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ERASMUS – EDU-2023-CB-VET – 101128761–DiT-ENT

DiT-ENT

Training Module 2

Understanding and Using New Technologies

3D Printing, Robotics and the Integration of Artificial Intelligence

July 2025

Project information

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15/07/2025	3.0	SPEL	Revised version after the piloting.

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1. Introduction

The module of *Understanding and Using New Technologies – 3D Printing, Robotics and the Integration of Artificial Intelligence* is the second part of a three-module training programme aimed at VET young trainees, providing them with basic workplace skills, IT skills etc, including entrepreneurship skills e.g., how to develop a business plan, raise finance, how to market a product and/or services, staffing issues, and how to use and integrate new technologies e.g., basic 3D printing and Artificial intelligence into the company.

The present module – *Understanding and Using New Technologies* – consists of eight units, as follows:

1. Introduction to New Technologies
2. 3D Printing
3. Robotics
4. Artificial Intelligence (AI) Integration
5. Machine Learning: Applying AI and ML in Business
6. Web development
7. Impact on Daily Life
8. Engaging with New Technologies

2. Learning Objectives

At the end of this module, the trainees will be expected to have a robust understanding of new technologies, their applications, and their impact on society. The aforementioned eight units will equip them with the knowledge and skills necessary to navigate and leverage these technologies creatively and responsibly in their personal and professional lives.

Below, you can find the specific objectives of each learning unit:

1	Introduction to New Technologies	– Understand what constitutes new technologies. – Identify and describe examples of new technologies, including 3D printing, robotics, and AI. – Recognise the significance and potential of these technologies in various fields.
2	3D Printing	– Explain the basic principles of how 3D printing works.

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		– Identify different types of 3D printing technologies and materials. – Explore practical examples of 3D printing in action, including its applications in industries such as healthcare, manufacturing, and art.
3	Robotics	– Introduce the concept of robots and their core functions. – Identify different types of robots and their uses in everyday life and various industries. – Explore real-world examples of robotics applications, including automation, medical robots, and service robots.
4	Artificial Intelligence (AI) Integration	– Define Artificial Intelligence and its key components. – Explore different types of AI, including machine learning, and their specific use cases. – Analyse examples of AI in everyday applications and industries.
5	Machine Learning: Applying AI and ML in Business	– Define machine learning and distinguish it from general AI. – Understand the principles of machine learning and how it is applied in business contexts.
6	Web Development	– Introduce the basics of web development and the importance of web technologies. – Understand the basis of fundamental programming languages, including HTML, CSS, JavaScript, SQL, and Python. – Understand how these languages are used to create and manage websites and web applications.
7	Impact on Daily Life	– Analyse how new technologies such as 3D printing, robotics, and AI are transforming everyday life. – Discuss the social, economic, and cultural impacts of these technologies. – Explore future trends and potential implications of continued technological advancements.
8	Engaging with New Technologies	– Encourage creative thinking and innovation through hands-on projects using 3D printing, robotics, and AI. – Develop problem-solving skills by tackling real-world challenges with these technologies.

Table 1 – Units' Learning Objectives

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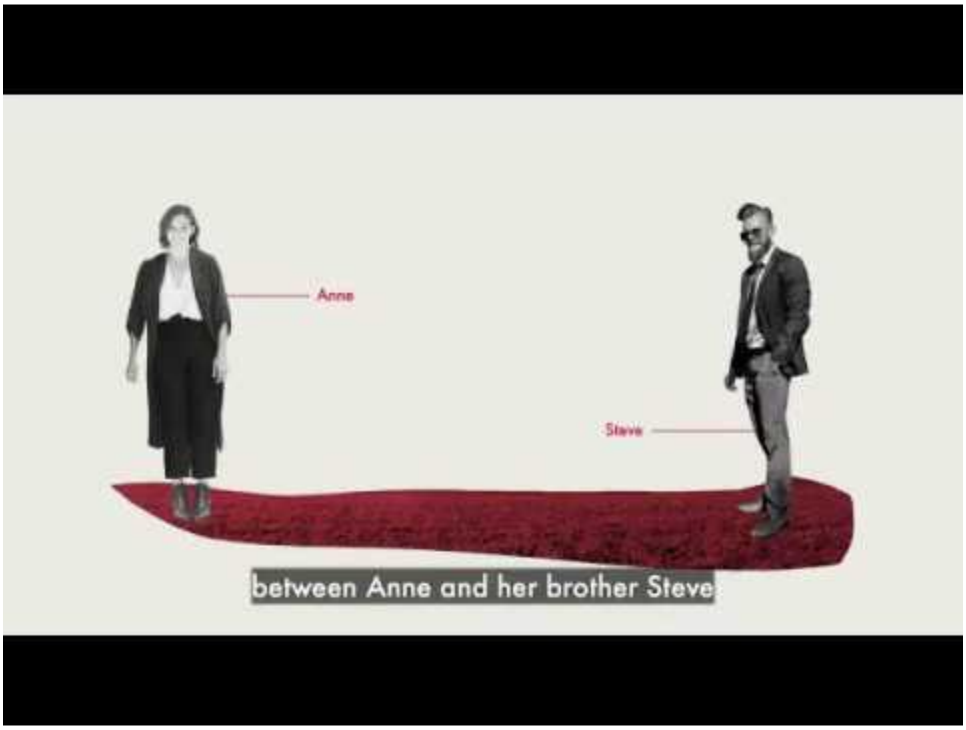
3. Learning Units

