

A Unified Vision for European Robotics

*A Strategy for Innovation, Growth
and Societal Impact*



eu-robotics.net

Foreword from euRobotics

The European robotics association euRobotics celebrated its 12th birthday in 2024 but it can trace its genesis to the year 2000. Since then it has published a series of strategy documents setting out the themes and challenges for European robotics. During the Horizon 2020 framework programme euRobotics became the private side of a Public Private Partnership (SPARC) with the European Commission. At the time this was the largest civilian robotics research programme in the world with a public programme of some €700 million. More recently euRobotics has been a driving force within the AI, Data and Robotics Partnership as a strategic founding member of the Adra association.

Historically, euRobotics has focused its strategy on a vision for robotics in Europe that is broader than the subset of topics championed within the framework programmes. It brings stakeholders together from diverse sectors and from across the technology spectrum to create opportunities.

euRobotics is the primary focal point for robotics in Europe. Its membership, its Topic Groups and its major European events act as an ecosystem that binds robotics in Europe and reflect the diversity of talent and range of interests of the European robotics community.



euRobotics Strategic Viewpoint

Europe faces a critical challenge in the field of robotics and AI. The stark disparity between public funding in Europe and the massive private investments seen in the US and China is alarming.¹ While public funding plays a role, significantly increasing private investment is crucial for maintaining European sovereignty and competitiveness in these key disciplines. This requires a multi-pronged approach, beginning with making robotics and not only AI a top policy priority.

To stimulate private investment, Europe must create a more favourable environment for robotics and their applications. This includes implementing attractive tax incentives, providing targeted funding to support the critical scale-up phase of young companies, and streamlining regulations to reduce barriers to innovation. Europe must become a global hub for robotics, promoting public acceptance and nurturing and attracting top talent. Europe must also maximise its existing robotics expertise and investments, ensuring that they deliver long-term value and contribute to maintaining a technological edge.

Robotics is multi-disciplinary, in delivering economic and societal benefits it must integrate a wide range of different technologies as well as address its socio-technical impacts. This requires agile research and innovation investment mechanisms to match the nature of robotics research and innovation. European public-private partnerships, while valuable, must be significantly simplified to ensure effectiveness and avoid slow progress. Ultimately, Europe must accelerate the deployment of robots across various sectors, ensuring that robotics becomes easily accessible to asset developers, solution builders and users.

¹ <https://techcrunch.com/2024/11/15/heres-the-full-list-of-44-us-ai-startups-that-have-raised-100m-or-more-in-2024/>



By taking decisive action now to incentivise private investment, support innovation, and foster a skilled workforce, Europe can harness the transformative power of robotics, driving progress and prosperity for its citizens.

Executive Summary

This strategy sets out the collective vision of the European Robotics community. It draws on multiple sources of information from within Europe, from euRobotics Topic Groups, from workshops and market studies, from tracking worldwide advances in robotics and by collaborating with other associations and organisations. It makes a series of recommendations about how both public and private organisations should work to ensure that robotics in Europe has economic and societal impact in the medium and long term. These centre on enabling European based products and services to create added value while sustaining Europe's strong robotics research and innovation base. It sets out the case for supporting uptake, creating a long term focus on research and addressing the fundamental need to support a strong innovation infrastructure in Europe from a robotics perspective. It explores the pathways for robotics innovation and the direction for innovative growth.

The value of robotics lies in its impact on service delivery and on raising productivity in manufacturing. Robots are the *only* reason Europe can still mass-produce cars and appliances, and keep its advanced, Internet driven supply chain running. These very real impacts are only a beginning and even with the robotics technology we have today there are many more opportunities that could be deployed with current technology. This requires the stimulation of uptake by end users and an exploration of robotics can have greater impact, but this is held back by a lack of awareness, low levels of investment and a lack of skilled people and tools to support wide-ranging development, deployment, and operation.

To overcome these hurdles, Europe must seize the opportunity to develop and deploy more capable, smarter robots. Europe has a leading position in the development of industrial and service robotics and this needs to be supported within research and in the translation of that research into innovative products and services. Here a challenge is presented by the long lead times needed to take robotics research through to market. It is not uncommon for this to take 10-15 years, some 3-5 times longer than software based innovation. In addition, the cost at each stage is far greater because of the time and resources needed to build experimental and prototype hardware, test it, validate it and integrate it into the existing systems it must work with to deliver economic and societal value. These long term investments and high costs do not match well with the short term cycles within R&I funding or with the return on investment expectations of investors used to the "sugar rush" of investment in AI and related software based technologies.

Alongside these difficulties lies the need for regulation that enables robotics based innovation, where current regulation is often aligned with human rather than robot work practice. This coupled to poor understanding, even in industrial environments, makes uptake far slower than it should be.

Europe has much to gain from exploiting the potential of robotics but this requires a “Whole Europe” approach to research, innovation, deployment and uptake. If Europe is to retain its current leadership in robotics it is essential that:

- ▣ The triangle of research, industry and policy makers (Member States and Commission) all work together within a common framework that supports innovation from lab bench to market in an unbroken chain.
- ▣ Standards and regulation are aligned with both market and innovation needs.
- ▣ Investment profiles and fiscal policy match the character of robotics to enable rather than inhibit growth, not only within the robotics sector but also within those sectors that can raise productivity through the greater use of smarter robots.

Europe will face multiple socio-political challenges in the next decade and beyond. Robotics is a critical part of the technology matrix that can deliver the change needed to counter these challenges. This requires strategic investment today; in education, skills, technology, research, deployment and uptake if robotics is to maximise its impact economically and societally.

These factors shape the necessity for a strategy focused specifically on robotics.

Europe needs to:

- ❏ **Capitalise on Europe's leading position** by reinforcing its investment in robotics to boost industrial competitiveness and deliver societal benefits.
- ❏ **Fully leverage the robotics expertise it generates** and build on the investments it has already made to ensure that they deliver value.
- ❏ **Ensure progress in AI is focused on the needs of robotics** and on the need to create AI that can inherently reason and learn within the constraints of the physical world.
- ❏ **Better connect, not merge, the different robotics related ecosystems** to ensure that opportunities are not missed because of a lack of collaboration or awareness.
- ❏ **Adopt a far more active approach** to technology investment and risk by delivering faster, more agile, and joined up, research and innovation investment mechanisms that match the robotics R&I profile.
- ❏ **Deploy more robots more widely** and do so faster and more effectively than our competitors. The economic and societal benefit of robotics comes from greater deployment.
- ❏ **Focus on maintaining a technology edge** in robotics for the benefit of everyone by addressing the challenges it has the expertise and resources to own. This requires investment funds shaped to support the long term retention of robotics technology and expertise in Europe.
- ❏ **Educate and train the current and future workforce** to prepare for the use and uptake of robotics so as to maximise their added value. This is a generational change that needs to start now and includes raising citizen awareness and acceptance of robotics.

This strategy makes a series of recommendations for action to ensure that Europe can achieve these goals.

Recommendations:

- ❏ **Make Robotics a policy priority** so as to ensure that Europe strengthens its leading position in robotics and rebalances the focus between Robotics and AI by treating these as parallel policy objectives.
- ❏ **Increase the scale and agility of investment in research and innovation** to ensure Europe's currently leading position in robotics is strengthened.
- ❏ **Focus long-term support on the unique challenges of robotics uptake** to support the longer return on investment and sustain the progression to market.
- ❏ **Stimulate collaboration between end users, technology innovators, and research** to foster the collaborations needed to achieve the deep integration of robotics into end user processes and systems and develop a continuum of understanding along the innovation pipeline.
- ❏ **Recognise and actively support the full robotics innovation pathway** that can take some 10-15 years to go from ideas to market thus stretching well beyond the lifetime of individual projects and investment cycles.
- ❏ **Maintain sovereignty over robotics capabilities through alignment between Member State and EC initiatives and the private sector** to ensure that Europe matches the scale of investment in the US and China to retain sovereign capability.
- ❏ **Create a European skills framework** to deliver the unique skills needed to design, develop and deploy robotics at scale in Europe and support companies in scaling their robotics deployment to deliver economic and societal advantages.
- ❏ **Provide tailored support for robotics scale-up** to ensure that innovative robotics companies can grow in Europe and are not lost to competitors through failures in the innovation market.
- ❏ **Improve societal awareness and acceptance of the need for robotics** to ensure that uptake is not limited by misunderstandings and fears and ensure that citizens understand the benefits that robotics can bring.

Introduction

"In an era where technology increasingly dominates, Europe grapples with the challenge of keeping pace with swift global advancements. The continent has not developed a robust industry or cohesive ecosystems capable of capturing the benefits of the new wave of enhanced innovation. This has led to a reliance on external technologies now vital to European companies."

Enrico Letta

"Much More than a Market" April 2024

<https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf>

"...Europe holds a strong position in autonomous robotics, hosting around 22% of worldwide activity, and in AI services, hosting around 17% of activity. But innovative digital companies are generally failing to scale up in Europe and attract finance, reflected in a huge gap in later-stage financing between the EU and the US.... In fact, there is no EU company with a market capitalisation over EUR 100 billion that has been set up from scratch in the last fifty years, while in the US all six companies with a valuation above EUR 1 trillion have been created over this period."

