



## Topic 2: Application of Internet of Things (IoT) and Robotics



Fig. 1: An employee at the Flex factory in Tcew, Poland (Flex).

### Learning Objectives:

Upon completing this topic, you will be able to describe application areas and development trends in terms of case studies, technical and market feasibility as well as ethical and social implications of robotics and Internet of Things (IoT).

### Table of Content:

- 2.1 Application areas, trends, case studies
- 2.2 Technical feasibility, market feasibility, and financial feasibility.
- 2.3 Ethical and social implications of IoT and Robotics.

### Suggested activities for learners before starting this topic

Create a case study about IoT or Robotic based on one of your results from the last activity in Topic 1 (experience report). Investigate which stakeholders are involved, what are their contributions and what benefit they get from it. Assess the advantages and disadvantages of the project. Post your case study in in the forum and discuss your findings with other students.



## Lesson 2.1 Application areas of Internet of Things and Robotics

Robotics is used in many different fields of application. As the technology evolves, more and more new applications are discovered. And they still will get more in the future.

### Strengths and weaknesses of humans and robots

Before we look at some application fields, first let's explore the question of what special skills robots have compared to humans, what they are particularly good at and what they are not so good at. The table 1 below shows a comparison of the strengths and weaknesses of humans and robots:



	Human 	Robot / IOT 
<b>Strengths</b>	<ul style="list-style-type: none"> <li>Ability to react and interpret</li> <li>Ability to improvise</li> <li>Ability to learn</li> <li>Recourse to experience</li> <li>High flexibility</li> <li>Ability to customization</li> <li>Sensory ability</li> <li>Association ability</li> </ul>	<ul style="list-style-type: none"> <li>High positioning and repetition accuracy</li> <li>High movement speed</li> <li>High strength and endurance</li> <li>Great coverage</li> <li>High computing power</li> <li>High availability</li> <li>Ability to multitask</li> </ul>
<b>Weaknesses</b>	<ul style="list-style-type: none"> <li>Fatigue behavior</li> <li>Limited strength and endurance</li> <li>No real multitasking</li> <li>Limited availability</li> <li>Affected by short-term memory</li> </ul>	<ul style="list-style-type: none"> <li>No recourse to experience</li> <li>No ability to interpret</li> <li>No ability to improvise</li> <li>Relatively inflexible</li> </ul>

Table 1: Comparison of the strengths and weaknesses of humans and robots (drawn on Petzold et al., 2021).

As you will have noticed, skills such as precision, endurance, strength and multitasking are where robots perform better than humans. On the other hand, humans are (at least still) superior to robots in terms of mental mobility and the ability to improvise and be creative. This in mind, now have a look at some examples from seven different fields of application.



## IoT in Manufacturing



Fig. 2: Human workers maintain machines in a factory. Maintenance tasks can be taken over by IoT systems. Source Pixabay, by shixugang.

More and more manufacturing companies use IoT devices to monitor production flow, manage equipment, and alert about maintenance tasks (fig. 2). In those companies, the manufacturing environment is automated so that multiple machines can communicate with each other and be managed and diagnosed remotely. Suppose a machine gets hotter than it should. Then, IoT sensors automatically report this problem back to the system to alert technicians to the problems, minimizing downtime and ensuring smooth operations.

## IoT in Logistics



Fig. 3: Autonomous forklift works in a high-bay warehouse: Source: Pixabay, by delphinmedia.

Logistics, in particular, has the potential to be at the forefront of this paradigm shift in manufacturing, but if we let it, it is likely to further complicate the relationship between logistics and the supplier network.

Andreas Tschiesner, Director of global management consulting firm McKinsey & Company, said in a recent interview that leaner manufacturing along with robust algorithms can reduce inventory levels

and delay times in parts delivery (Markus Loeffel, Andreas Tschiesner, 2013). Siegfried Dais, deputy chairman of the board of Robert Bosch GmbH, added in the same interview: “Those who make the system user-friendly so that the people who use it every day can immediately identify problems and know how to do it without getting involved to become entangled in a web of dependencies” (Markus Loeffel, Andreas Tschiesner, 2013).