3.1 Introduction to New Technologies

New technologies are innovations that significantly change the way we live, work, and interact with the world around us. They often bring about substantial changes by introducing new processes, improving existing systems, or creating entirely new industries. These technologies are characterised by their ability to solve problems in novel ways, increase efficiency, and push boundaries. Moreover, new technologies are drivers of innovation, as well as promoters of disruption and advancement, as we can see below:

Innovation: New technologies introduce novel solutions or improvements. An example is the development of blockchain technology which has revolutionised digital transactions, offering a decentralized and secure method for recording transactions. However, blockchain's potential goes beyond cryptocurrencies and can be applied to supply chain management, healthcare, and finance;



Video 1 - What is BLOCKCHAIN? The best explanation of blockchain technology. Source: Lucas Mostazo on YouTube

Disruption: New technologies can disrupt existing markets or create new ones, being the advent of the internet a prime example due to the transformation of numerous industries such as

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media, retail, and communication. Other examples are online platforms such as Amazon and Netflix, which have disrupted traditional retail and entertainment sectors, while social media platforms like Facebook and Twitter have changed how we communicate and consume news.

Advancement: New technologies push the boundaries of what was previously thought possible. Quantum computing, for instance, promises to solve complex problems that are currently unsolvable with classical computers, potentially revolutionizing fields like cryptography, materials science, and drug discovery.

Examples of New Technologies

3D Printing

3D printing is also known as additive manufacturing, and it is a process of creating three-dimensional objects from a digital file. It involves laying down successive layers of material until the object is complete, allowing the creation of complex and customised items with precision.

3D Printing Applications		
Healthcare	**Manufacturing**	**Art and Design**
– Creation of prosthetics, implants tailored to fit the individual’s anatomy, enhancing comfort and functionality. – Development of bioprinting which has the potential to create organs and tissues for transplantation, addressing the shortage of donor organs.	– Production of prototypes, tools, and end-use parts, reducing the time and cost associated with traditional manufacturing methods. – Rapid prototyping, allowing for faster iteration and innovation.	– Creation of intricate models, custom designs and complex geometries, that would be difficult or impossible to produce using traditional methods.

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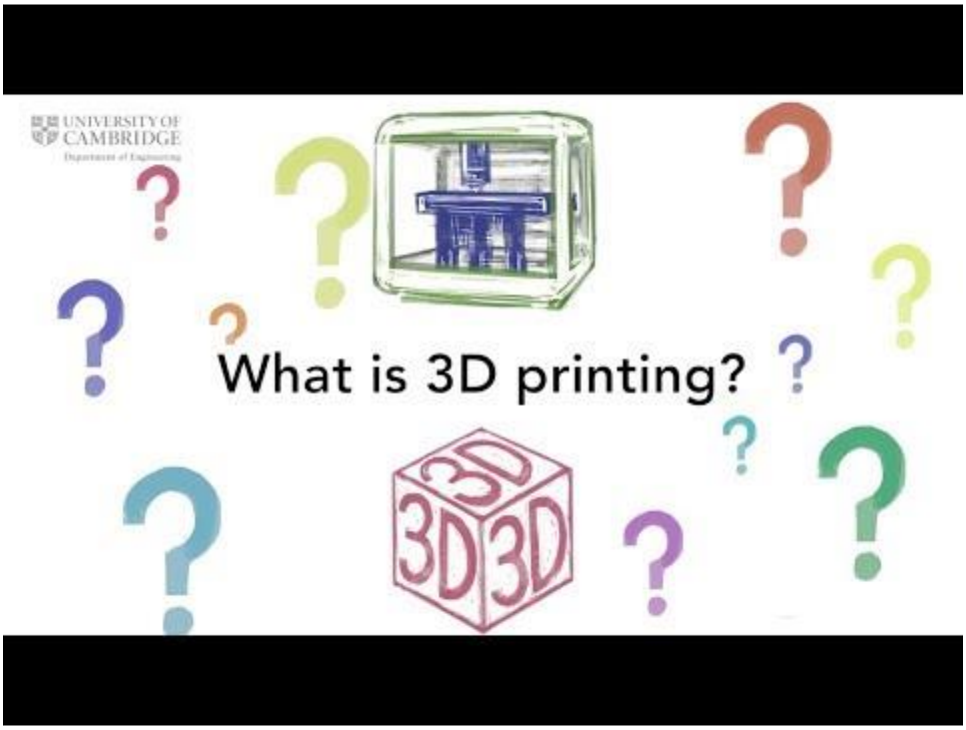

Video 2 - What is 3D printing? Source: Institute for Manufacturing (IfM), University of Cambridge on YouTube

Kenian Success Story in 3D Printing

Ultra Red Technologies is a Kenyan company that provides advanced 3D printing services for sectors such as architecture, healthcare, engineering, and product design. They use different types of 3D printing techniques to produce everything from detailed prototypes to large functional parts. Their success comes from combining modern technology with local know-how to offer flexible, high-quality manufacturing solutions for a wide range of clients.