Mario Draghi

"The Future of European competitiveness" September 2024

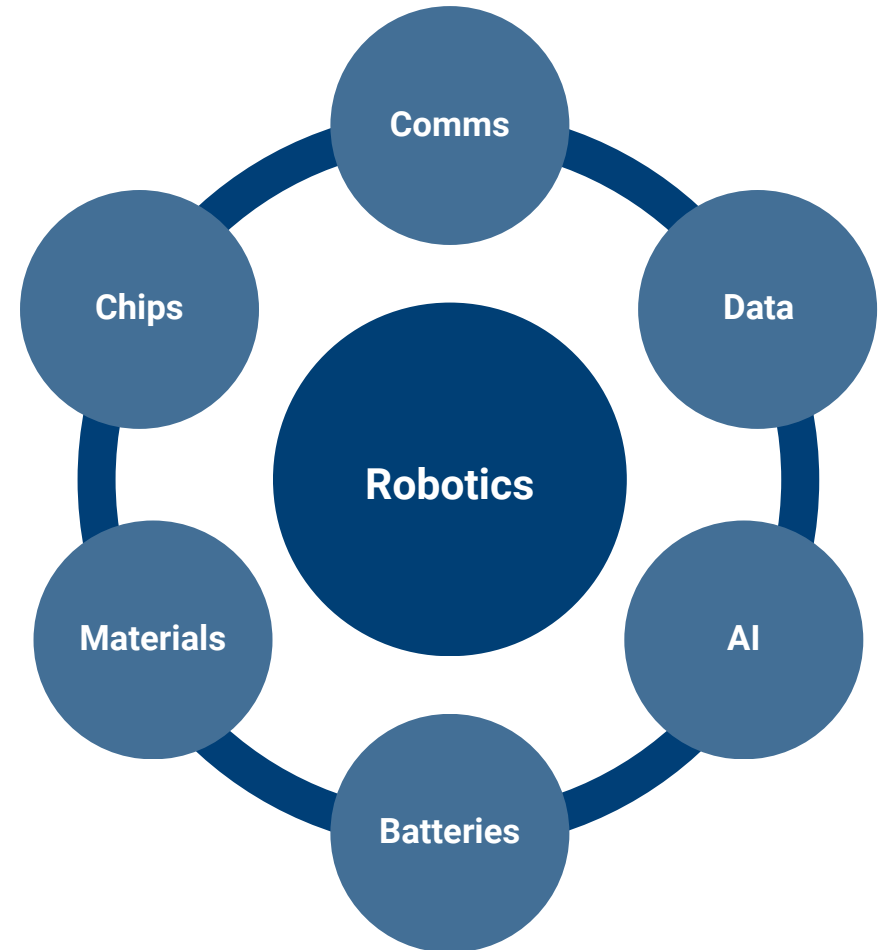
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A strategic call to action for European robotics

This new strategy, with its long-term vision and concrete calls to action, distils inputs from a wider range of sources to set out a direction for Europe. The world has shifted significantly since the previous strategic plan, with societal concerns evolving in the wake of the pandemic, ongoing geopolitical instability, and the escalating impacts of climate change. These factors have also altered societal awareness of technology more generally and changed expectations about its impact. This new strategy reflects these changes. It reflects changes in the market, changes in technology and changes in the approach Europe is taking to technology in general and robotics in particular.

The strategy takes a uniquely robotics view of a complex landscape that encompasses a range of allied technologies, including AI, that robotics relies on and integrates with. It sets out not only the expected progression of robotics but the need for associated progression in the technologies that robotics depends on.

Making transformative progress requires an integrated map of the technical development, uptake and infrastructure that will be needed in the coming decade to ensure Europe retains its leading position in robotics.



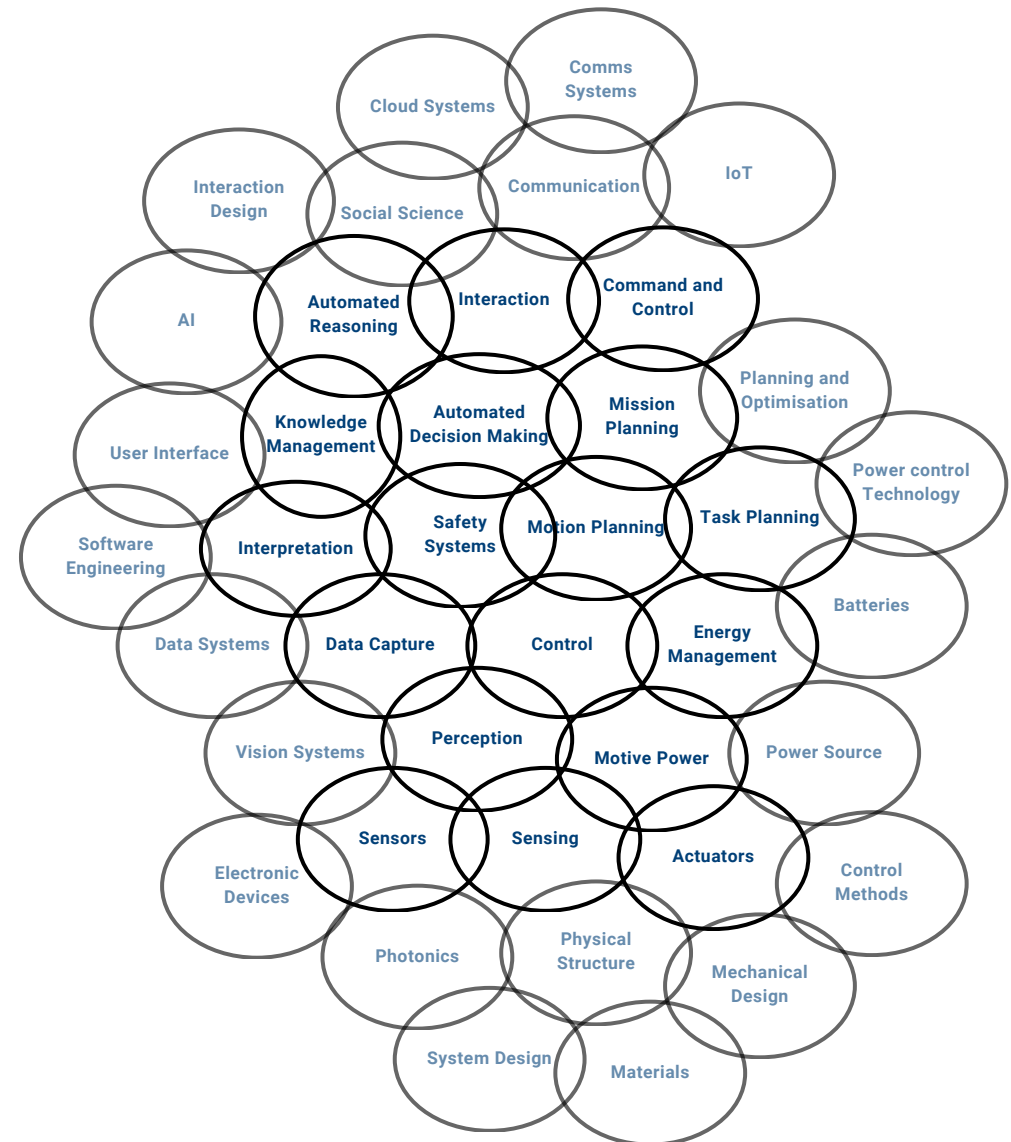
Now is the time to invest in a unified strategy for robotics, ensuring Europe drives technological progress and harnesses the full economic and societal potential of robotics

Robotics: much more than a technology

From a purely technical standpoint Robotics is a complex amalgam of multiple technologies, each essential for creating complete robotic systems that deliver functional, economic, and societal advantages. Robots are no longer isolated machines performing repetitive mechanical tasks; they are integrated within the infrastructure of farms, factories, utilities, transportation networks, and even our homes, hospitals, and cities.

This interconnectedness extends beyond the purely technical realm. Supporting the deployment of robots requires focused attention on skills development, education, regulation, technology adoption processes, innovation pathways, service infrastructure, supply chains, and how various sectors (industry, services, and the public sector) access, integrate, and benefit from robotics.

This evolution of robotics requires strategic action to address the challenges and opportunities presented by robotics' expanding role in society, necessitating greater engagement with Social Science and Humanities to better understand the impact and value of robotics. We must consider not only the research and development of robots themselves but also the wider implications for the economy, workforce, and everyday life.



Robotics today

Today, robots are already at work in various sectors across Europe. They are a cornerstone of modern manufacturing, driving up quality and productivity, they transform work by removing people from hazardous environments and underpin the supply chains that fuel the internet marketplace. Their benefits span the whole of production, from manufacturing to agriculture while, in the service sector, robots inspect infrastructure, enhance security, clean our homes and contribute to better healthcare outcomes.