### The manufacturing IoT Infiltration

You could almost look at the Internet of Things in manufacturing as a pyramid of functions, as illustrated in the figure 4.

At each stage, the autonomy of the IoT system increases and human dependency decreases.

This allows the manufacturer to increase the efficiency of its production by saving material and storage costs, minimizing downtime and being able to react flexibly to changing market requirements.

As connected devices become cheaper, smaller and more powerful, new growth opportunities will emerge for any company that implements IoT into their production.

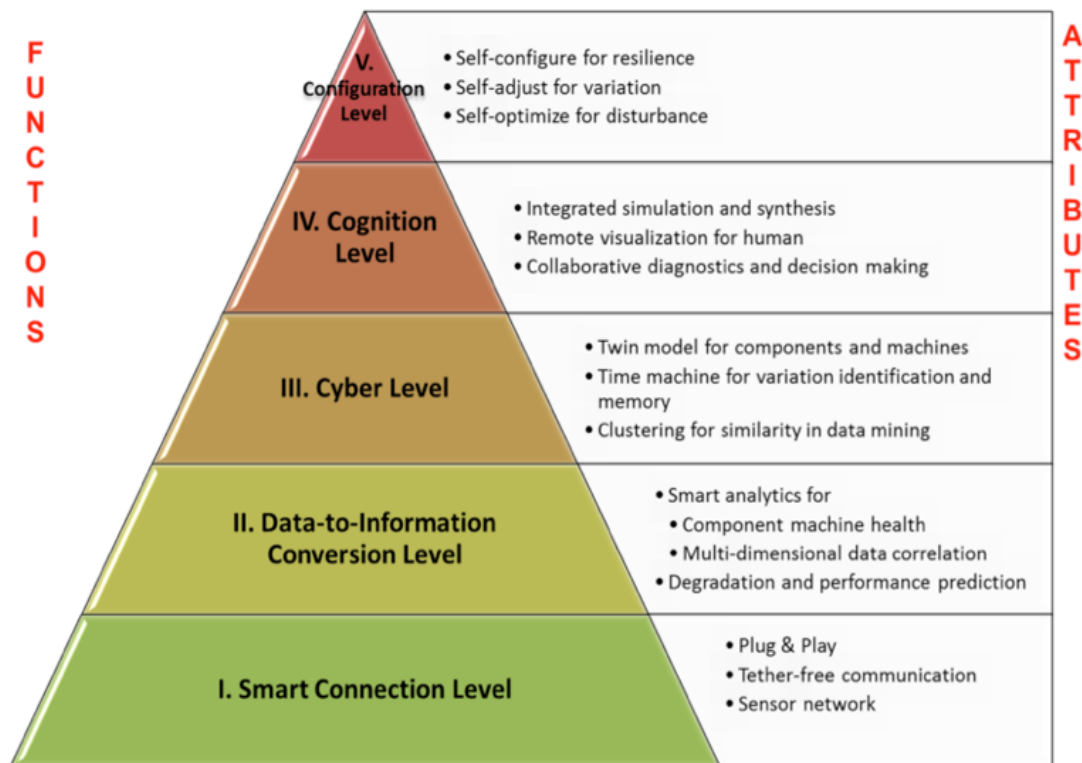


Fig. 4: 5C Architecture for Designing Cyber-Physical Systems in Manufacturing. Source: Behrad3d, Wikipedia.



## Robotics in Manufacturing

Industrial robots are used in factories to automate repetitive tasks such as assembly, welding, painting, and packaging. Robots can do jobs like putting things together, which saves time and reduces mistakes. Example: A robot in a car factory fits car doors to the car body. The robot gets a door from a conveyor belt and uses its mechanical arm to lift the door. It then precisely aligns the door with the car body and bolts it into place. All of this happens very quickly and with great precision. This robot can work non-stop without getting tired, and it does its job perfectly every time. So, it's faster and makes fewer mistakes than if a human was doing the same job.