Robotics

Robotics involves the design, construction, operation, and use of robots. These are programmable machines that can perform a series of actions autonomously or semi-autonomously. Robotics technology ranges from simple mechanical devices to complex systems incorporating AI and machine learning.

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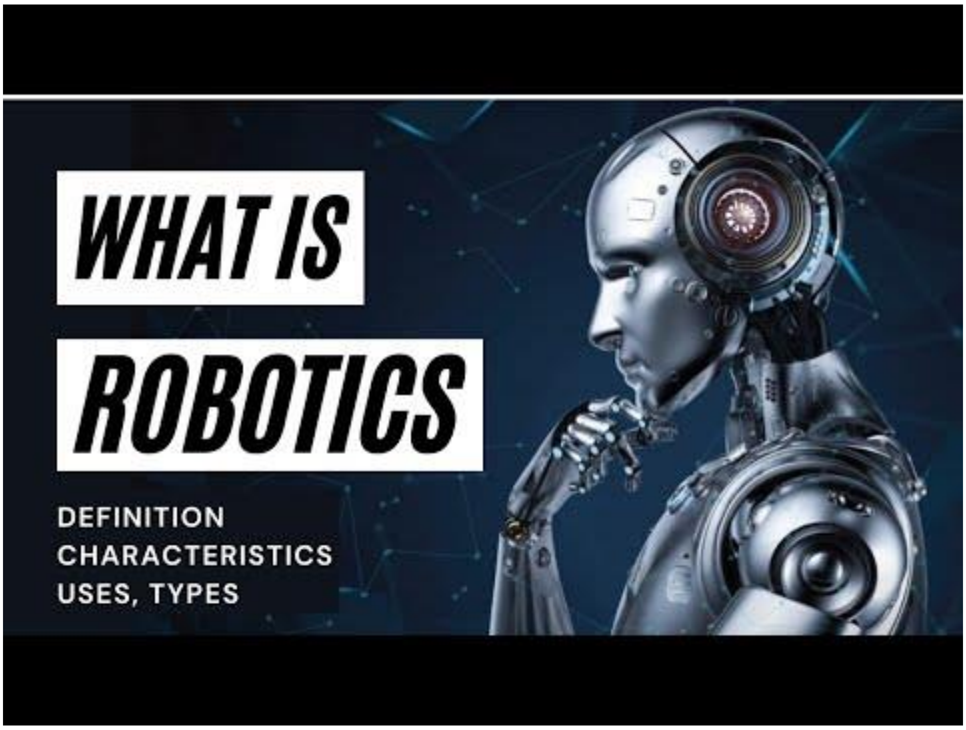
Robotics Applications		
Industrial Automation	**Healthcare**	**Service Industry**
– Performance of repetitive tasks in manufacturing, increasing efficiency and precision. – Development of tasks such as welding, painting, and assembly, which improves productivity and safety.	– Surgery support, enhancing the precision of surgeons and improving patient outcomes by enabling minimally invasive procedures. – Rehabilitation services, assisting patients in recovering from injuries or surgeries by providing consistent and targeted therapy.	– Customer service assistance in retail and hospitality, interacting with customers, providing information, and improving service efficiency. – Autonomous package delivery, enhancing logistics and reducing delivery times.



Video 3 - What is ROBOTICS | Robotics Explained | Robotics Technology | What are Robots. Source: Tech Might on YouTube

