.

As manufacturers face mounting pressure to enhance efficiency, reduce operational costs, and meet sustainability goals, the demand for innovative solutions that streamline processes and optimise resource allocation has grown. This segment not only addresses immediate financial pressures but also aligns with the broader industry shift towards digital transformation and Industry 4.0, where automation, data analytics and smart technologies play pivotal role. Furthermore, as global supply chains evolve and manufacturing paradigms shift, companies that invest in cost reduction initiatives are poised to gain a significant competitive edge, driving profitability and market share. With the market projected to grow at a robust pace, investing in cost reduction solutions offers a chance to capitalise on a transformative trend that is reshaping the manufacturing sector and delivering long-term value.

RAPLAS
Production Additive Manufacturing

Quality Improvement Systems

Quality Improvement Systems focus on **enhancing product quality, reducing defects, and ensuring compliance with stringent industry standards**. Key benefits of implementing QI systems are to reduce costs and optimise resource efficiency. By integrating advanced technologies such as AI, robotics, and data analytics, these systems enable manufacturers to implement real-time monitoring and control processes throughout the production lifecycle allowing for early detection of anomalies, minimising waste and rework.

Deployment Model: Robot Cells

Robot Cells consist of **multiple robots configured to work together** in a defined area, performing complex tasks that require precision and coordination. Robot Cells can enable enhanced precision and consistency through automation, real-time quality control using enhanced sensors and vision systems, increased throughput with quality assurance, and improved flexibility & scalability.

Use Cases

1. **Articulated Robots:** Robots with a high degree of freedom and can perform complex tasks, such as welding, assembly, and material handling within a robot cell. They can be programmed to follow strict tolerances and quality and can integrate with vision systems to allow for real-time quality checks and immediate detection of defects.

2. **SCARA Robots:** Selective Compliance Assembly Robot Arm robots excel in horizontal movement and are ideal for assembly, packaging, and quality inspection tasks. They can be integrated with sensors that monitor the assembly process ensuring quality specifications are met.

3. **Delta Robots:** Delta Robots are designed for high-speed picking and packing applications. They can be used to ensure that items are accurately placed in packaging without damage and integrated quality control measures allows for real-time monitoring of product conditions.

4. **Collaborative Robots (Cobots):** Designed to work alongside human operators to enhance productivity while maintaining high safety standards. Cobots can assist in tasks such as quality inspection, assembly and even training human workers on best practices.

Business Model: Performance-Based Contracts

Performance-Based Contracts align the financial incentives of both the manufacturer and the service provider. It is a model which focuses on achieving specific quality outcomes and metrics.

By **tying payments to measurable quality improvements**, manufacturers can ensure that the solutions implemented are not only effective but also aligned with their quality objectives.

Use Cases

1. **Robot-as-a-Service:** RaaS models allow manufacturers to access robotic technologies on a subscription or pay-per-use basis. By integrating RaaS into operations on a performance-based contract, manufacturers can rapidly deploy robotic solutions that are tailored to specific improvement objectives, such as precise assembly, consistent inspection, and error reduction.

2. **Power-by-the-hour:** PBH is a business model that focuses on providing machinery and equipment services based on usage rather than ownership, turning capital expenditures into manageable operational expenses.

3. **SCADA Systems:** These systems can be evaluated based on effectiveness in monitoring and controlling industrial processes. Performance metrics such as system uptime, alarm response times, and data accuracy can be tied to performance-based contracts. They provide comprehensive monitoring of production environments, enabling immediate identification of quality issues. By aggregating data from various sensors and controllers, SCADA facilitates trend analysis.

Company Example – Intellium AI

Intellium AI has developed a **cloud-based enterprise platform** that generates actionable insight from complex manufacturing process analysis to empower engineers to improve productivity and accelerate net zero goals.

The collaborative R&D project resulted in BoostBot, an innovative Generative AI enterprise platform, which streamlines and automates various tasks, translating complex manufacturing data into conversational English to help operators identify opportunities to optimise processes, backed up data-driven insights.

Intellium AI understood that the trickiest bit of digital transformation projects is upskilling the workforce and changing the culture. With that in mind, they worked with GKN Aerospace to develop and test a novel AI solution which uses advanced predictive modelling, intelligent process optimisation, real-time monitoring and what-if analysis to identify opportunities to upskilling its workforce.