## Human-robot collaboration (HRC)



Fig. 5: An employee at the Flex factory in Tcew, Poland. Source: Flex.

Human-robot collaboration (HRC) involves direct interaction between humans and robots in the workplace (fig. 5). It merges human skills like problem-solving with robots' precision and endurance, emphasizing safety and ergonomics. This ensures a risk-free and productive partnership, allowing businesses to swiftly respond to market changes while considering employee needs.

Robots in HRC systems assist rather than replace human workers. They are equipped with sensors to respond to human presence and adapt through Artificial Intelligence (AI) and machine learning, enhancing their collaborative capabilities over time.

## Agriculture

In agriculture, robots are used to automate tasks such as planting, harvesting, and weeding. They can also help monitor crops and animals. On farms, devices can check things like weather or soil quality. Robots can do jobs like planting seeds or picking fruits. Together IoT and robotic systems make farming more efficient, cost-effective, and precise, which benefits both farmers and consumers.

### Example 1: As the robot picks the apple

Let's look at an apple-picking robot. This machine moves through the orchard using sensors and cameras to identify ripe apples based on their color and size. Once it finds a ripe apple, it uses a specially designed arm to reach the apple. The arm is gentle enough not to damage the apple or the tree but firm enough to securely grasp the apple.

The robot then carefully detaches the apple from the tree and places it in a collection bin. This process continues until all ripe apples are picked. Using a robot for this task can reduce the labor costs and speed up the harvesting process. Plus, the robot can work in all sorts of weather conditions and even at night, so the apples are picked as soon as they're ready.

The automation manufacturer KUKA is developing this robot for automated apple harvesting (Fig. 6). Learn more about this exciting project at <https://www.kuka.com/en-de/company/iimagazine/2022/automated-apple-harvesting>.



Fig. 6: Pilot project - The KUKA CropBot has mastered its first harvesting operation. It gently sucks the apples from the tree – supported by a vision system. Source: KUKA.



### Example 2: IoT in Agriculture – checking soil moisture in the ground

How does this IoT device check soil moisture? This is a sensor that's placed in the ground among the crops. It regularly checks how much water is in the soil by measuring the soil's ability to conduct electricity, which increases as the soil gets wetter. These sensors can check multiple spots, giving an accurate picture of the whole field's moisture levels.

Once the sensor detects that the soil is too dry, it sends a signal to a central system. This system could then automatically turn on the irrigation system, ensuring the crops get the right amount of water exactly when they need it (Fig. 7). This setup not only saves water, but also can improve crop yields as plants get optimal growing conditions.

Read the case study here: <https://www.mdpi.com/2073-4441/11/10/2061> (Millán et al, 2019).