This is just the beginning of what is possible. Robotics will transform transport systems, reshape urban environments, personalise healthcare, deliver sustainable food and increase national security. Robotics has the potential to be a key component in achieving a fair, secure, and more sustainable society because its impacts align with the United Nations Sustainable Development Goals (SDGs) and Europe's key missions.

As the field continues to evolve, we can expect even greater advancements and a broader range of applications that will further benefit society and contribute to a more sustainable future. However this requires a strategic focus on investment that can deliver these benefits.



Vertical hydroponic farm with robots used to move produce trays.

The strategic importance of robotics in Europe

In economic terms Europe struggles, as do the other older economies, with a falling level of total factor productivity growth; estimates indicate that this has been steadily falling for decades, not helped by an ageing European population and the younger generation seeking a better work-life balance through greater flexibility. In combination with these factors Europe has also shifted further towards a service-based economy.

Historically, scientific and technical progress has been instrumental in the societal and economic development of Europe and robotics is now a key part of the next wave of this progression.

How can robotics be used to boost Europe's economy and enhance the standard and quality of living going into the future? How can its role as a primary instrument of manufacturing productivity growth be used to impact other sectors (agricultural, services, healthcare etc.)? For Europe the development of advanced technologies unlocks a prosperous economic future and, more importantly, will enable Europe to be competitive both in the internal market and globally.

Against this opportunity Europe faces multiple socio-economic challenges in the coming decade in addition to the growing geopolitical threats. To address these challenges a "Whole Europe" approach is needed where Member States and European agencies work together to maintain the sovereignty and equality that underpin Europe's rights-based society.

Unlocking productivity growth

Europe excels at high value production and needs to maintain global competitiveness. With the need to pull manufacturing and production within its borders it must raise productivity to remain competitive.

The key to productivity growth in the next two decades will be an ability to not only develop but deploy robotics to carry out functions that increase economic and societal value. While robotics is the reason why large scale manufacturing remains in Europe, it also has the untapped potential to underpin efficiency, security and sovereignty gains in multiple areas of production and service.

Retaining technical sovereignty

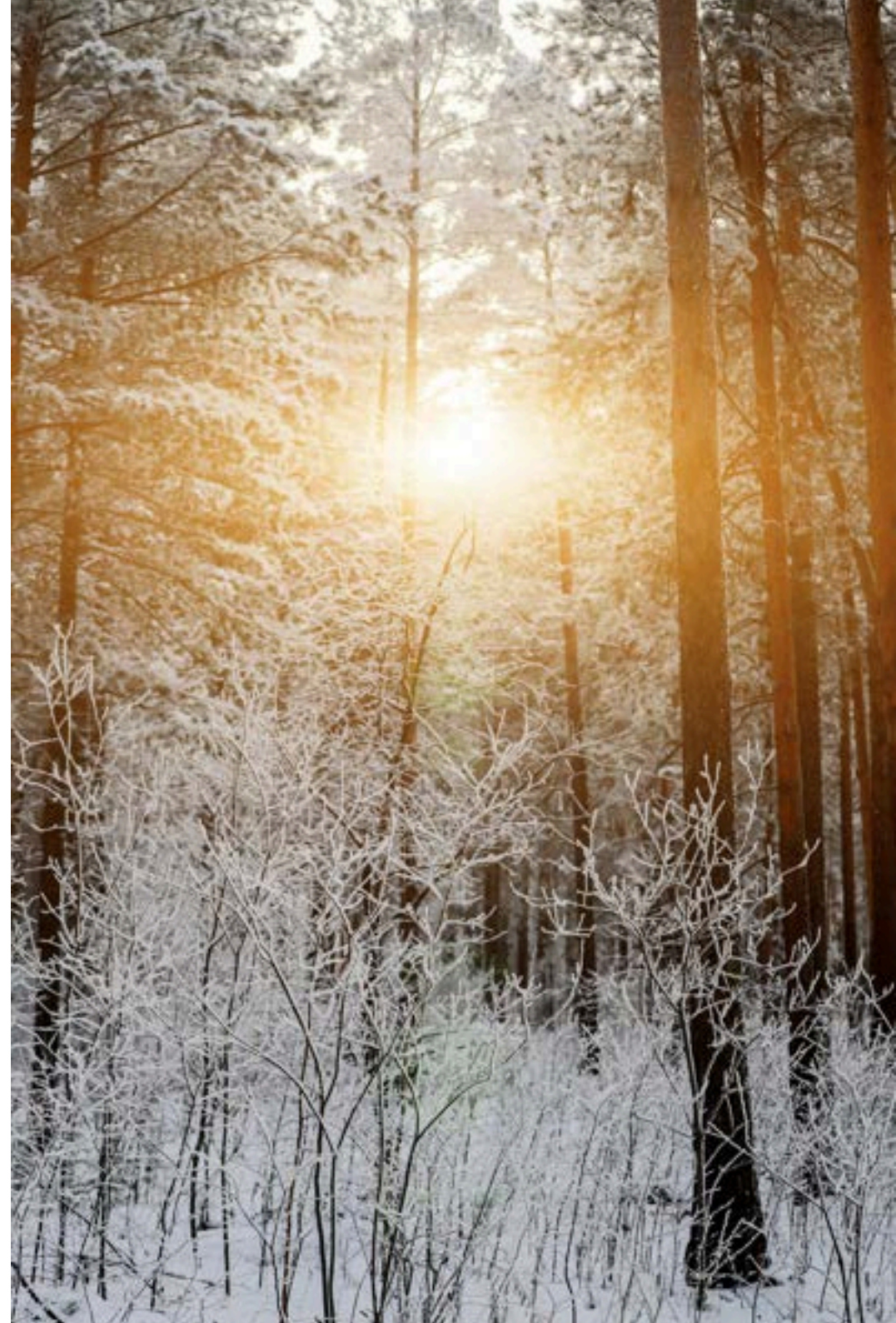
Europe has enjoyed a long period of technical sovereignty in key areas of trade underpinned by a balanced approach to delivering public good. There is a danger that the new and emerging technologies that will impact and create future trade are increasingly developed, commercialised and sourced outside of Europe. Europe currently enjoys a leading position in the development of robotics and it is essential that this lead is enhanced through investment in future technology and through the delivery of commercial strengths. Maintaining this lead is a critical element in European technical sovereignty.

Supporting the working population

Europe's health and social care systems will come under increasing strain in the next decade as its population ages and especially given the natural expectation that standards of care will be maintained. This demographic shift will also shrink the workforce. Productivity depends on maximising the effect of labour in the economy and increased technological uptake is almost the only way that Europe can respond. Robots have a role to play on both sides of the demographic shift, making it easier for people to do useful work for longer and helping to scale production and the delivery of services as the population ages and the workforce reduces.

Reducing climate change impact

Climate change is already having an impact on crop yields, life expectancy, the built environment and the natural environment. Above all Europe needs to ensure that its food, water and energy supplies are maintained. Increasingly recognised as a climate emergency, the dramatic climate variations of the 2020s require greater technical intervention. Robots are being seen as a means to not only fill the shortfall in labour but to ensure that natural resources are used sustainably. In the medium to long term this makes robotics an important part of delivering security of supply and enhancing the circular economy while monitoring and mitigating environmental impact.



What robots do ...



Why are robots useful?

Today we use robots to do useful work because of three special characteristics:

Endurance and repeatable consistency: Robots excel at repeating a task, day in day out with high levels of accuracy and consistency over long periods of time; typified in the image of a car factory with two parallel rows of robots busy building cars together. The same scene is found in all areas of mass production where parts must be positioned quickly and accurately time and time again. Robots are essential to mass manufacturing in Europe and help free up workers from dirty, dull and dangerous tasks to focus on more engaging and fulfilling ones.

Augmenting human capability: In working environments where people cannot or should not go, robots can transpose human motion to where it is needed, miniaturising or amplifying motion and strength as needed. This allows us to work in unsafe or inaccessible places; under the sea, in nuclear facilities or inside the human body.

Awareness of location: Robots can use their sensing systems to determine their location on a map, to capture and reference information from around them and do so inside or in some outdoor environments. This enables them to efficiently plan and move from place to place; transport people or goods, clean our houses or guide tractors in a field.

Each of these characteristics is already enabling different types of robot work to be undertaken alongside people; improving productivity, increasing safety and augmenting human endeavours.



Unimate, pouring coffee for a woman at Biltmore Hotel in Los Angeles, Calif., 1967 by Frank Q Brown

Creating robots with these capabilities has been the work of the 20th Century starting with the Unimate robot patented by George Devol 70 years ago in 1954.

This strategy is about what happens next...

Manufacturing today

Robots have been used in manufacturing for over 60 years mainly for mass production. Over the last 10 years robots have extended their reach into factory supply chains and are starting to work in collaboration with production workers in more complex applications.