They developed an interface, a web-based tool to enable an engineer or operator to ask a question in plain English, and receive an accurate, verifiable data-supported answer with a list of actions to give them the insights they require, without writing a single line of code.

BoostBot is now being used by GKN and Intellium AI is now demonstrating its solution to other companies in aerospace, and sectors including naval shipyards. As a business, Intellium AI has expanded its team by two to 15 as part of its growth strategy.

Quality Improvement Systems represent the opportunity to enhance operational efficiency, reduce costs, and drive competitive advantage. As industries face more pressure to deliver higher quality products while minimising waste and meeting regulatory requirements, businesses producing robot and product types within this value proposition can be on the cutting edge of reducing defect rates, rework costs and enabling greater customer satisfaction through consistent production excellence. As manufacturers adopt Performance-Based Contracts that tie financial incentives to quality outcomes, the demand for innovative QIS is set to increase.

Productivity: Throughput Enhancement Technologies

Throughput Enhancement Technologies (TETs) centre on **optimising production efficiency** and increasing output without compromising quality. TETs leverage automation, real-time data analytics, and innovative process design to streamline operations, reduce bottlenecks and minimise downtime.

Deployment Model: Mobile Robot Fleets

Mobile Robot Fleets can **automate the transportation of materials** and products within a manufacturing facility, reducing manual handling and minimising delays. By ensuring that materials are delivered efficiently to various workstations, these robots contribute to streamlined operations and improved overall throughput. Their flexibility allows manufacturers to varying production demands, making them an asset in enhancing productivity.

Use Cases

1. **Human-Machine Interface:** HMI systems facilitate communications between operators and mobile robot fleets. They provide users with the ability to monitor and control robotic operations, making it easier to respond to changes in production demands or resolve issues quickly. A well-designed HMI can enhance the effectiveness of mobile robot fleets by ensuring that human operators can interact seamlessly with automated processes, thereby improving throughput.

2. **Automated Guided Vehicles:** AGVs follow predefined pathways to transport materials between locations in a manufacturing environment. While they may require more structured navigation compared to AMRs, AGVs are effective for repetitive transport tasks and can significantly enhance throughput by streamlining material handling processes in a controlled manner.

3. **Manufacturing Execution Systems:** MES effectively coordinate the activities of mobile robot fleets by providing data inventory levels, production schedules and workflow requirements. Integrating MES with mobile robots allows manufacturers to ensure that materials are delivered precisely when and where needed, enhancing throughput and operational efficiency.

4. **Autonomous Mobile Robots:** AMRs are designed to navigate and transport materials autonomously within a facility. They can adapt to dynamic environments and optimise their routes in real time, making them ideal for enhancing throughput by ensuring timely delivery of materials to various production areas.

Business Model: Leasing/ Financing

Allowing manufacturers to acquire mobile robotic systems without significant upfront costs, leasing or financing options enable companies to implement cutting-edge technology while conserving capital. This financing model **facilitates the adoption of mobile robot fleets**, thereby enhancing throughput and operational efficiency.

Use Cases

1. **Distributed Control Systems:** DCS are used for controlling production processes across various manufacturing environments. They provide real-time monitoring and control capabilities, which are essential for optimising throughput and ensuring process efficiency. Given the complexity and cost associated with implementing DCS, leasing or financing options allow manufacturers to access critical technology without the need for large capital upfront investment.

2. **Collaborative Robots:** Cobots' versatility and ease of programming make them attractive for businesses looking to enhance throughput in various applications. The Leasing/Financing model allows manufacturers to adopt this advanced automation technology without the burden of large upfront costs. They can scale their operations as needed and stay competitive.

3. **Enterprise Resource Planning:** ERP systems integrate various business processes and functions, providing comprehensive visibility and control over operations, including production, inventory and supply chain management. Leasing/Financing options for ERP systems can make it easier for organisations to adopt these sophisticated solutions without substantial upfront CAPEX. This approach supports ongoing upgrades and improvements, helping businesses optimise their throughput and adapt to changing market demands.

Company Example – Deep.Meta

Deep.Meta has developed a new AI platform which has demonstrated the potential to help steelmakers reduce energy and CO^2, while improving productivity and profit.

Deep.Meta, based in London, collaborated with a consortium to develop an R&D project to test its flagship product the Deep.Optimiser which uses factory data across multiple processes to inform decision-making. It has demonstrated the potential to reduce energy consumption by 24 kilowatt hours per tonne of steel, cutting 5% of CO^2 emissions, and shown in simulations to improve productivity by 20%. For a manufacturer producing 2m tonnes per year, that equates to a reduction of 48-terawatt hour (TWh) – the collective equivalent of the energy used by over 3,000 homes a year in the UK.