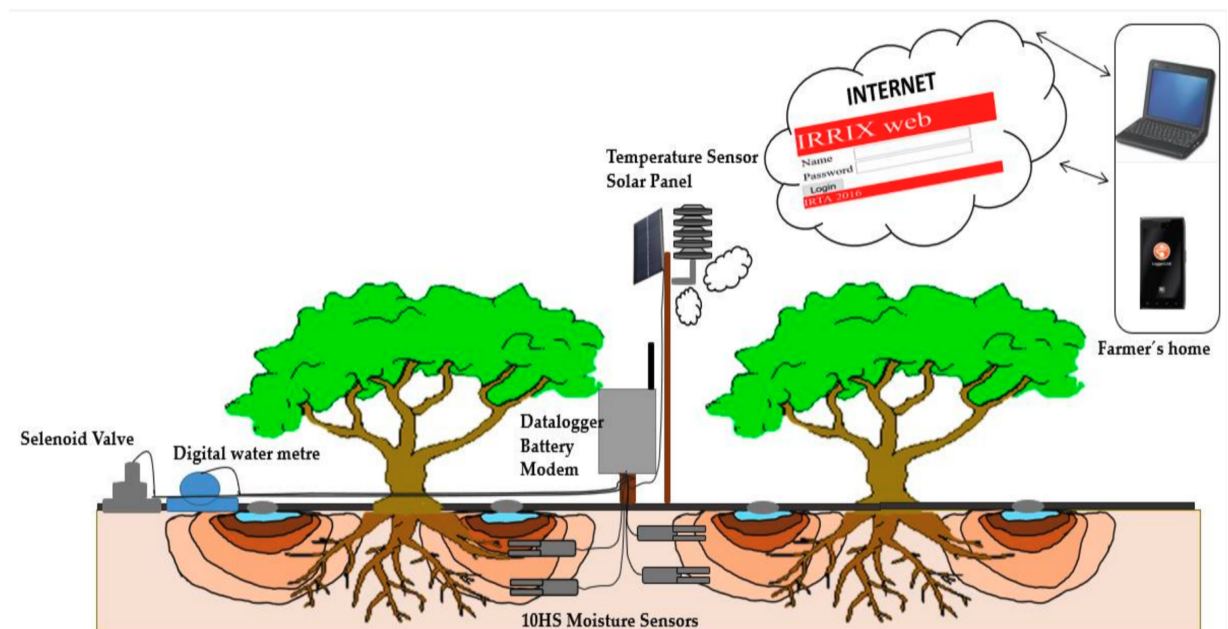


Fig. 7: Components of an automatic irrigation system consisted of two fundamental components: (a) field equipment; and (b) the IRRIX software (Millán et al).



## Education

In schools and universities, IoT devices can help create interactive and personalized learning experiences. Robots can help in teaching coding and other STEM (Science, Technology, Engineering, Mathematics) subjects, making learning more engaging and practical.

### *Example 1: A smartboard in a classroom that allows students to interact with lessons*

Imagine you are in a classroom equipped with a smartboard (fig. 8). The teacher starts the lesson by presenting a math problem on the smartboard. Instead of just listening, you get to interact directly with the lesson. You walk up to the board and use your finger or a special pen to draw your solution right on the smartboard, which everyone can see. You can also move elements around on the smartboard, like numbers or shapes. This makes learning more engaging and fun. The smartboard can also be connected to the internet, so the teacher can pull up relevant videos or websites to supplement the lesson. This interactive and connected approach to teaching and learning is one of the ways IoT is transforming education.



Fig. 8: Scenario of a hybrid classroom connection to IoT. Source: Logitech, 2023.



**Example 2.: A robot that students can code to perform different tasks**

Imagine you're in a programming class and your teacher introduces you to a small robot (fig. 9). This isn't just any robot – it's one you'll learn to control. The teacher explains that by writing code, you can make the robot do different things.

For your first task, you're asked to code the robot to move in a square. You use a simple programming language on a computer to write instructions for the robot. You tell it to move forward, turn right, move forward again, and so on. You upload your code to the robot and set it on the floor. With a press of a button, the robot springs to life, moving exactly in the square pattern as you programmed.

This hands-on approach makes the coding lesson exciting and real. You can see the results of your code in the actions of the robot, helping you understand the impact and power of programming. This practical use of robots is just one way robotics is enhancing education.



Fig. 9: Students of secondary school learn to assemble and program a robot. Source: Makeblock, 2023. Retrieved from <https://www.makeblock.com/blogs/for-educators/coding-robots-for-kids-elementary-school-middle-school-high-school> on 21.07.2023.



**Below you will find an overview of other areas of application for robotics and Internet of Things:**

### **Automotive**

In cars, devices can give information about things like traffic or car health and send this information to a data cloud where they are analyzed. *Example:* a self-driving car that can take you where you want to go. A car that alerts the driver if there's a problem with the engine.

### **Logistic Robots**

Logistic Robots are used to sort and store goods. They can also help with picking and packing products. *Example:* in a warehouse the goods are transported by a warehouse robot from and to the delivery vehicle

### **Retail**

In stores, devices can keep track of what's in stock. Robots can help move things in warehouses or deliver things to customers. *Example:* A device that alerts a store owner when they're running low on a product, and a delivery robot bringing a package to your home.