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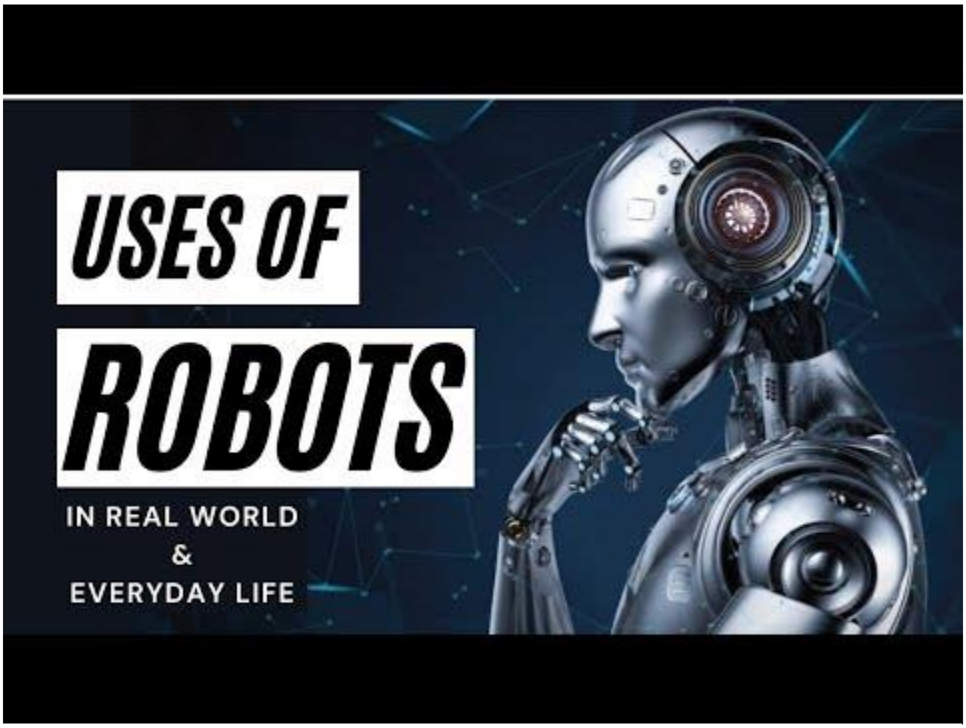

Video 4 - USES OF ROBOTS | Robotics in Daily Life. Source: Tech Might on YouTube

Kenian Success Story in Robotics

Robot Café Nairobi is a recently opened establishment that combines a traditional café experience with advanced technology and robotics, offering customers a unique and innovative environment. The concept blends familiar hospitality with futuristic elements, creating an engaging and modern space for visitors.

Artificial Intelligence (AI)

AI refers to the simulation of human intelligence processes by machines, especially computer systems. This includes learning (acquiring information and rules for using it), reasoning (using rules to reach approximate or definite conclusions), and self-correction. AI technologies range from simple algorithms to complex neural networks.

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AI Applications		
Finance	**Healthcare**	**Everyday Life**
– Fraud detection, protecting consumers and financial institutions. – Optimisation of investment strategies and increased market efficiency through algorithmic trading and AI's ability to make split-second trading decisions.	– Assistance in diagnostic processes, aiding in the analysis of medical images to detect diseases like cancer with high accuracy. – Personalised treatment recommendations based on patient data.	– Virtual assistants (e.g. Siri and Alexa) use natural language processing to understand and respond to user commands, making everyday tasks easier. – Recommendation systems (e.g. on Netflix and Amazon) enhance user experience by suggesting relevant content and products. – Autonomous vehicles use AI to navigate and operate without human intervention, promising to reduce accidents and improve transportation efficiency.