Deep.Meta developed an AI architecture that replicates the dynamics of a plant by building up a digital framework using reusable modules, each representing key assets. The result is the Deep.Optimiser which generates recommended actions to optimise the production process in real-time.

Leveraging historical and live data, an effective digital twin of the process was constructed in which the AI agents – the intelligence in the software – were trained with 40 years' worth of production cycles.

The AI alerts shop floor operators when products should be removed from furnaces. The cloud-based app, accessible via the web or tablet, then provides steel producers with recommendations to optimise productivity and energy efficiency.

Deep.Meta

"This technology has huge implications for supporting the UK steel Industry in building resilience and bringing down costs, it's an industry vital for national security and infrastructure. The potential gains are very exciting. Reducing the energy and the CO^2 per tonne of steel means being able to produce more with a lower unit cost per product, improves the margins significantly."

Dr Omoigiade, Founder of Deep.Meta

Company Example — Harrison Spinks Products

Spring manufacturer, Harrison Spinks Products (Spinks) has unlocked and accelerated productivity, net zero and innovation gains with the support of industrial automation specialists.

Harrison Spinks Products (Spinks), based in Leeds, collaborated with Bespoke Automation Controls Solutions (BACS) also based in Leeds, on a collaborative R&D project through Made Smarter Innovation. The solution – which leverages IIOT technologies, networking, machine learning and analytics – has digitised and automated a traditional analogue process which has remained relatively unchanged for decades. Tests on two production lines demonstrated an increase in Overall Equipment Effectiveness (OEE), a measure of Availability, Performance and Quality, of 25%, reduced waste by 56% and slashed energy use by 4%.

As a result, access to vast amounts of previously 'invisible' data and introducing analytics into the real-time and post-production processes has been transformative for Spinks. Analytics also means the Spinks can identify issues quickly and with more accuracy, reducing any downtime of machines, and reducing bottlenecks to the onward spring coiling process. Across the two lines involved in the project, OEE has been increased by 25%.

Process parameter improvements means that Spinks has reduced the number of die changeovers by 75% and increased the amount of wire produced per die by 60%. On top of this the amount of time it takes to replace die sets is down by 33%, the equivalent of an hour for an 11-block machine, and 30 mins for a five-block machine.

The ability to react to issues and the accuracy of the process has reduced the amount of scrap waste by 56%. Spinks have reduced the energy required to pull the wire through the die by 4.3% with potential to reach 25% with refined monitoring. Visualisation means the leadership team can access and analyse the performance data to identify trends and scrutinise batch data to identify any issues with wire quality.

Harrison Spinks
The True Bedmakers

Throughput Enhancement Technologies represent a compelling value proposition for investors due to the sector's urgent need for increased efficiency and competitiveness. As global markets evolve, and customer demands shift towards faster delivery and higher quality, manufacturers are actively seeking innovative solutions to optimise their production processes. TETs which encompass automation, data analytics, and integrated systems, directly address these needs by enabling firms to streamline operations, reduce downtime, and maximise output. Furthermore, advancements in AI and robotics are driving unprecedented growth in this segment.

Flexibility & Resilience Enablers

Flexibility & Agility enablers (which include technologies such as modular production systems, robotics, advanced data analytics) enable manufacturers to **rapidly reconfigure production lines** and produce a diverse range of products with minimal lead time. This allows them to respond to fluctuations in demand while minimising waste and optimising resource allocation. Integrated flexibilities enhance the capacity for customisation while putting manufacturers in a good position to pivot their strategies in response to emerging trends and challenges.

Deployment Model: Integrated Production Systems

IPS models allow for the seamless integration of **multiple automated processes** enhancing the overall flexibility and responsiveness of manufacturing operations. IPS enable manufacturers to quickly reconfigure workflows, **accommodate diverse product lines**, and respond to market changes with minimal disruption.