### **Healthcare**

IoT and robotics in Healthcare: In hospitals, special devices like heart rate monitors can send information directly to doctors. *Example 1 (IoT):* A patient wearing a heart rate monitor at home that sends updates to their doctor in real-time. *Example 2 (robotics):* In medical robotics, robots are used in surgery to perform precise and minimally invasive procedures. They can also help with patient rehabilitation and care.

### **Smart Cities**

In cities, devices can control things like traffic lights or garbage collection. Robots can do jobs like watching for danger or fixing things. *Example:* Traffic lights that change based on real-time traffic conditions, and a robot fixing a broken street light.

### **Smart houses and services**

In houses, IoT devices can control things like lights or temperature. *Example 1 (IoT):* A smart thermostat can change the temperature based on your preferences, and a robot vacuum cleaning the floors. *Example 2 (robotics):* Service robots are used in a variety of settings, including hotels, restaurants, and hospitals, to perform tasks such as cleaning, delivering food and drinks, and receiving and entertaining guests.

### **Military and security robotics**

Robots are used in military applications to perform tasks such as reconnaissance, defusing bombs and rescuing people in dangerous situations. They can also help monitor borders and public places.

### **Activity: Explore application fields of Robots**

You will find a comprehensive overview of the range of applications of robots with numerous examples at <https://robotsguide.com/robots/>.



## 2.2 Technical feasibility, market feasibility, and financial feasibility

As you have seen, robotics and the Internet of Things can be used in almost all areas of life to enable improvements and thus solve a wide range of problems. This raises fundamental questions about what is feasible and desirable from the point of view of technology, economy, and society. And there is also the question of where the limits of these technologies lie. There are no general answers to these questions. Technology, economy, and society are constantly evolving. The discussion about these questions must therefore be conducted again and again by all stakeholders, citizen and political decision-makers, and a social consensus must be reached.

Not least for this discourse, we need deeper knowledge of feasibility from the perspectives: People, technology and economy. Let us therefore take a closer look at the three levels in the following chapter.

### Technical feasibility

When we talk about the technical feasibility of robots, we're considering whether it's possible to design and build a robot that can perform a specific task successfully, safely, and efficiently. Several elements influence the technical feasibility of robots:

- **Hardware:** This includes the robot's physical body and components like motors, sensors, and actuators. The hardware needs to be robust and durable, able to perform the task without breaking or wearing out too quickly.
- **Software:** This involves the programming that controls the robot's actions. It needs to be smart enough to handle the task and respond to any unexpected situations. It's not just about the main task - the robot also needs software to handle things like navigation, obstacle avoidance, and safety protocols.
- **Power:** Robots need an energy source. The robot's power requirements will depend on its size, the complexity of its tasks, and how long it needs to operate between charges or refueling. Energy efficiency is a big part of robot design.
- **Communication:** Many robots need to communicate with other systems, whether it's a central computer, other robots, or the Internet of Things. They'll need the right kind of networking and communication protocols to do this.



## Financial feasibility

A robot needs to be cost-effective. That means the benefits gained from using the robot need to be greater than the costs of designing, building, maintaining, and operating it. As the term **Financial feasibility** already intends, there are two main factors to consider **costs** and **benefits**:

**Costs:** On the one hand, the use of robotics causes costs for the operator on various levels:

- **Initial Purchase Price:** Robots, especially advanced ones, can be expensive to purchase. The type, size, functionality, and capability of the robot will strongly influence the costs.
- **Installation and Integration Costs:** Getting the robot up and running may involve costs for installation, integration into existing systems, and possible infrastructure changes.
- **Maintenance and Repair Costs:** Robots require regular maintenance to keep them functioning optimally, and they may occasionally need repairs. The complexity of the robot impacts these costs.
- **Operational Costs:** These are the ongoing costs associated with powering the robot and any necessary supplies or consumables it uses.
- **Training Costs:** Employees may need training to operate, supervise, or work alongside the robot.