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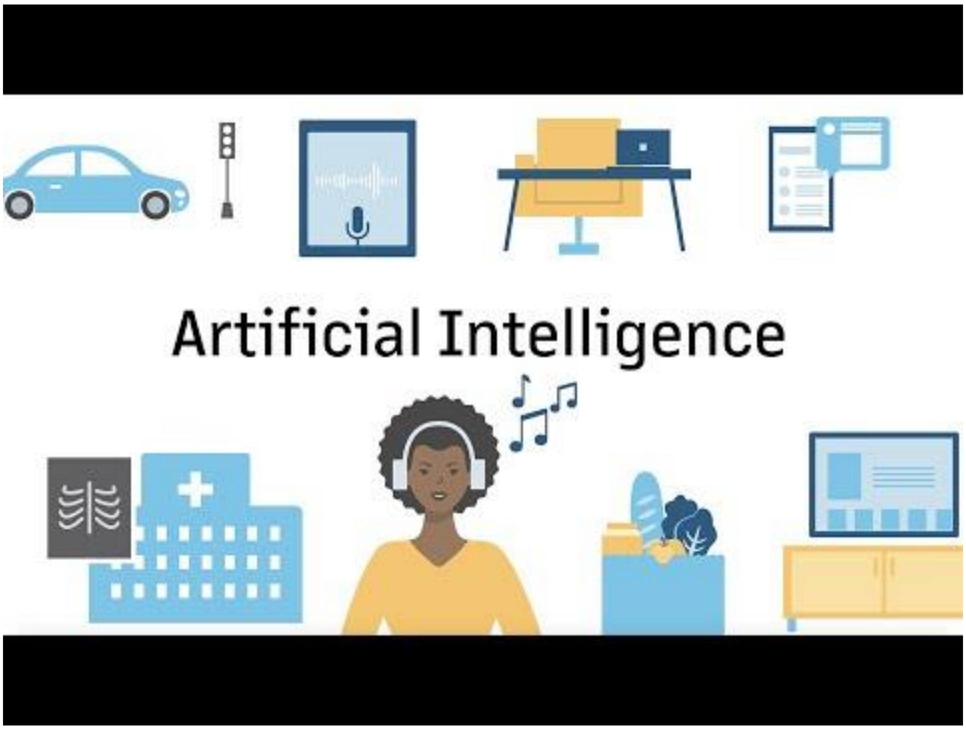
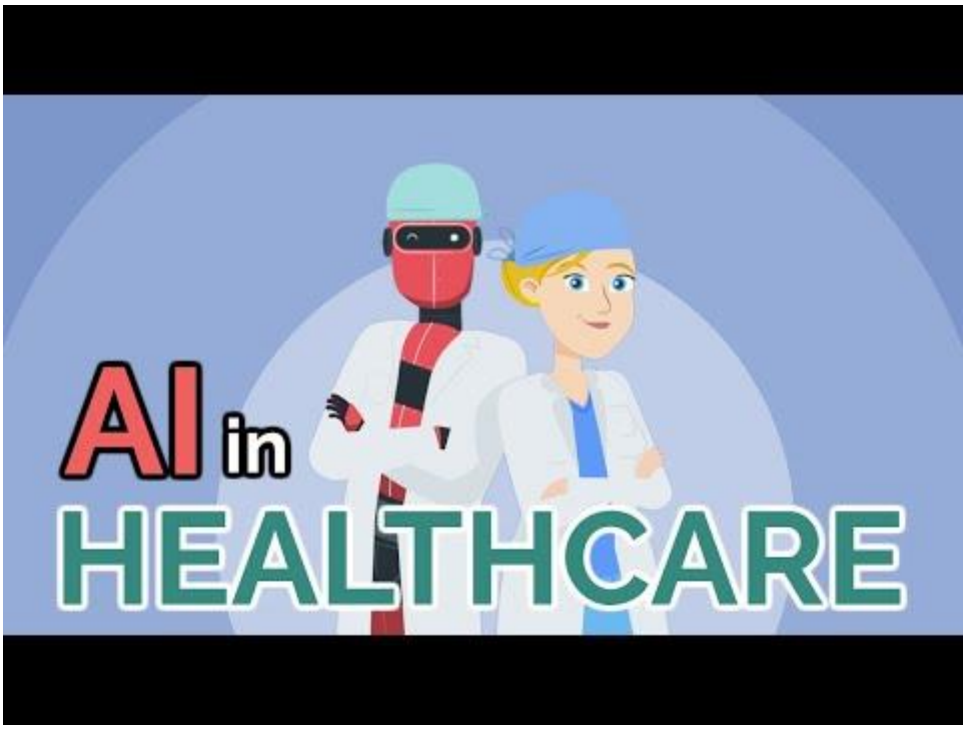


Video 5 - What is AI? Source: Museum of Science on YouTube



Video 6 - 4 Ways Artificial Intelligence is Transforming Healthcare. Source: Med School Insiders on YouTube

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Kenian Success Story in AI

Fastagger is a Kenyan tech startup that empowers small and medium-sized businesses by using artificial intelligence to turn mobile money transaction data into actionable business insights. Their tools are designed to work on basic smartphones, making advanced analytics accessible even in low-connectivity areas. Fastagger is a successful case because it combines local relevance with cutting-edge AI, helping underserved entrepreneurs make smarter business decisions and grow sustainably.

Significance and Potential of New Technologies

New Technologies' Impact		
Economic	**Social**	**Cultural**
Job creation Emerging fields, such as AI development, 3D printing design, and robotics engineering require the creation of new jobs, due to the required specialized skills and knowledge. Thus, it is important to train, and in some cases, upskill, employees regarding new technologies.	**Healthcare** Healthcare access and outcomes are improved by innovations such as AI diagnostics, robotic surgery, and telemedicine. The latter allows patients to receive medical consultations remotely, which increases access to healthcare services, particularly in underserved areas.	**Digital Media** Artists use technologies such as 3D printing and AI as a way to develop their creativity and create new products. With these tools, artists can create innovative works that blend traditional techniques with modern technology, expanding the possibilities of artistic expression. Additionally, digital media platforms enable artists to share their work with a global audience, increasing visibility and engagement.
Efficiency and Productivity Robotic automation is capable of performing repetitive tasks more efficiently than humans, freeing up workers for	**Education** Educational-oriented technological tools facilitate personalised learning experiences and make education more	**Heritage Preservation** Cultural heritage sites and artefacts can be preserved with the use of technologies such as 3D scanning and printing. This ensures their preservation for

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more complex and creative activities, enhancing productivity and reducing costs. By shifting towards automation, businesses can streamline operations and focus on innovation.	accessible. People are now able to learn at their own pace and from anywhere resorting to online platforms like Coursera.	future generations, through the creation of digital replicas, for instance, which can used for research, education, and virtual exhibitions, making cultural heritage more accessible to the public.