Use Cases

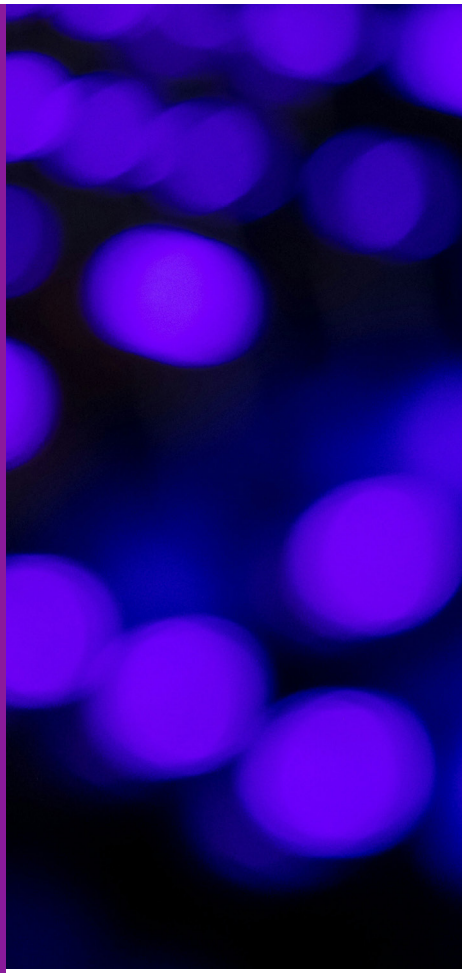
1. **Articulated Robots:** Versatile and capable of performing a wide range of tasks due to their flexible joints and multi-degree-of-freedom design. They can be used for welding, assembly, painting, and more, making them suitable for environments where tasks may change frequently. Their adaptability allows for quick reconfiguration in response to production needs.

2. **Manufacturing Execution Systems:** MES are crucial for integrating and managing manufacturing operations on the shop floor by providing real-time data and visibility. This in turn enables a quick and flexible response to changes in production requirements.

3. **Cartesian/Gantry Robots:** Cartesian or Gantry robots are known for their precision and can be easily programmed for various tasks. They are highly adaptable and can be used in applications ranging from material handling to assembly. They have a noted ability to cover large areas and perform repetitive tasks efficiently.

4. **Enterprise Resource Planning:** ERP systems help in integrating all facets of an operation, including planning, purchasing, inventory, sales, marketing, finance, and human resources.

5. **Integration of enterprise and shopfloor-level systems:** Vertical (ISA-95) or distributed (cloud-based, edge computing supported) integration of enterprise-level systems (e.g. ERP) with shopfloor level execution (MES) and data acquisition & control systems (e.g. SCADA and DCS) enable a higher degree of oversight and agility into manufacturing operations, allowing manufacturers to respond much quicker to changes in product specification and demand.



Business Model: Platform-as-a-Service

Platform-as-a-Service (PaaS) with marketplace ecosystem where manufacturers can access pre-built modules and custom solutions.

Use Cases

1. **Low-Code Manufacturing Apps:** Digital platforms that enable rapid development and adoption of custom manufacturing applications without specialized programming skills.
2. **Digital Product Configurator:** Systems that translate customer specifications directly into production parameters using LLM models.
3. **Smart Factory Simulation:** Digital tools that allow manufacturers to test plant layout changes and new production methods virtually before physical implementation.

Company Example – HAL Robotics and A3L

Transformational software companies HAL Robotics and A3L have developed an innovative self-learning robotic solution to reduce the barriers to adopting automation for finishing tasks.

A3L, a **robotic systems integrator** based in Sheffield, and HAL Robotics, a **human-robot collaboration software** company based in London, partnered on a collaborative R&D project.

They co-created an automated finishing and polishing robotic cell capable of measuring and reacting to the size, shape and requirements of the part to be processed, thereby making it self-programming and adapting.

Successful tests with plastics and automotive manufacturing processes demonstrated the potential for huge productivity gains.

The project developed three core technological breakthroughs: Firstly, HAL Robotics created an **adaptive programming solution** that allows operators with no robotics expertise to influence how a robotic system undertakes a task.

The second innovation was through A3L's development of an **adaptable end effector**. Sensors measuring surface roughness and geometry feedback into a software solution to automatically generate any necessary corrective robot toolpaths to ensure a consistent and even process and determine when it is complete.

These two technologies were integrated into an automated finishing and polishing robotic cell capable of measuring and reacting to the size, shape and requirements of the part to be processed, thereby making it self-programming and adapting.

The third breakthrough saw A3L begin developing a system which feeds digital images and sensor data into an **AI model** to determine the surface roughness of consumable abrasives like sandpaper.