**Benefits:** On the other hand, users benefit from Robotics in several ways:

- **Productivity Increase:** Robots can often perform tasks faster or more accurately than humans, leading to increased productivity. This can result in more products produced, fewer errors, and improved customer satisfaction.
- **Labor Cost Savings:** Robots can perform tasks 24/7 without breaks, sick leave, or holidays. They can also undertake dangerous or monotonous jobs, potentially reducing labor costs and health and safety issues.
- **Lifespan of the Robot:** Robots have a certain lifespan or service life after which they may need to be replaced. Longer lifespan increases financial feasibility.
- **Resale Value:** If the robot has a good resale value once it's no longer needed, this can also enhance its financial feasibility.



## Market feasibility

Whether a new technology will be successful in the market, depends on many factors. For robotics, the following factors play a key role:

- **Market Need:** There must be a demand or need for the specific application of robotics being offered. This could be a brand-new application (e.g., filling a market gap), or an existing area where the robot can perform tasks more efficiently or cost-effectively.
- **Target Audience:** It's important to understand who will buy and use the robot. This could be businesses in a specific industry, consumers for personal use, or institutions like hospitals or schools.
- **Competition:** Other companies also offer similar robotic solutions. Therefore, it's crucial to know the competition and differentiate oneself from them with a unique selling proposition.
- **Regulatory Environment:** Depending on the industry, certain regulations can influence the use of robots. These regulations can affect the design, functionality, safety measures, and even the disposal of robots.
- **Technological Developments:** The pace of technological change can impact the market feasibility. If the technology advances quickly, a robot can become outdated rapidly.
- **Pricing Strategy:** The price for your robot should be appropriate for the target market. This includes considering the customers' willingness and ability to pay and ensuring that the price covers production and marketing costs and leaves a reasonable profit margin.
- **Sales and Distribution:** It's crucial to use the right distribution channels to sell and distribute the robot.
- **Support and Services:** Complex products like robots require highly qualified customer service, skilled maintenance, and repair services, which often cannot be performed by the user themselves. So this service has to be guaranteed by the manufacturer and supplier of a robotic product.



## 2.3 Ethical and social implications of IoT and Robotics

As we have seen in Chapter 2.2, there are also questions about the social desirability and limitation of new technologies such as robotics and the Internet of Things. These questions are important because IoT and robotics, in addition to many advantages, can also bring many disadvantages for people and society. This gives rise to questions about personal rights, health, data security and fundamental ethical questions about the relationship between people and technology in society.

### A) Social and environmental disadvantages:

- **Societal and economic divides:** Not everyone has the same access to IoT or robotics technologies. This can lead to a widening of the digital divide between those who have access and those who do not, which can increase societal and economic divides.
- **Dehumanization:** The increasing use of robots in roles traditionally filled by humans, like caregiving, could lead to issues like decreased human interaction and loss of personal touch.
- **Job Displacement:** Robotics can replace human labor in certain sectors, leading to job displacement. This raises ethical questions about the responsibility of organizations and societies to those whose employment is threatened.
- **Environmental Impact:** The production, use, and disposal of IoT devices and robots can have significant environmental impacts.

### B) Ethical challenges

- **Privacy:** With the proliferation of IoT devices collecting and sharing data, privacy becomes a major concern. IoT devices could collect personal information without the user's consent or awareness.
- **Manipulation:** IoT devices can be used to manipulate user behavior, often without the user being aware of it.
- **Human Dependence:** Increased dependence on IoT and robotics may decrease our ability to perform tasks without technology, potentially reducing skill sets and fostering over-dependency.
- **Responsibility and Liability:** In case of accidents caused by robots or IoT devices (like self-driving cars), determining responsibility can be challenging.
- **Bias and Discrimination:** Algorithms used in IoT and robotics can replicate or exacerbate societal biases if not carefully designed and tested.