Video 7 - Printing replicas of ancient artifacts with a 3D printer. Source: Vanderbilt University on YouTube

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Video 8 - How AI Art Could Enhance Humanity's Collective Memory | Refik Anadol | TED. Source: TED on YouTube

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Checkpoint

Here, you can verify the level of knowledge acquired in the Unit. You are invited to check the previous pages and come back here as many times as needed.

Q1	New technologies refer only to digital innovations such as computers and the internet.	**T** / **F**
Q2	3D printing is also known as additive manufacturing.	**T** / **F**
Q3	Robotics only applies to industrial manufacturing and has no use in healthcare.	**T** / **F**
Q4	Artificial Intelligence (AI) involves only the automation of repetitive tasks and cannot be used for complex problem-solving.	**T** / **F**
Q5	One of the disadvantages of digital technology is its susceptibility to signal degradation over time.	**T** / **F**
Q6	3D printing can be used to create customized prosthetics and implants in the medical field.	**T** / **F**
Q7	New technologies can create new job opportunities but have no impact on the efficiency of existing processes.	**T** / **F**
Q8	Robotic surgery enhances precision and reduces recovery time for patients.	**T** / **F**

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3.2 3D Printing

Basic Principles of 3D Printing

3D Printing Process

3D printing, known also as additive manufacturing, is a transformative process that involves creating three-dimensional objects from a digital file. The process begins with the design phase, where a digital 3D model is created using computer-aided design (CAD) software. The model here produced will act as a blueprint for the object to be printed. Then, the model is sliced into thin horizontal layers using slicing software, with each slice representing a cross-section of the final object.

Finally, the 3D printer reads these slices and deposits material layer by layer, gradually building the object from the bottom up. This layer-by-layer construction method allows the deposition of material precisely where needed for each layer, facilitating the creation of complex geometries and intricate designs that are often unattainable with traditional manufacturing techniques. Through this process, we can attain a more flexible design and produce highly customized objects.

Video 9 - The Journey of a 3D Printed Object. Source: LearnFree on YouTube

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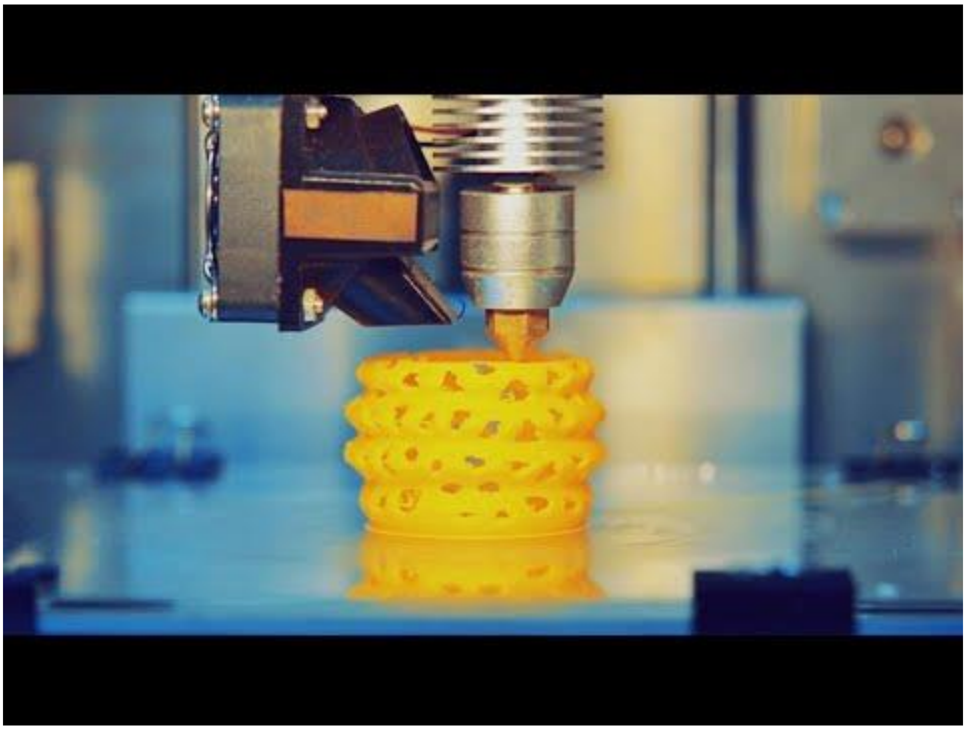
Types of 3D Printing Technologies and Materials

Fused Deposition Modeling (FDM)

Fused Deposition Modeling (FDM) is one of the most accessible and widely used 3D printing technologies. It operates by extruding melted thermoplastic filament through a heated nozzle, which moves to deposit the material layer by layer. Common materials used in FDM include PLA (polylactic acid), ABS (acrylonitrile butadiene styrene), and PETG (polyethylene terephthalate glycol-modified). FDM printers are popular because they are affordable and easy to use, making them ideal for prototyping, for educational purposes or simply to develop a hobby.