Robots are now becoming more accessible to small companies because the unit cost of access is lower and they are far easier to programme than before. This expanded use in a wider variety of applications is raising productivity and retaining competitive manufacturing in Europe even in high wage economies. This advent of smaller easily programmed industrial robots is ensuring their wider use in supply chains and enabling their use in bespoke high value manufacturing.



Healthcare today

Teleoperated surgical tools have been in Europe since 1999 in laparoscopic surgery. The sophistication of these systems has steadily increased to the point where the more advanced systems deploy multiple reconfigurable robots to work simultaneously with a surgical team. Robots can also be found in pharmacy dispensing, in the logistics operations within hospitals delivering supplies, and in patient positioning systems for radiotherapy and neuro-surgery. Outside of the hospital robots are used in laboratory automation to develop new treatments and process test samples.

Robots are enabling complex operations that without their high precision would be too risky to undertake. Behind the scenes in large hospitals their ability to autonomously transfer supplies and goods between facilities is increasing dependability and efficiency. More recently they are being used in complex rehabilitation and are providing greatly improved support for amputees.



Food and farming today

Robots have been extensively used to manage and milk dairy herds since 2005. Semi-automated tractors and grain harvesters have been around since 2008. More recently food warehousing has been transformed with fully automated storage and retrieval systems able to operate at fridge and freezer temperatures. Almost the whole process of vertical farming is automated apart from the final harvesting. Aerial robots are increasingly used to monitor crops and provide selective precision spraying of herbicides and pesticides.

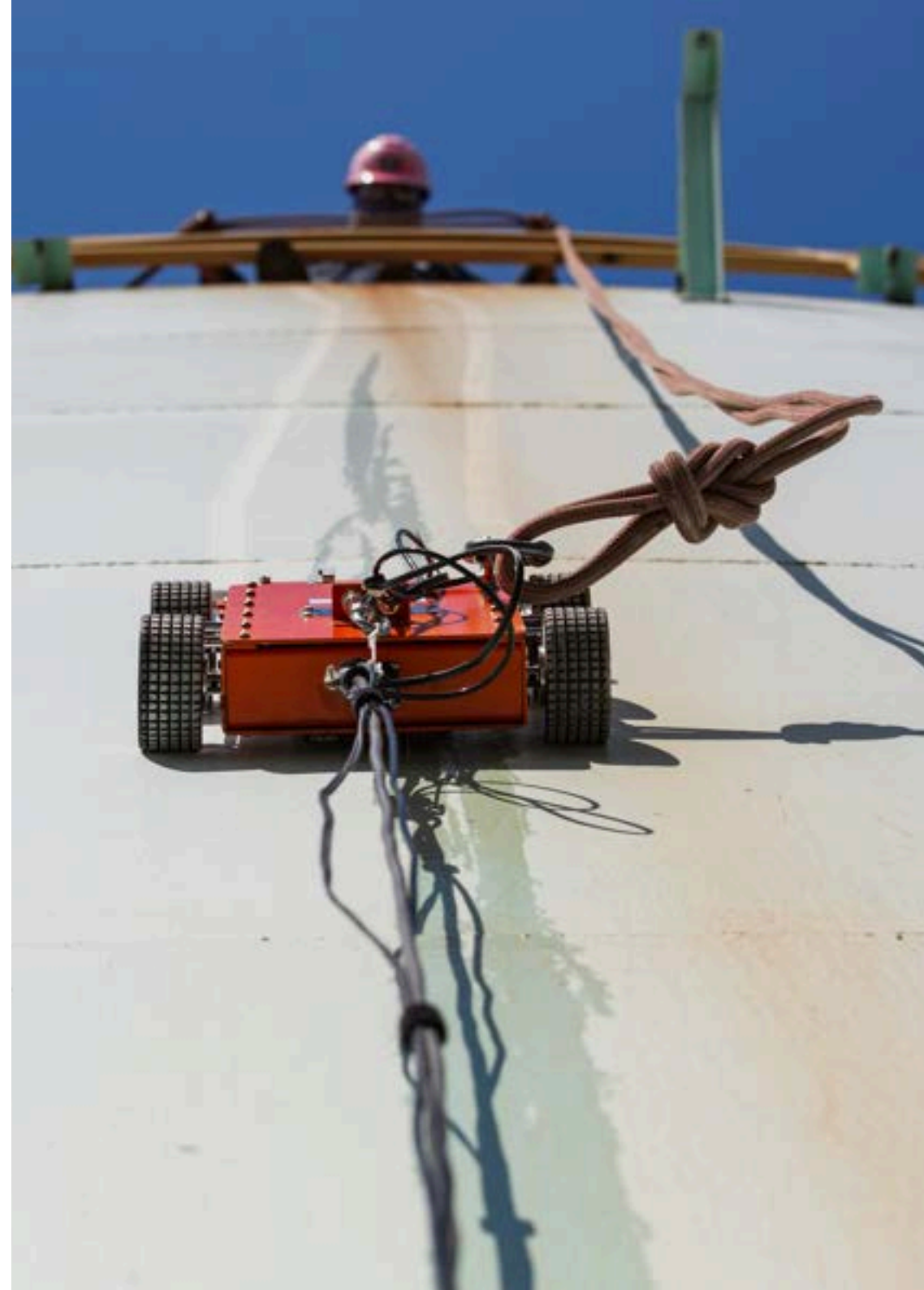
Robots with cameras, infrared and other sensors allow crops, grazing areas, and irrigation monitoring to optimise human sustainable exploitation, complementing field sensors and satellite observations. Robots have contributed to improved levels of animal health, to greater crop yields and to lower levels of waste in the food supply chain.



Infrastructure today

The last decade has seen an exponential growth of the use of robots in the inspection of infrastructure, from road and rail infrastructure; industrial storage containers, pipes and chimneys that are difficult to inspect safely. Robots, on the land, sea and air, equipped with special cameras are able to see in infra-red as well as visible light, or with radar-like sensing can sense beyond the surface of a structure. They can enable quick, accurate and repetitive assessment based on measurements made over time at precise locations, with inspection guided by a human operator.

Robots reduce the risk to people inspecting and maintaining infrastructure, they reduce the need to construct physical access routes for people and thereby reduce the cost of building plant, the downtime of plant and the cost of operations.



Logistics today

Robotics has been automating the delivery of goods inside warehouses and factories since the early 2000s. More recently the boom in internet based goods transactions and the digitisation of trade, that automates from order to delivery is now driving up the use of robotics across newly installed warehouses and factories in the delivery of goods and parts.

The speed of Internet ordering and the need to preserve perishable food quality while efficiently managing demand spikes has led to increased automation in warehouses in order to keep pace with demand and handle the wide variety of goods being dispatched. This reduces perishable waste and reduces the cost of storage and shipment, which in turn impact on road utilisation and energy use.

While it may be difficult to retrofit robotics to the large number of existing warehouses, even here robots are being used to automate stock taking and in the internal transport of pallets; raising productivity and order accuracy.



Domestic use today

Robots have been used in homes for over 20 years, mainly for vacuum cleaning. These robots are able to autonomously navigate a room and clean the floor. The success of domestic robot vacuum cleaners can be attributed to their ability to map out the room that needs to be cleaned and divide the task into sections autonomously, recharging when necessary. Some are able to automatically empty the dust collected and others are able to wash as well as vacuum floors. These high levels of autonomy make them easy to use and able to adapt as a room changes over time.

In addition to vacuum cleaners, robots are also used for other tasks in the home, such as mowing the lawn and cleaning pools. All these robots free up people from regular domestic tasks and can help the elderly and disabled be more independent.



Security use today

Teleoperated robots have become an essential element in both civil security and defence operations, as highlighted by the war in Ukraine. They are used to carry out surveillance and provide transport in hazardous conditions as well as deliver ordinance. Unmanned systems are being used to patrol and monitor shipping routes and protect critical infrastructure such as undersea cables. They are also used to defuse bombs and assess threats during terrorist attacks.

Aerial systems provide a unique observation capability for civil security to combat illegal shipping and smuggling operations. Here the use of infrared cameras is essential to nighttime operation in conditions where a conventional helicopter could not be used. Robots are also helping during civil disaster recovery, after earthquakes and explosions to enter and survey collapsed buildings when it is too dangerous for people to enter.



What will robots do tomorrow?

During the coming decade robots will acquire new abilities and take new physical forms to deliver capability that will open novel areas of application and new markets. These advances are likely to derive from four key areas of robotics development and their integration into applications.

Adaptation and learning

There is a continuum of learning that stretches from the fine tuning of a mechanical system, to the lifelong learning needed to adapt a robot to the needs of a particular user or use case. Learning in robotics is not simple. There are limits imposed by the physical world and by safety regulations that the robot must continue to obey, even while it changes how it behaves; robots cannot be allowed to hallucinate or degrade performance through learning. Current developments only scratch the surface of robot learning; to be successful we need to provide performance and safety guarantees while learning.

Perception and physical interaction

Perception has always been a major challenge in robotics. Being able to identify, fully characterise and interact with objects, working environments and even people, is critical to being able to extend the types of physical work robotics can address, and do so safely, efficiently and precisely.