For HAL Robotics, the solution has resulted in huge reductions in programming time for finishing processes. A complex reprogramming task that would have taken up to a week to complete, now takes seconds. This not only unlocks massive productivity gains, but it democratises the deployment of robots into previously impracticable finishing processes. Early results from the plastics manufacturer have been striking, replacing an existing manual process which took up to 10 working days to just 12 hours.

For A3L, the design and delivery of its highly adaptive tool has improved the company's capability and knowledge of finishing processes and are now being applied to other R&D projects with potential application to other sectors. Beyond the industry-ready results of the project, the R&D process has demonstrated clear areas for future focus such as the AI to improve the life of finishing consumables, reduce waste and optimising the efficiency of robotics.

Flexibility & Agility Enablers represents a transformative shift in how industries adapt to rapidly changing circumstances. In an era where speed, customisation and efficiency are paramount, businesses that can leverage **flexible and agile manufacturing systems** gain a significant competitive advantage. These enablers, not only improve operational efficiency but also reduce time-to-market for new products. As companies increasingly turn to digital solutions to enhance their production capabilities, investing in this space offers the potential for outsized returns. Furthermore, as the demand for sustainable and personalised products rises, adaptable manufacturing processes have strong long-term viability.

A3L HAL robotics

Safety Systems

Safety Systems are centred around the commitment to creating a secure and efficient workplace, enhancing operational integrity and employee well-being. They cover all key areas of the production process including Product Safety (goods), Worker Safety (human), Cyber-physical safety (infrastructure). By leveraging technologies such as IoT sensors, machine learning and predictive analytics, these systems facilitate real-time monitoring and assessment of potential hazards, enabling proactive risk management. Systems such as these are put in place to not only **reduce the likelihood of accidents** and injuries but also **minimises costly disruptions** and liabilities while also helping businesses stay compliant and enhance their credibility and reputation.

Deployment Model: Decision/ Support Optimisation

Integrating safety systems with decision support tools, manufacturers can analyse huge volumes of data from a mixture of sources, **identifying potential hazards**, inefficiencies, and compliance risks more effectively. Decision/Support optimisation underlines risk management by providing insights that inform safety protocols and operational adjustments. This approach enhances situational awareness among workers and management, allowing for swift responses to emergency situations. Additionally, it aids in resource allocation, ensuring that safety measures are deployed where they are most needed, optimising safety and productivity.

Use Cases

1. **Humanoid Robots:** Humanoid robots can assist in monitoring and interacting with human workers in various tasks, especially in environments where safety is critical. They can be equipped with sensors and decision support algorithms to analyse human behaviour, ensuring compliance with safety protocols and providing assistance when necessary.

2. **SCADA Systems (Supervisory Control and Data Acquisition):** SCADA systems gather data from various sensors and control devices and provide operators with the necessary information to make informed decisions. By utilising SCADA within the Decision/Support Optimisation model, manufacturers can enhance situational awareness, quickly identify safety issues and optimise responses to hazards.

3. **Human-Machine Interface:** HMI systems serve as the critical link between operators and machines, allowing for efficient interaction and control of equipment. A well-designed HMI can enhance safer and more informed decision-making processes by presenting data in an intuitive manner, facilitating quick understanding.

Business Model: Capital Purchase

Capital Purchase in this context constitutes manufacturers making a direct investment in safety systems and technologies, allowing them to own the equipment outright. Capital purchases allow businesses to **customise and integrate safety systems** according to their specific operational needs.

By investing in high-quality safety systems through a Capital Purchase, manufacturers can ensure robust performance and longevity, leading to long-term costs savings associated with accident prevention and compliance. Additionally, owning the equipment allows for complete control over maintenance schedules and upgrades.

Use Cases

1. **Distributed Control Systems:** DCS are integral to managing complex industrial processes, providing a centralised system for monitoring and controlling safety parameters across various manufacturing operations. With DCS, manufacturers can ensure that safety measures are consistently applied and maintained, thereby reducing risks and enhancing compliance with safety regulations. The Capital Purchase model allows organisations to own and customise their DCS to meet safety requirements.

2. **Exoskeletons:** Exoskeletons are designed to support and augment human capabilities, particularly in tasks that require heavy lifting or repetitive motion. By investing in exoskeletons, manufacturers can reduce the risk of workplace injuries related to manual handling and increase worker safety. The Capital Purchase model allows businesses to own and tailor exoskeleton solutions to meet the specific ergonomic needs of their workforce.