Video 10 - Fused Deposition Modeling (FDM). Source: Berkness Company on YouTube

Stereolithography (SLA)

Stereolithography (SLA) is a high-precision 3D printing technology that uses a laser to cure liquid resin into hardened plastic in a layer-by-layer fashion. The laser traces a cross-section of the object on the surface of the liquid resin, solidifying the material. SLA is known for its exceptional accuracy and smooth surface finish, making it suitable for applications requiring detailed and intricate designs, such as jewelry, dental models, and engineering prototypes.

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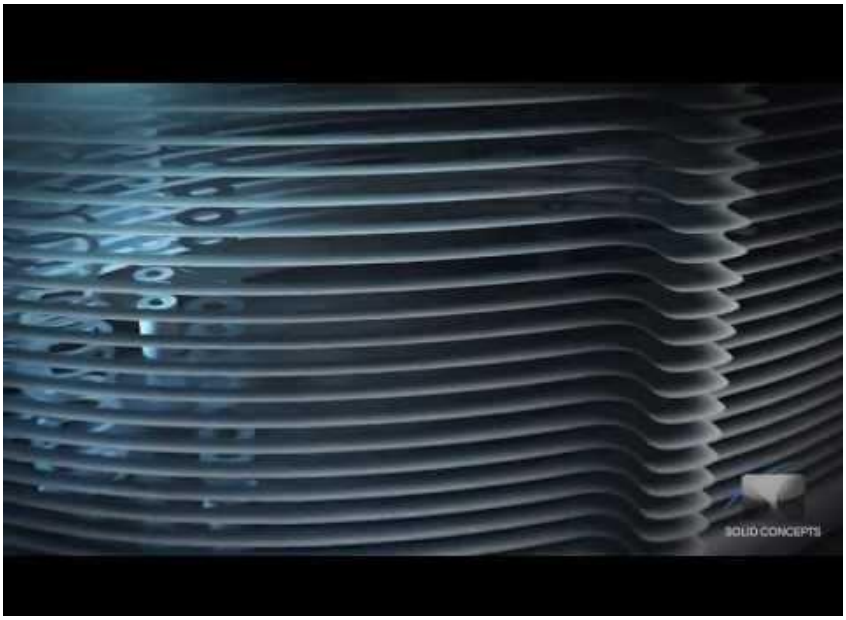
Video 11 - 3D Printing with Stereolithography (SLA) — How Does it Work? Source: Materialise Manufacturing on YouTube

Selective Laser Sintering (SLS)

Selective Laser Sintering (SLS) uses a laser to fuse powdered material, such as nylon, into a solid structure. The laser selectively sinters (heats and fuses) the powder based on the digital model, and the process repeats for each layer. SLS value lays in its ability to produce durable and functional parts without the need for support structures. It is widely used in industrial applications, including aerospace, automotive, and medical devices, due to its ability to create complex geometries and high-strength componentes.



Video 12 - Selective Laser Sintering (SLS) Technology. Source: Solid Concepts on YouTube

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Materials		
Plastics	**Metals**	**Ceramics and Composites**
With options such as PLA, ABS, nylon, and resin, plastics are the most common materials used for their versatility and suitability for various applications, from simple prototypes to functional parts.	It is possible to make 3D prints using materials like titanium, aluminium, and stainless steel, which are often employed in aerospace, automotive, and medical applications where high strength and durability are essential.	Ceramics and composite materials are used for specialised applications that require unique properties, such as high heat resistance, electrical insulation, and biocompatibility.

Practical Examples of 3D Printing in Action

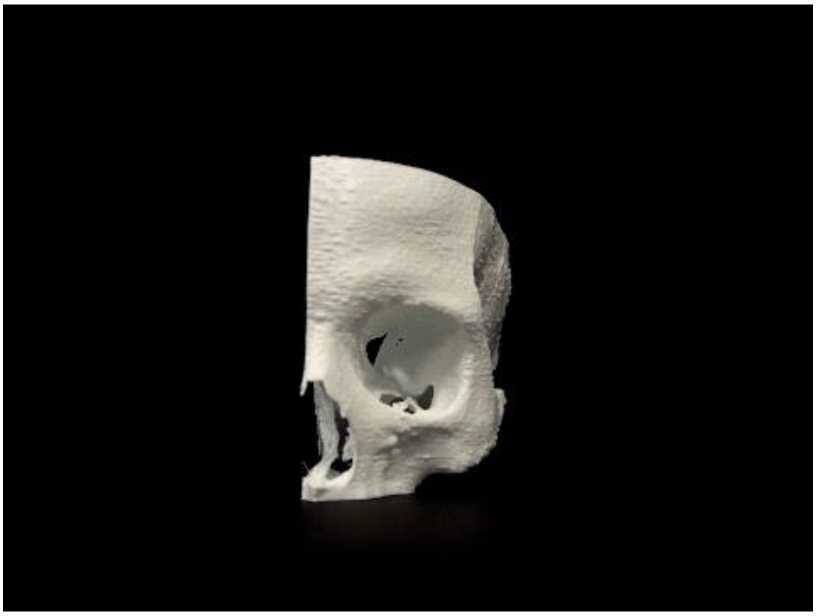
Healthcare

Prosthetics: Traditional prosthetics can be expensive and time-consuming to produce, but 3D printing allows for rapid production and cost-effective solutions. With the customisation that 3D printing brings, prosthetics can be designed to fit the unique anatomy of each patient, improving comfort and functionality.