Manipulation and dexterity

Only when you realise how much of the human brain is dedicated to the perception and control of the hands do you realise how complex the challenge of dexterity is. Humans are almost the only species that has developed highly sophisticated tool use, and for robots to be useful, they need capabilities and, importantly, speed and sensitivity similar to our own. We are able to identify materials, texture, strength and fluidity and react our grasp to match these in an instant. Dexterity has a wider context too, in the whole body motion needed to balance, especially when carrying a heavy object. No robot currently has these capabilities in a practical form.

Autonomy and control

The window of autonomy is slowly widening from where it currently operates over short time scales, for example in autonomous driving, to longer term autonomy able to make decisions about how, and in what order, tasks should be carried out. How much autonomy and how much human control is needed is determined by the task and the operating environment. In some applications, for example in hazardous environments, higher levels of human control and oversight are essential for safety, while in other environments, for example in the home, greater autonomy of the robot is desirable.

The robotics paradox

The current first generation of application areas, where robotics is having an impact, focus on autonomous mobility, in domestic vacuum cleaning, in teleoperated surgery, in inspection by robots and in the transport of goods in warehouses. In all these areas robots are successful because the manipulation of objects and the need to autonomously interact with people are at a minimum.

These applications are the “low hanging fruit” where reduced levels of interaction capability are not a barrier to uptake. The reach of robotics into more complex, real world applications in unstructured environments that require human level dexterity, proprioception, physical awareness and adaptation is currently beyond what can be physically achieved with robots even in our best research laboratories.

While current AI can beat the best chess or Go player, our best robots cannot manipulate a stack of wooden bricks with the dexterity of a 3 year old child. This is an instance of Moravec’s paradox; what humans find easy, artificial intelligence finds hard and vice versa. Part of the clue to this paradox lies in the fact that the rules of chess and Go are well defined and finite, whereas interacting with the physical world is profoundly more complex. The challenge lies not just in the sheer number of objects in a cluttered environment, but fundamentally in how robots perceive and interact with the physical world. Unlike games with clearly defined rules, the real world presents a constantly shifting landscape of forces, textures, and unpredictable events. Even seemingly simple actions, like picking up a block, require complex sensory feedback and motor control that humans develop effortlessly, but which are incredibly difficult to replicate in robots.

This ability gap is holding back robotics in areas where the world is unstructured and complex. New developments are needed to encode this nuanced understanding of the physical world within a machine, allowing robots to operate safely and robustly in our unstructured environments.



Building the complexities of the real world into robots is a challenge. While AI excels at tasks with well-defined rules, like chess, it struggles with seemingly simple physical tasks that humans find easy, like manipulating objects in unstructured environments. This paradox is a major focus for robotics and Europe has a key role to play in finding a solution.

Smart Robots

To advance all areas of application we need smarter, more capable robots, we need them to be able to work in our cluttered world.

If we go to the fridge and see that the milk carton we want is at the back obstructed by many objects, plates of food, other containers and bottles, then we must start to answer more complex questions; *“What happens if I take the plate out first? Can I reach in and grab the milk carton and pull it out without knocking over the bottle?”*

Robots need to be able to ask themselves and answer these types of questions. Sometimes the answer cannot be determined except by reaching in and seeing if it is possible, and then dynamically replanning based on knowledge about how things move inside a cluttered fridge.

Sometimes, after it goes wrong, a robot will need to ask itself *“What would have happened if I had not moved the plate first?”*² both to learn from an experience and to test a future plan.

Today we do not have the robots or technology to address these problems and provide competence at scale, and yet this type of function is critical to the extension of robotics into the real human world that is unstructured and dynamic.³

² <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2408534/#:~:text=Thinking%20about%20what%20might%20have,2005%3B%20Roese%2C%201997>

³ Appendix E provides a more detailed overview of AI and Robotics.



The European landscape

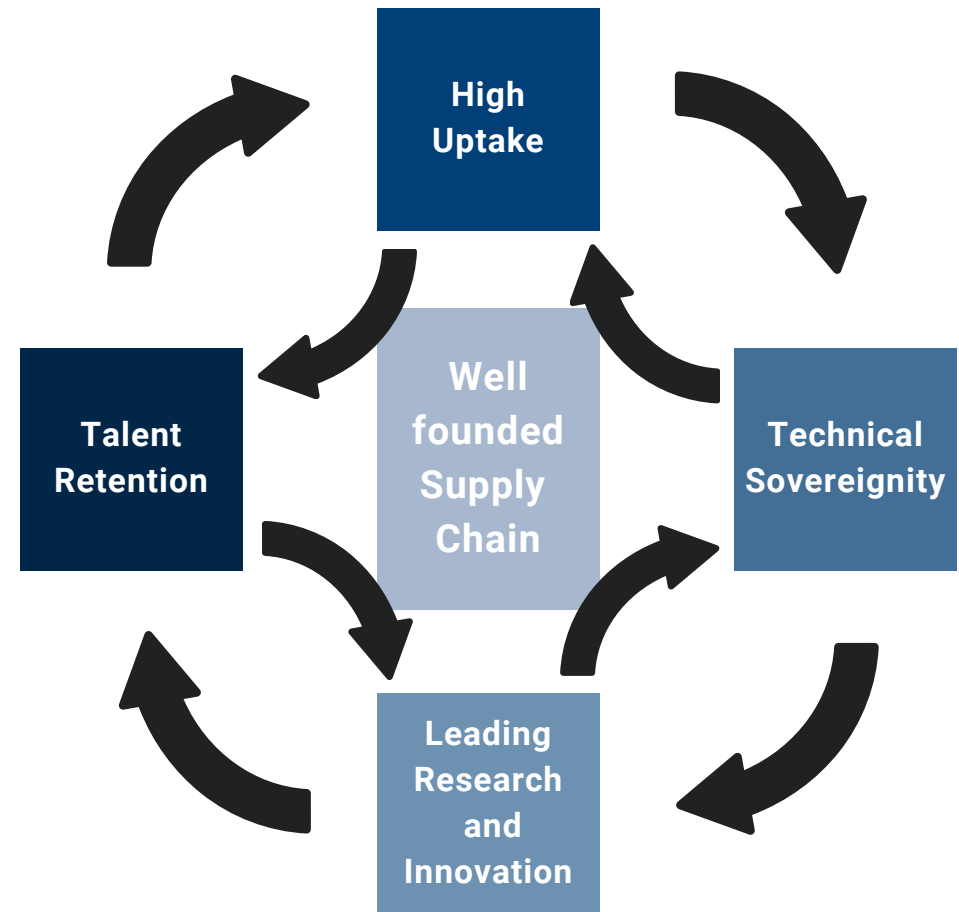


European robotics

Europe holds a strong position globally in professional service robotics⁴ and in industrial robotics. This is built on a strong underlying research base, a significant talent pool and a myriad of small and mid sized companies specialising in the development of robotics and their integration and deployment into a wide variety of manufacturing and service sectors. The goal must be to ensure that Europe builds on this global position.

Each part of this ecosystem is mutually dependent on the others, talent drives innovation, research and uptake, high uptake ensures technical sovereignty which in turn drives high value research and innovation. All of which relies on and contributes to the development of a well founded, dynamic and robust supply chain.

Maintaining sovereignty in this pan European robotics ecosystem needs to become a strategic priority for Europe because of the critical importance of robotics in raising manufacturing productivity and in enhancing the delivery of services across multiple sectors from transport to healthcare.

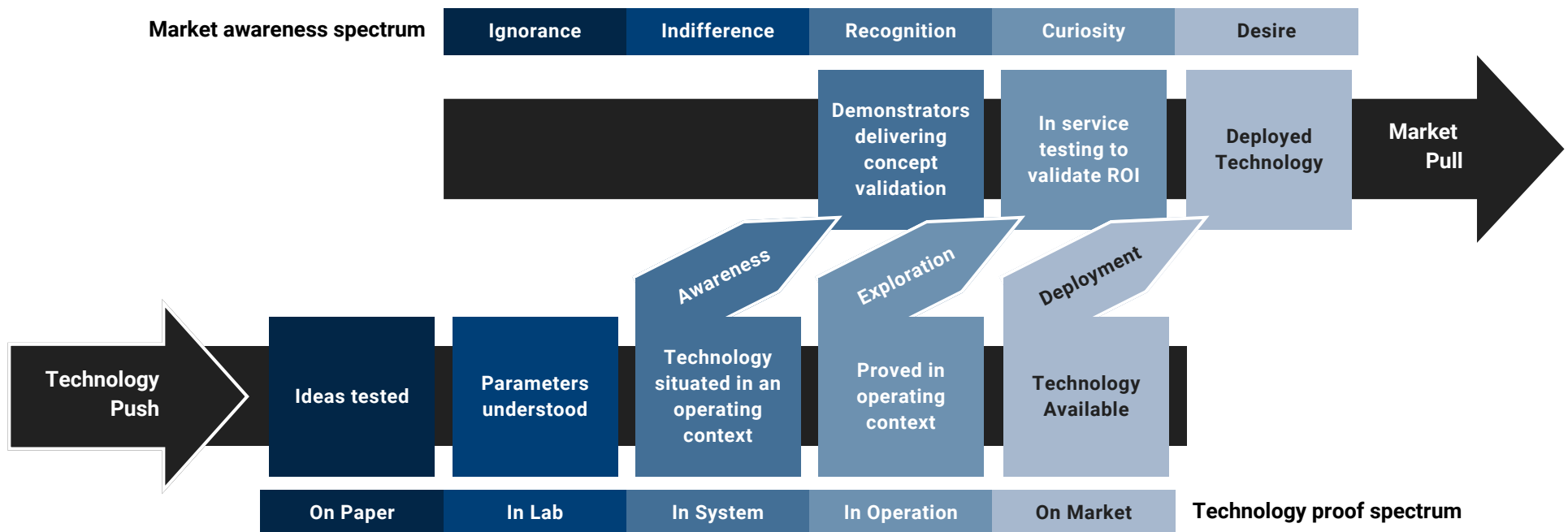


⁴ Recent International Federation of Robotics figures (September 2024) indicate that Europe has some 36% of the service robotics companies in the world, more than the USA with 33%, in a market growing at 30% per annum.
https://ifr.org/img/worldrobotics/Press_Conference_2024.pdf (Slides 32 & 34)