3. **Machine Sensing Systems:** MSS play a critical role in enhancing workplace safety by monitoring equipment conditions and detecting anomalies that could lead to hazardous situations. Through the Capital Purchase model, manufacturers can directly integrate them into their operations, ensuring continuous monitoring and immediate alerts to potential safety threats.

Company Example – Rivelin Robotics

Rivelin Robotics has demonstrated a faster, cheaper, and safer approach to **finishing 3D-printed components** that could transform tightly regulated industries.

Rivelin Robotics, based in Sheffield, has collaborated with aerospace manufacturer GKN Aerospace, orthopaedic and dental implant manufacturer Attenborough Dental Laboratories and turbomachinery manufacturer Material Solutions on a collaborative R&D project.

The project, CAMPFIRE (Certified Additive Manufactured Parts Finished with Intelligent Robotics Engine), developed two robotic demonstrator micro-factories to automate finishing for parts and components. Powered by Rivelin's NetShape 2.0 software platform, these micro-factories enable the planning, simulation, and execution of robotic machining operations, inspections, and measurements—without requiring CAM, CNC, robotics, or computer programming expertise.

Post-processing metal AM (Additive Manufacturing) parts is a well-known bottleneck, particularly at scale. Traditional methods are labour- intensive, time-consuming, costly, and pose safety risks.

In response, Rivelin developed a robotics solution: an enclosed microfactory that integrates an industrial robot with a variety of tools, cutting-edge sensors, and their teaching, simulation and control software NetShape.

The outcome was that the hardware and software are viable for production lines. For Material Solutions, robotic finishing significantly reduced processing time by 28% per part (from 2.1 hours to 1.5 hours). This equates to a 50% increase in throughput when operating 24/7. The cost per part also decreased by 24% (from £64.65 to £48.87). As a result, Material Solutions identified several components that would benefit from automated finishing and plans to deploy the technology in the next 12–18 months.

Safety Systems will benefit from the increasing emphasis on workplace safety, regulatory compliance, and operational efficiency. As industries adopt more automated and high-tech processes, the demand for robust safety systems that mitigate risks and enhance protection against accidents rises significantly. This sector is not only poised for growth, driven by technological advancements such as IoT, AI, and machine learning enhancing safety protocols, but it also aligns with global trends prioritising employee well-being and environmental sustainability. Furthermore, companies implementing effective safety systems often see reductions in insurance costs, downtime, and liability exposures, translating into improved bottom lines.

Investor Case Study – CPI Enterprises

CPI Enterprises is the ventures arm of CPI, part of the High Value Manufacturing Catapult. CPI is a strategic investor, leveraging its world class technical expertise, facilities and strong partnership network to invest in deep tech companies and provide value to them as they scale.

CPI combine a robust investment process, comparable with that of VC fund managers, with deep technical and market due diligence from experts in the wider organisation. They also provide active follow-on support, connecting portfolio companies with industry stakeholders and support with access to other sources of funding and finance.

CPI have also backed EverQuest Capital Partners, a fund manager whose thesis constitutes investment into disruptive deep tech enabling technologies. This includes Advanced Manufacturing companies.

We spoke to **Hannah Wade**, the **Managing Director of CPI Enterprises**, about the Advanced Manufacturing sector and why they feel confident deploying capital into it.

Why is the Advanced Manufacturing sector 'investable'?

There is a very real need for Advanced Manufacturing solutions in a world where we face labour shortages, increased supply chain disruption and rising energy prices. As we enter a 'wartime' economy, Advanced Manufacturing, particularly additive manufacturing, is considered critical for defence supply chain resilience. Equally, Advanced Manufacturing has a role to play in facilitating our transition towards Net Zero. Moving to industry 4.0 and beyond lowers costs, improves productivity and reduces waste. Growth in the sector can help us achieve a cleaner environment, a healthier society and a vibrant UK economy.

Barriers to entry remain, however, for incoming investors. The industry is still viewed as high risk and highly capital intensive by some which is whythe CPI aims to make it quicker and cheaper for companies to move towards commercialisation. By accessing CPI's assets and technical expertise, companies stand to benefit from an accelerated journey and lower CapEx requirement. Lowering the amount of investment needed and the time to exit makes these companies more attractive to investors.

How would you describe the current pipeline of businesses in this space?