### C) Technical and security related disadvantages

- **Privacy issues:** IoT devices and robots collect a lot of data, and that can cause privacy issues.
- **Data & physical security:** IoT devices and robots can also be vulnerable to hacking, which causes risks to data security and our physical security. Many of these systems don't have very strong security standards, which makes them even more vulnerable (see below).

**Example: IoT devices can be vulnerable to hacking**



Right now, there are several harmful actions that people take to mess with the safety and privacy of IoT devices and robotics. One new way that's coming up is the attacks that abuse the use of sensors on robots or IoT devices. These devices are easy targets because there's not a good way to protect their sensors from misuse by applications. When people take advantage of these sensors (like motion sensors, rotation sensors, microphones, light sensors, etc.), they can steal info from the device, put harmful software on it, or make it do something harmful.

### Principles of ethics for robots and the Internet of Things

To address these challenges, we need clear rules and guidelines. We are thinking about a set of rules to guide how these technologies should be designed and used to make sure they're beneficial and fair for everyone. Here are some ideas of those rules:

- **Respect for Autonomy:** This means tech should empower users, not undermine their independence. You should be in control of your data, and IoT devices should be designed with your permission in mind.
- **Beneficence:** robots and IoT devices should be designed and used to do good and improve life without causing harm.
- **Privacy and Security:** This is very important. Your data needs to be protected from people who shouldn't have it. This means using secure protocols and encryption, and collecting as little data as possible, in a transparent way, and keeping it anonymous if we can.
- **Justice:** Tech shouldn't create or increase inequality. Access to IoT and robots shouldn't be limited to the privileged few, and we should address issues like job losses due to automation.
- **Responsibility and Transparency:** When things go wrong, we need to know who's responsible. IoT device and robot makers should be held accountable for their products, and the decision-making processes, especially with AI, should be transparent.
- **Sustainability:** We should think about the environmental impact of creating, using, and getting rid of these technologies.



## The first robot rules by Isaac Asimov

At the end of this chapter, let's listen to the Russian-born American science fiction author Isaac Asimov (fig. 10), who had written the first basic rules for robot in a human society.



Fig. 10: Isaac Asimov. Source: Robotic Industries Association.

Asimov first used the word "robot" in his short story "Runabout" in 1942. Asimov was optimistic about the role of robots in human society, portraying them as helpful servants. Asimov proposed three "robot laws" that his robots, as well as many other science fiction robot characters, followed (drawn on Kräußler, 2022):

**Law One:** A robot may not injure a human being or, through inaction, allow a human being to come to harm.

**Law Two:** A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.

**Law Three:** A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

### **Why the EU Parliament is calling for laws for robots**

According to Julia Reda from the German Pirate Party, robots are playing an increasingly important role in our everyday lives. If all of machine's decisions can no longer be directly traced back to the actions of a person, it must be clarified who is liable if something goes wrong (Spiegel Netzwelt, 2017).

The European Parliament has been discussing regulations for the use of robotics and the Internet of Things for a long time. In a resolution from 2017 passed by a large majority, it called for comprehensive laws for robots and artificial intelligence at EU level entitled *REPORT with recommendations to the Commission on Civil Law Rules on Robotics*.

### **Unresolved liability issues**

In May 2016, an autonomously controlled vehicle from Tesla caused a fatal accident in the US state of Texas. The car's sensors did not detect a truck swerving in autopilot mode. This is one of the reasons why Parliament is now calling for EU-wide security rules to be created. The resolution states that "harmonized rules are urgently needed," especially when it comes to autonomous driving.

To date, there are practically no civil law laws in the EU: Who is liable in such accidents? The status of robots is also not defined: what ethical rules apply to them? Do they have rights? In its report, Parliament calls for long-term consideration of "creating a special legal status for the most autonomous robots as "electric people" in order to differentiate them from humans. "A robot is not a human being and never will be," clarified Mady Delvaux from Luxembourg, the rapporteur responsible for the EU Parliament (Spiegel Netzwelt, 2017).