Creating transformative impact

Robotics has not yet reached the point where it has completely transformed industries outside of manufacturing but it has the potential to do so in key sectors. As highlighted above, current robotics technology is becoming sufficient to deliver economic and societal benefit, if it is applied widely. But creating wider uptake requires a pivot from technology push to market pull.

Driving end user awareness towards the first stage of “recognition” is the initial step towards this pivot point. This initial market engagement is needed to highlight the problems of integration and explore the feasibility of primary applications. Driving uptake requires the championing of a “Whole Europe” approach to robotics uptake, driven at a European and Member State level so that end users and investors can see that a market is being created because capability and need are matched.



This requires a high degree of reactivity to assess the policy directions being pursued and if needed correct balance and focus to create new opportunities. Only an integrated, joined up “Whole Europe” approach is likely to succeed. European fragmentation will not build the capability needed to meet the challenges Europe faces from the US or China.

Improving the innovation pathway

The physical demands of robotics drive a different methodology both in research and innovation, and the longer and riskier innovation pathway for robotics creates a very different investment profile.

Robotics requires long-term sustained investment in capability. This is driven by the 15-20 year innovation pipeline in robotics from lab bench to product on the market; approximately 3-5 times longer than developments in software based innovation. This risk is further enhanced by the fact that robots are typically designed for specific functions in specific environments.

Although there will doubtless be major achievements that make important progress, the core challenges robotics faces have been challenges for several decades and will remain challenging for several more. This therefore requires a long term strategy, beyond single funding cycles, to enable a continuous development pathway that operates to meet the intensity of our competitors. This should be driven by the need to enhance operating capability while challenging cost, size and complexity.

A long-term approach to research and innovation funding is essential, even in early stage research, to ensure that ideas are not stopped early. In particular the desire of funding agencies to chase trends is counterproductive when changed funding priorities directly prevent continuity.



Setting strategic priorities for investment

Unfortunately there are times when Europe has paused funding at the wrong moment, failed to invest in uptake appropriately and has lost the initiative in a market only to have to catch up at a later date and find a niche where it can excel having lost talent and advantage through hesitation. Robotics is at such a juncture and increasing investment is a necessity if technical sovereignty and talent are to be retained.

Robotics presents unique challenges for both public and private investment. The physical nature of robotics drives the investment profile; the longer time to market, the progressive cost increases at each development step, the need to assure safety and validate function. These factors result in a higher business risk level that can stifle investment and create a significant funding gap earlier in the progression to market.

Because of the higher level of investment risk, particularly in the later stages of development, competitor nations with lower levels of risk aversion will snap up our best work when Europe dithers on longer term investment delivery. Without a transformation of the risk profile triggered by public side acknowledgement of its role in absorbing risk, we are destined to feed our competitors with excellent innovation. These factors shape the necessity for a strategy focused specifically on robotics.



How should Europe respond?

In robotics Europe has the capability, the talent and the breadth of market to succeed globally but the current fragmentation, lack of coherent vision and limited investment are holding it back.

Europe has a narrow window of opportunity to ensure that its current advantage in industrial and service robotics is scaled to deliver the economic and societal advantages that Europe needs to overcome its current challenges. Competitors are already investing in the long term with a full understanding of the advantage robotics can bring to every sector and to society at large. Europe needs to raise the stakes and invest in retaining talent, supporting the innovation chain and focusing on creating and retaining technical sovereignty in robotics and its related technologies. The current status quo will not deliver the impetus in funding, regulatory support and market pull needed to extract the benefits from Europe's leading position.

All stakeholders in Europe have a role to play in stimulating a demand side pull for robotics and, in parallel, ensure that research and innovation are supported long enough to deliver advantage.

To address these challenges Europe needs to address the following strategic goals:

Capitalise on Europe's leading position by reinforcing its investment in robotics to boost industrial competitiveness and deliver societal benefits. Investments to date have resulted in its current leading position globally. However now is the time to strengthen this investment as the market grows at some 30% per annum. This demands a broad based strategy that enables investment at every stage of the research, innovation and deployment pipeline and recognises that robotics is a socio-technical discipline with needs beyond the purely technical. It requires a well defined regulatory landscape that supports and enables innovation and deployment and it requires the workforce to be able to deliver the unique skill set that robotics needs.

Fully leverage the robotics expertise Europe generates and ensure that it maximises the delivery of economic and societal value. Europe needs to ensure that the value added by public support for novel research and its translation to innovation is not lost to competitors because the second and third round financial packages are missing from the European portfolio.

Ensure progress in AI is focused on the needs of robotics so that AI is able to inherently reason and learn within the constraints of the physical world; AI that can account for physical parameters such friction, inertia, energy and mass; AI that can streamline design, development and deployment processes. AI that can deliver optimisation, decision making and planning throughout the lifecycle and AI that helps users interact and use robots to their advantage. Adding AI to robots must make them more functional, more trustworthy, safer and appropriately adaptable to the real world and the people in it. AI must be focused on enhancing what and how robots deliver benefits to users in the physical world, dependably and with trust.

Better connect, not merge, the different robotics related ecosystems to ensure that opportunities are not missed because of a lack of collaboration or awareness. Europe has expertise across all areas of robotics and across all the areas of technology that closely couple to robotics. However this expertise is not well connected and the various ecosystems barely overlap. Much greater emphasis is needed on these overlaps, not by merging the elements but by highlighting the difficulties of collaboration at the boundary and by applying support tailored to the needs and profiles of each side. Merging smothers these differences and makes it harder to progress.

Adopt a far more active approach to technology investment risk by delivering faster, more agile, joined up, research and innovation investment mechanisms that match the longer term robotics risk and investment profile. Europe needs to shift from being risk averse to a “push the limits till they break” approach, but to do so in a controlled, well defined, way. Mechanisms need to be coherent across Europe backed by a “Whole Europe” approach, be reactive to new emerging trends while simultaneously supporting long term underpinning fundamentals.

Deploy more robots more widely and do so faster and more effectively than Europe’s competitors. Europe needs to stimulate a wider range of robotics applications to create impact in sectors currently not benefiting from robotics and to embed them in continuous operations. It needs to identify and assess the economic impact of the service and industrial application areas where robotics will provide the most benefit to Europe and then enable and invest appropriately.

Maintain a technology edge in robotics for the benefit of everyone by addressing the challenges it has the expertise and resources to own. Achieving this requires investment shaped to support the long term retention of technology in Europe. It needs the triangle of research, industry and policy makers (Member States and the Commission together) to align and take steps to maintain Europe’s current advantage, with a European perspective, as it has done in other areas.

Educate and train the current and future workforce to prepare for the use and uptake of robotics so as to maximise their added value. This is a generational change that needs to start now and includes raising citizen awareness and acceptance of robotics. Education is needed at all levels from primary education through to postgraduate level. The multi-disciplinary nature of robotics demands new approaches and a clear framework of certification to promote transferable skills at all levels.

To reinforce these goals Europe needs a regulatory environment that encourages robotics innovation and accelerates deployment supported by stronger financial instruments that enable growth and drive scaleup. These instruments must match the longer investment timeframe typical in robotics while supporting the growth of talent and the retention of technical sovereignty.

Recommendations

To achieve these goals euRobotics makes the following recommendations:

1. Make Robotics a policy priority

To ensure that Europe strengthens its leading position in robotics there is an urgent need to rebalance the focus between Robotics and AI and treat these as parallel policy objectives. This elevated priority should translate into concrete actions, such as driving uptake and market translation; stimulating investment; fostering collaboration; developing skills and talent and investing in research and innovation.

2. Increase the scale and agility of investment in research and innovation

There are structural and strategic reasons, set out above, why both public and private investment will need to increase at scale during the coming decade and beyond.