We are seeing a strong pipeline of opportunities from across the UK. From semiconductors in the North East, materials in the North West and pharmaceuticals in Scotland, there are plenty of innovative start ups and spin outs looking to scale in the UK. CPI benefits from our relationship with key UK universities. We have MOUs with several of them and our dedicated strategic partnerships team help us to identify disruptive technologies early on.

As different technologies like AI converge, we have the ability to make things smarter, greener and more efficient creating an exciting pipeline of opportunities.

What are the risks and opportunities associated with investing into Advanced Manufacturing?

There are risks associated with this sector: there's always the question of whether the industry will adopt advanced manufacturing. Long sales cycles, high cash burn rate, entering foreign markets, etc. all present challenges.

We believe these risks are offset however by the opportunity to tap into technology developments and fulfil tangible strategic needs. There are early adopters of Advanced Manufacturing technologies looking to get an edge on the competition and ensure sustainability and equally necessity is increasing industry pull.

What role is regulation playing in encouraging investment into this space?

Government have brought together a regulatory taskforce and there are a range of regulatory considerations involved depending on the sector looking to adopt the technology. A good example of this is the pharmaceutical sector where high standards are imposed to ensure patient safety.

Providing clear and proportionate regulation and making procurement into large customers easier are examples of measures that could be introduced to help adoption of Advanced Manufacturing technologies.

How do you see the Advanced Manufacturing market evolving? What trends or developments are exciting you right now?

The digital capabilities team at CPI have been working on sensor technology that will optimise manufacturing processes; enabling businesses to read, visualise, and interpret data relating to their operations. This supports businesses to take decisions relating to their operations that can increase efficiency and productivity.

The next exciting step will be to integrate AI - this has the potential to support remote operating and decision taking ahead of time to improve operations, for example being able to carry out predictive maintenance and reducing down time. We are some way off that but CPI is here to support companies taking their first steps towards digitalisation and then beyond.

Productivity technologies using digital products to enable making things in a way that is cheaper and faster are also continuously optimising and improving which investors and industry should be rightly excited about.

Innovate UK

Innovate UK is the UK's innovation agency. Our mission is to help businesses across the UK grow through development and commercialisation of new products, processes and services.

The UK is one of the largest global manufacturing nations. Materials and manufacturing are pivotal to our economy and our society. These sectors are facing radical change. Our Materials and Manufacturing Vision 2050 and the analysis behind it demonstrates significant opportunities to make a real economic, environmental and societal difference to the UK.

Our commitment to UK businesses leveraging these growth opportunities is reflected in our investments detailed here.

Made Smarter Innovation

The Made Smarter Innovation Challenge's mission is to build a digital innovation ecosystem that inspires and supports UK innovators and manufacturers in the development of novel application of industrial digital technologies within manufacturing.

A £300m Challenge funded by government and industry targeting:

- Increase in GVA by **£2.3 billion**
- Create thousands of highly skilled jobs
- Raise productivity by **30%**
- Create a **4.5% decrease** in carbon emissions
- Create a **25% decrease** in manufacturing waste

Over 100 projects supported involving more than 400 manufacturers, technology developers and academic institutions.

Resource Efficiency for Materials & Manufacturing

The programme supports organisations to understand the environmental, social and economic impact of the full product lifecycle and thrive from adoption of resource efficient solutions which are fundamental to UK and global Net Zero ambitions.

Programme impact:

- **50** projects supported
- **103** project participants
- Median turnover increase of circa **£1m**
- Median full-time employees increase of approx. **8**

Driving the Electric Revolution

The Challenge, delivered by Innovate UK, is part of the UK's wider investment to achieve a Net Zero economy. It aims to position the UK as a global leader in electrification. This initiative focuses on advancing the UK's capabilities in Power Electronics, Machines & Drives (PEMD).

£405.5m was the realised co-investment reached because of the programme. The Challenge's catalysed funding ratio was nearly 16:1.

Programme impact:

- **150** organisations funded
- **385 increase** in employment over 3 years
- **91%** of funded organisations reported job creation & enhanced research

CLIMATES: Circular Critical Materials Supply Chains

The £15m CLIMATES programme aims to develop and grow circular UK supply chains for rare earth elements and to increase supply chain resilience and de-risk security of supply through innovations that enable recycling, capitalising on the growing material feedstock as products reach end-of-life.

Programme impact:

- **£174m** indicative co-investment
- **35** funded SME projects
- **36** R&D projects
- **£18.1m** total R&D project value

Smart Sustainable Plastic Packaging

The Challenge has contributed to the UK's drive for clean growth and industrial decarbonisation by funding ground-breaking research and innovation to make plastic packaging fit for a sustainable future.