### **European AI Act**

Since March 2024, the European Union has been the first legislator to set clear rules for the use of artificial intelligence (AI) and thus also for robotics and Internet of Things applications in the so-called Artificial Intelligence Act (2024). The law classifies the rules according to the risk that artificial intelligence can pose. The AI Act completely bans some particularly sensitive applications. AI systems, and therefore also robots and IoT systems, are regulated based on their risks. Some systems are completely banned and others must meet requirements in order to be used. All remaining systems can initially operate without further restrictions, although the Commission reserves the right to expand the list of regulated systems if the risk is sufficient.

The central subject of the regulation is high-risk AI systems that must meet comprehensive documentation, monitoring and quality requirements. The users and providers of high-risk AI systems bear the brunt of the requirement.



## Sources

- Behrad3D (2015). CPS for Manufacturing.png. Wikipedia, <https://en.wikipedia.org/w/index.php?curid=44938292>, retrieved on 21.07.2023.
- European Parliament (2017). REPORT with recommendations to the Commission on Civil Law Rules on Robotics A08-0005/2017. [https://www.europarl.europa.eu/doceo/document/A-8-2017-0005\\_EN.html](https://www.europarl.europa.eu/doceo/document/A-8-2017-0005_EN.html), retrieved on 10.10.2023.
- European Parliament (2024). Artificial Intelligence Act. [https://www.europarl.europa.eu/doceo/document/TA-9-2024-03-13\\_EN.html#sdocta2](https://www.europarl.europa.eu/doceo/document/TA-9-2024-03-13_EN.html#sdocta2), retrieved on 28.04. 2024.
- Kemal, M. (2019). Five benefits of capitalizing on your data with advanced analytics and the Internet of Things. Image retrieved from [https://www.researchgate.net/figure/Internet-of-Things-Source-Jacob-2019\\_fig2\\_332570291](https://www.researchgate.net/figure/Internet-of-Things-Source-Jacob-2019_fig2_332570291) on 21.07.2023.
- Kräußlich, W. (2022). Faszination künstlicher Kollege. Alles Wissenswerte zu Robotern: Geschichte, Typen, Anwendung. Automation Next <https://www.ke-next.de/kollegeroboter/grundlagen/alles-wissenswertes-zu-robotern-geschichte-typen-einsatzbereiche-101.html#name> retrieved on 15.07.2023.
- Logitech (2022). Classroom of the Now <https://www.logitech.com/en-ch/education/education-center/article/classroom-now.html>, retrieved on 21.07.2023.
- Löffler M, Tschiesner A (2013). The Internet of Things and the future of manufacturing. McKinsey Digital, <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-internet-of-things-and-the-future-of-manufacturing#/>, retrieved on 21.07.2023.
- Millán S, Casadesús J, Campillo C, Moñino MJ, Prieto MH (2019). Using Soil Moisture Sensors for Automated Irrigation Scheduling in a Plum Crop. *Water*. 2019; 11(10):2061. <https://doi.org/10.3390/w11102061>, retrieved on 21.07.2023.
- Petzoldt, C, Keiser, D, Siesenis, H, Beinke, T, Freitag, M (2021). Ermittlung und Bewertung von Einsatzpotenzialen der Mensch-Roboter-Kollaboration: Methodisches Vorgehensmodell für die industrielle Montage" *Zeitschrift für wirtschaftlichen Fabrikbetrieb*, vol. 116, no. 1-2, 2021, pp. 8-15. <https://doi.org/10.1515/zwf-2021-0002>, retrieved on 10.03.2024.
- Spiegel Netzwelt (2017). Künstliche Intelligenz: Warum das EU-Parlament Gesetze für Roboter fordert. <https://www.spiegel.de/netzwelt/netzpolitik/kuenstliche-intelligenz-eu-parlament-fordert-regeln-fuer-roboter-technologie-a-1134949.html>, retrieved on 10.12.2023.
- World Economic Forum (2022). Here's how automation and job creation can go hand in hand. <https://www.weforum.org/agenda/2022/09/how-automation-job-creation-hand-in-hand/>, retrieved on 25.07.2023.