The societal impacts set out at the start of this document argue for an urgent need to address them through the greater application of technology. Robotics is an integrating force for a range of technologies that can impact on the effects of climate change, on the demographic shift and is a key driver of productivity growth in manufacturing and the service sector.

Increased investment at scale is critical to joining up funding from research to innovation and to bridge between public and private investment. The longer return on investment and the capital intensive nature of robotics development, especially closer to market, mean that as robotics shifts from development to deployment the funding support needed to sustain progress and to retain market needs to be amplified.

3. Focus long-term support on the unique challenges of robotics uptake

Robotics maximises its benefit when it is deployed at scale. This requires a long term strategic approach, enabled by public funding, to address market hesitancy and drive uptake by stimulating long term private investment to create scale. The investments needed to build infrastructure, develop skills and change business models require trust in the technology coupled to a well defined impact evidence base.

Robotics presents unique challenges not only in its research and innovation but in its uptake and deployment that can be accelerated by public engagement matched by private co-investment.

4. Stimulate collaboration between end users, technology innovators, and research

Robotics, because of its deep integration into processes and systems at the point of use, and because of its need to develop unique solutions that match the demands of a specific task, requires mutual understanding between end users, technologists and researchers early in the development process. This is a systemic theme within robotics and requires mutual support and investment by both the public and private sides.

Achieving this collaboration requires awareness and trust to be built between technology providers and end users and the active development of effective links between end user needs and technical capability.

5. Recognise and actively support the full robotics innovation pathway

In robotics the full path of innovation investment is long term, beyond the remit of individual projects or investment cycles. It can take 10-15 years to go from a lab bench prototype through in-field testing and on to a product integrated into the processes of an end user. For continued success this journey needs investment and business support coupled to knowledge exchange mechanisms that join up. The robots we see today are the result of 70 years of continuous development.

Only by recognising the full innovation pathway and investing in research, innovation, talent and infrastructure will Europe succeed in sustaining the long term economic and societal benefit from the robotics advantage it has already built.

6. Maintain sovereignty over robotics capabilities through alignment between Member State and EC initiatives and the private sector

Maintaining sovereign capability requires a joined up approach that ensures investment matches the growth curve of robotics companies. Investment in infrastructure and financial support mechanisms that match the scale and timeline of robotics need a new approach, fragmentation slows innovation and results in lost opportunities. The long-term retention of talent and the translation to market of the innovation it delivers is critical. Europe needs to crack the problem of retaining primarily hardware based high growth companies.

Europe and Member States need to not only think but act at scale to drive uptake and the translation between research and industry. Fully aligning public and private investment needs to become a priority to ensure that Europe works, as it should, at the scale of the US and China.

7. Create a European skills framework

Robotics can be the future of Europe. But without the right skills in the workforce driving adaptation to new ways of working, without the understanding needed in management and in the application of regulation; uptake will be stifled by a shortage of human capital.

It takes a decade to train a new workforce and in a decade from now the growth of robot applications will be significant. If Europe is to maximise the gain from this shift it must look now at developing the educational and skill infrastructures needed to support such a change in work. With smart robots as tools, workers will need new kinds of knowledge and those who maintain, install and configure such systems will need specialist skills.

Europe must now train a generation of workers and engineers to be aware of the capability and opportunity presented by these smart robots, with knowledge of how to deploy and work with them and an understanding of their limitations and challenges.

8. Provide tailored support for robotics scale-up

SMEs and SMC⁵s are the backbone of the growing robotics ecosystem in Europe. A decade from now it is certain that some will have grown into larger organisations. It is important to nurture this transition to ensure that as many as possible find their market, expand and grow. We know that many, indeed most will fail in their objective, but the lessons learned through failure are often a keen stimulant for new, bolder ideas that succeed. As with other recommendations the long journey and the increased capital need are key factors in supporting SMEs to scale into SMCs and beyond.

Europe needs to invest in the scale-up of robotics companies so that companies built in Europe stay in Europe as they grow, there should be no barriers to growth in Europe. Financial mechanisms need to take account of the specific needs of robotics and its long term investment profile.

⁵ Small Midcap Companies

9. Improve societal awareness and acceptance of the need for robotics

The societal awareness of robotics is more informed by Hollywood than by citizens encountering or recognising robotics in daily life. Acceptance is critical to uptake, and benefits from direct practical knowledge. More needs to be done to promote robotics to citizens and to those that make decisions in order to both set out the benefits and to understand and address concerns and fears.

Europe needs to focus on how best to deploy robotics for the benefit of citizens, how to ensure it avoids harms and how it creates acceptable regulation that both protects citizens and promotes innovation.

Finally:

To fully realise the potential of robotics, Europe must prioritise it as a key policy area, on a par with AI. This strategic focus will attract investment, signaling the sector's critical role in Europe's future. It will foster a thriving environment for robotics companies and research, accelerating innovation and deployment across diverse sectors. Robotics is an essential ingredient in Europe's ability to address societal challenges, boost productivity, and enhance its global competitiveness.

Appendices



Appendix A: Key technical challenges for robotics

In addition to the challenges of perception, dexterity and understanding, detailed elsewhere in the document the following are also critical areas for technical progress:

Performance enhancement: In terms of the raw performance metrics of robotics there are significant challenges in making them faster, lighter, more accurate, agile and dexterous. Even more so when these are needed in combination. Rigid structures and conventional actuators have limits and progress will be made with novel forms built from new materials, for example, to create safe human interaction.

Scaling: The ability to handle very large loads of 100s of tonnes with high accuracy, or the ability to manipulate objects at the micro and nano scale set unique challenges on both the physical construction of robots and on the control algorithms used to provide motion. The construction of buildings and infrastructure and processing of nanomaterials require robotics.

Ease of use: For widespread adoption the skill level needed to install, maintain and configure robots to new tasks must be brought within the reach of workers and technicians. Robots need to be made simpler to use and the training needed to use them must be widely available.

Human interaction: Robots need to significantly enhance their ability to interact with people, both in terms of text and spoken communication and in terms of physical and social interaction. Robots need to be able to understand the environment and react appropriately to varying demands.

Endurance: Robots need to extend their window of autonomy so that they can operate in more complex and dynamic environments for longer periods of time without direct human intervention and do so with greater levels of dependability.

Harsh environment operations: Robots need to operate in extremely harsh environments and this often creates challenges for their design and operation, from the creation of bio-compatible robots to those able to work underwater, in high temperature or nuclear environments.

Knowledge integration: The connection of robots to data and information requires significant improvements both to the means of communication and in the definition of how communication is conducted. Knowledge, semantic understanding of the environment and skill exchange can transform how robots operate in the real world.

Development of tools and systems: Robots require specialised easy to use design and deployment tools coupled to development systems that accelerate the design, configuration and deployment of systems. This is essential to the acceleration of uptake.

Safety, security and privacy: Robots need to operate safely and securely in every application area, both physically and in terms of their operation. People and organisations need to be confident that what robots see and hear remains private and is not being directed to benefit others. This needs the embedding of cybersecurity within each robot to ensure privacy and protection from external threats.

Appendix B: European mechanisms

Robotics is a part of each of the nine drivers of competitiveness set out by the Commission in its communication on long term competitiveness.⁶ Growth in robotics is built on a functioning single market and contributes to productivity, wellbeing, fairness, resilience and sustainability. It depends on a growth enhancing regulatory framework and the public investment in infrastructure. It contributes to circularity, digitalisation, energy, trade and strategic autonomy.

If robotics is to play a full part in the future of Europe and deliver on the opportunity it can create then there needs to be a change in the way that Europe finances growth and invests in research and its outcomes. The communication sets out changes in funding policy that benefit robotics investment and therefore uptake and deployment by enabling easier routes to finance for SMEs and SMCs to scale up. But this will only happen if these new instruments are shaped to the longer term higher investment levels needed in robotics. Too many European robotics companies have been sold to the US and China because they were unable to find European investment for their next stage of growth. We cannot afford to let the investments made in research that translate to startups that grow into well founded companies dissipate because the long term funding is missing.

In addition there is a need to be both reactive to new developments in technology, wherever that occurs, while at the same time support fundamentals that underpin robotics. Both are needed, they are not a mutually exclusive choice. Reactivity is currently impossible with the extended time frames needed to develop work programmes. It takes two years to get a project funded and running from the starting point of recognising a trend, and then 3-5 years before results are delivered. This just results in Europe remaining a “late follower”. Far more needs to be done to both spot early opportunities and then react appropriately, and quickly if justified. Far greater grass roots flexibility is needed in the definition stage and far more reactivity in delivering funding is needed to ensure that European research and innovation are not left standing. Waiting for a top down approach to grind out or the Commission to respond with a long term strategy before taking action is not an option.