The Challenge directly supported the 2025 targets in the UK Plastics Pact, which includes many of the UK's major brands, retailers and plastic packaging suppliers among its signatories.

Programme impact:

- Co-investment so far of **£274m**
- **17m+ units** of single-use packaging potentially replaced or avoided
- Launch of an Open Standard for packaging data
- First UK refillable plastic milk bottle
- World first advanced recycling plant
- World-first mechanical recycling plant for food-grade polypropylene

Sustainable Bio-Based Materials & Manufacture

The programme aims to enhance UK global competitiveness by supporting research and innovation that focuses on developing new and disruptive sustainable biomanufacturing products and processes by 2050.

The programme supports the Innovate UK materials and manufacturing vision 2050 aiming to meet the UK's clear potential to become a world-class destination of choice for advanced low-carbon manufacturing.

Programme impact:

- **60** projects supported
- **154** project participants
- Median turnover increase of circa **£370k**
- Median full-time employment increase of approx. **5**

Transforming Foundation Industries

The TFI Challenge is a £66m programme helping transform the UK's foundation industries to become internationally competitive, secure more UK jobs and grow in an environmentally sustainable way.

Programme impact:

- Has unlocked **£275m** Industry follow-on investment
- Leading to **3000** new jobs
- **£66m** Challenge investment plus another **£100m** committed by industry
- **£40m** for industry test beds
- **25 $MtCO^2e$** cumulative reduction over 10 years

High Value Manufacturing Catapult

The High Value Manufacturing (HVM) Catapult operates at the forefront of the UK's innovation ecosystem, distinguishing itself through a comprehensive approach that uniquely addresses both Engineering and Manufacturing transformation. This dual focus represents a strategic advantage for investors seeking exposure to the complete digital value chain, as the Catapult bridges the traditionally siloed worlds of product development and production systems through integrated digital technologies.

The Engineering transformation dimension focuses on upstream digital and AI technologies that revolutionize how products are conceptualized, designed, and validated. This encompasses advanced simulation environments, computational modelling, digital twins of products, and virtual testing methodologies that significantly compress development timeframes while enhancing product performance.

Complementing this, the Manufacturing transformation dimension applies digital technologies, robotics and AI directly to production environments. Here, the HVM Catapult aims to advance smart factory concepts, interoperable systems, adaptive automation systems, and data-driven process optimization that enhance productivity, quality, and resource efficiency.

Rather than treating design, manufacturing, operation, and decommissioning as discrete phases, the HVM Catapult develops digital frameworks that create continuous data flows across these traditionally disconnected stages.

With dedicated Robotics and automation innovation programmes, HVM Catapult is responding directly to the UK's concerning underperformance in digital adoption compared to international competitors. Their work includes AI-embedded robot controller systems, smart sensor networks, and intelligent automation solutions for complex tasks like sorting, disassembly, and remanufacturing—directly supporting circular economy objectives. Complementing this, the HVM Catapult's flexible automation initiatives address the UK's critical skills gap by developing simpler, more accessible systems that can be readily reconfigured to meet shifting market demands without requiring specialized programming expertise.

CATAPULT
High Value Manufacturing

Appendix

Innovate UK Funding Data

Innovate UK has **awarded £367m in grants** to high potential businesses through its manufacturing programmes since 2020.

These grant recipients have received **over £2.5bn in private investment** over the same period.

Exit Case Study: Invar Group

Inteq (formerly Invar Group), a company specialising in **integrating automation and robotics into supply chains** was acquired by Wincanton, a subsidiary of GXO Logistics for £25.5m in March 2024. Invar's expert value-add was the integration of automated warehouse solutions powered by its proprietary software, the Invar Warehousing Software (IWS).

In a press release at the time of the acquisition, Wincanton said "This acquisition represents a key milestone in Wincanton's strategic roadmap to create sustainable supply chain value through technology and automation. It aligns the people, processes and technology which will enable Wincanton to deliver more robotics and automation projects at pace for its customers. Several projects are already under way, focusing on AMR (autonomous mobile robots) deployment across Wincanton's existing blue-chip customer base."

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To learn more about our investment activities:
iuk-business-connect.org.uk/investment

To learn more about our work in manufacturing:
iuk-business-connect.org.uk/manufacturing

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