The US and China benefit from very well connected innovation funding mechanisms that are able to operate seamlessly between the lab bench and first deployment. Europe needs to mirror this to ensure our best researchers remain in Europe and our best research is translated to our advantage. There is considerable opportunity in using public procurement to stimulate research. Europe has a well developed public procurement system focused on key sectors; space, defence, nuclear, transport, healthcare etc and these can be leveraged to focus funding on innovation pull through. However this needs a supporting regulatory infrastructure and incentives for public agencies to take and manage risks and technical challenges in order to progress.

⁶ Long-term competitiveness of the EU: looking beyond 2030; COM(2023) 168 FINAL https://commission.europa.eu/system/files/2023-03/Communication_Long-term-competitiveness.pdf

Appendix C: Robotics Infrastructure

In researching and developing novel robotics, in creating startups and in scaling up SMEs to engage in the end user markets for robotics there is a need to provide accessible and well structured support infrastructures that take account of the need to be able to test and validate robotics operation in safe but real environments. In providing a successful robotics development infrastructure there are three critical aspects that must be addressed:

- ▣ The need to ensure that IP is not exposed or diluted by testing on infrastructure owned by a third party.
- ▣ The need to ensure that access to infrastructure is fair and appropriate
- ▣ The need to ensure that regulatory frameworks are agile enough to allow novel testing in real environments

Robotics infrastructure can take many different forms; High Performance Computing infrastructure; materials processing facilities, high resolution 3D printing in metals, plastic and ceramic; real or near real test beds such as roads or underwater infrastructure, pipe networks or hospital replicas.

Universities and SMEs cannot be expected to create all of the infrastructure facilities needed to develop and test advanced robotics to the extent needed to prove and validate operation sufficiently to either deploy or invest. These need to be created as a shared resource and accessible from across Europe. However an SME or academic going to use such third party resources needs to be assured that there is no risk to their IP by doing so, that the host will not somehow claim rights, or take ideas to use as their own. IP concerns also extend to the data that may be collected within the facility and the ownership of that data.

By their nature such resources will be limited and so access regulation is needed if the normal market mechanisms are not to distort accessibility. Clear guidelines and access policies are needed that provide fair access to academics and SMEs, and there needs to be investment both in the physical infrastructure and support staff needed to operate the facilities with good technical knowledge and well managed accessibility.

Such facilities, particularly when they involve living labs to create real or near real testing environments, require well founded regulation to protect those in that environment and those seeking to experiment within it. It is likely that these testbeds will in some way challenge existing regulation and so it is important that this does not impede research or innovation and where necessary special exemption is built into regulation where robotics may be operating where regulation is geared to protecting human operators.

Appendix D: Robotics and AI

There are four aspects to the relationship between the disciplines of AI and Robotics that require some explanation in the context of a robotics strategy for Europe.

- ◆ **Distinct Development Paths.** The way that advances in AI and in Robotics are achieved is very different and each discipline needs to be supported in a way that matches their specific research and innovation characteristics.
- ◆ **Expanding Horizons with AI.** While many robotics applications thrive on established AI techniques, emerging AI capabilities, such as those offered by advanced foundation models, open up exciting new frontiers for robotics innovation.
- ◆ **The Imperative of Physical Trustworthiness.** Robotics needs physical trustworthiness in addition to the trustworthiness of AI.
- ◆ **Embodied and Grounded AI.** Bridging the gap between AI and the physical world requires AI practice to focus on how AI can be made to inherently account for real world phenomena and use them to create an advantage.

Distinct Development Paths. The means of achieving advances in Robotics and in AI differ in multiple respects. The most significant difference being the time it takes to go from initial research to marketable product. In robotics the need to create bespoke hardware increases both time and cost. In AI it is far easier to create generic methods that apply across multiple sectors especially where rich sources of data already exist. Because of these differences; in the time it takes to translate robotics innovation to market, on the scale up of investment needed and in the level of validation and testing processes needed along that journey; it is better to appropriately support the interface between AI and Robotics than in common.

Expanding Horizons with AI. While there is no doubt that robotics needs enhanced AI, many potential robotics applications do not use AI or only use very well established AI methods; for example the recognition of objects from images, or optimisation methods in path or task planning, or the use of semantic data in knowledge management, or reasoning in decision making. These established AI techniques, already used within robotics, are successful in application areas where information and the environment are moderately well structured. A working environment can often be “engineered” so that robots can operate successfully; even in a domestic setting people will make sure the floor is clear to allow the robot vacuum to operate successfully.

To make smarter, more versatile robots able to operate in progressively more unstructured and uncertain environments, with high levels of dependability and reliability, will require new forms of AI to be developed and focused specifically on the challenges of such environments. It is not currently clear if providing more data is sufficient to generate the necessary AI, it is possible that new AI architectures, including hybrid architectures, will be needed to enable the next generation of smart robots to handle increasing levels of uncertainty..

Developing AI that can enable robots to operate in unstructured and dynamic environments, adapt to unforeseen circumstances, and learn from their experiences opens up opportunities for robots to take on more complex and challenging tasks, such as those involving physical human-robot interaction and collaboration, intricate dexterous manipulation, and operation in unpredictable settings. New forms of AI are also revolutionising the work of developers and integrators during deployment by speeding up the bespoke aspects of programming and configuring. Large language and foundational models are also dramatically accelerating application programming, error analysis, and recovery. AI-powered tools are simplifying complex tasks like setting up perception systems and handling workpieces, leading to unprecedented efficiency in robotics development and deployment. By embracing these advances in both robot capabilities and development tools, Europe can push the boundaries of robotics and create innovative solutions for a wider range of applications.

The Imperative of Physical Trustworthiness. Physical trustworthiness emerges as a crucial requirement for robotics. Trustworthiness in robotics is critical when robots are used in hazardous or challenging environments. Many of the most economically and societally important applications of robotics are where humans cannot or will not work; in space, inside nuclear reactors, inside sewers and industrial pipes, deep underwater or in a humanitarian disaster. In these cases robots cannot fail if they are to add value. Here trustworthiness is measured by failure rates that are in the order of 1 in 1,000 to 1 in 10,000 and in addition when failures do occur it is important to be able to understand exactly why so that the system can be modified. Such considerations are governed by a framework of regulation that applies to robotics deployment and in many cases also includes sector based regulation. Robots often have to work between these regulatory environments and to deliver a level market in Europe needs to develop and support innovation and deployment focused regulatory frameworks.

However, ensuring trustworthiness goes beyond technical reliability and encompasses ethical considerations, especially in Europe. The European Union's AI Act, with its risk-based approach, aims to regulate AI systems, including those used in robotics, to ensure responsible development and deployment. This legal framework reflects Europe's broader commitment to ethical considerations going beyond safety to include societal impact, human autonomy, and transparency. This focus on ethics distinguishes Europe as a leader in responsible AI development. While other regions have similar efforts, the comprehensiveness and legally binding nature of the EU's approach establish a higher standard.

While the goal is to deliver robots that are both reliable and ethically aligned with human values and societal well-being there is a clear danger that it will inhibit innovation and deployment. Companies are already avoiding robotics development in Europe because of the strict regulations, and are seeking countries with lighter or more adaptable regulatory regimes that enable deployment, while still maintaining safe operation. While much of the definition of terms in the AI Act and its applicability is yet to be determined the resulting uncertainty is slowing down development processes considerably without any obvious gain.

Embodied and Grounded AI. While current AI techniques have proven valuable in structured environments they lack the flexibility needed to operate in more dynamic unstructured environments. This underscores the need for a greater focus on embodied and grounded AI, where robots need to be able to reason about their interaction with the physical world using an inherent understanding of physical laws; force, momentum, friction, and the intricate cause-and-effect relationships that govern real-world robot operation. Achieving this requires a concerted effort to develop new AI architectures and methods specifically for robotics and invest in the creation of extensive, diverse datasets that reflect the complexities of real-world applications. These datasets are essential for training and evaluating these new AI models, enabling them to learn and adapt to the unpredictable nature of real-world environments. By embracing these challenges and supporting the development of embodied and grounded AI, Europe can unlock the full potential of new AI methods and drive innovation in robotics, leading to the creation of trustworthy robots that can operate safely, reliably, and effectively in a wider range of applications.

Europe has an opportunity, given its current advantage in robotics and its expertise in AI, to take a global lead in developing the AI that robotics needs. However this urgently requires a strategic focus to be placed on robotics to fully exploit Europe's current strength and leadership in Robotics.

About euRobotics



euRobotics (eu-robotics.net) is an international non-profit association for all stakeholders in European robotics. Established in September 2012 and serving its founding purpose: to strengthen Europe's competitiveness and to ensure industrial leadership of manufacturers, providers and end-users of robotics technology-based systems and services, it forms the largest network of roboticists and business in Europe with about 250 institutional members, covering small and large companies, associations and institutions, universities, laboratories and RTOs.

The objectives of euRobotics are to boost European robotics research, development and innovation, to foster a positive perception of robotics, to support the widest and most effective uptake of robotics technologies and services for professional and private use, and to ensure the excellence of the robotics science base in Europe is maintained. euRobotics is a founding member of the AI, Data and Robotics Association (ADRA) and was the private partner in the SPARC partnership with the EC during Horizon 2020.

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