Figure 1 - 3D printed dog prosthetics. Source: My Pet's Brace on https://mypetsbrace.com/prosthetics-by-3d-pets/

Medical Models

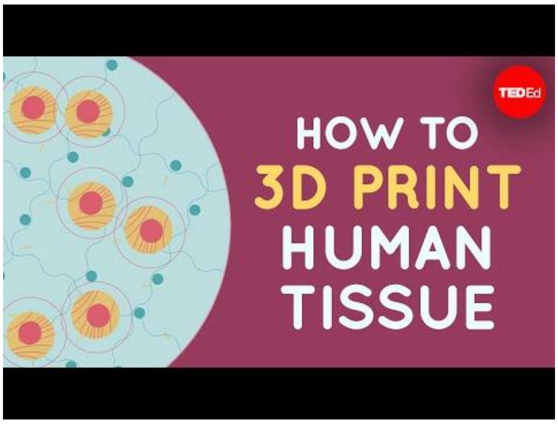
Surgeons use 3D-printed models of patients' anatomy for preoperative planning, allowing for more precise and effective surgeries. These models, created from medical imaging data, such as CT scans or MRIs, provide a tangible representation of complex anatomical structures. Through this, surgical outcomes are improved since it allows surgeons to practice and visualise the procedure beforehand.



Video 13 - 3D Printing Changes the Game in Surgery - Cultivating Health. Source: UC Davis Health

Bioprinting

Bioprinting involves printing layers of cells to create tissues and potentially organs for transplantation. This innovative approach aims to address the shortage of donor organs and improve regenerative medicine. Bioprinting combines cells, growth factors, and biomaterials to fabricate living tissues that can mimic natural structures. While still in the experimental stage, bioprinting holds promise for future medical treatments and therapies.



Video 14 - How to 3D print human tissue - Taneka Jones. Source: TED-Ed on YouTube

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Manufacturing

Prototyping: 3D printing is widely used for prototyping, enabling designers and engineers to create and test iterations of a product quickly. This accelerates the development process and reduces costs by allowing for the identification and correction of design flaws early in the development cycle. Prototyping with 3D printing can significantly shorten the time to market for new products and enhance innovation.

Figure 2 - SLA 3D Printing car prototype. Source: ZONGHENG3D on https://www.zongheng3d.com/from-concept-to-reality-building-functional-prototypes-with-sla-3d-printing/

Tooling: Custom tools and jigs can be produced quickly and cost-effectively using 3D printing, and are essential for improving the efficiency of production processes. For example, custom fixtures can be designed to hold parts in place during assembly, reducing errors and increasing productivity. 3D printing allows for the rapid production of these tools, which can be tailored to specific tasks and easily modified as needed.

Video 15 - 3D Printed Tooling: Advanced Manufacturing. Source: FATHOM|Oakland on YouTube

Art and Design

Sculptures and Installations: Artists use 3D printing to create intricate sculptures and installations that would be difficult to produce with traditional methods, allowing for greater creative freedom and the ability to experiment with complex designs and new forms of artistic expression. For example, artists can create highly detailed and intricate

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patterns that would be challenging to achieve through manual techniques. 3D printing also enables the production of large-scale installations by assembling multiple printed components.

Figure 3 - Monika Horcicova - K2, 2011. 3D printed plaster composite. Source: Rirkrit Tiravanija and Pilar Corrias Gallery, London. Photo by Phillip Barcio on https://www.ideelart.com/magazine/3d-printed-art

Fashion: 3D printing has been incorporated into fashion, creating unique and customisable garments and accessories. With it is possible to achieve complex patterns, textures, and structures that are not possible with traditional textile manufacturing. For instance, 3D-printed fashion pieces can be tailored to individual body shapes, providing a perfect fit. Additionally, the use of sustainable and recyclable materials in 3D printing can contribute to more eco-friendly fashion practices.

Figure 4 - 3D printed garment. Source:3D printed fashion – use cases from 2013 to 2018 on https://geekqoeschic.co/2018/06/15/3d-printed-fashion-usecases-from-2013-to-2018/

Checkpoint

Here, you can verify the level of knowledge acquired in the Unit. You are invited to check the previous pages and come back here as many times as needed.

Q1	The 3D printing process starts with the creation of a physical model.	**T** **F**
Q2	Fused Deposition Modeling (FDM) uses a laser to cure liquid resin into hardened plastic.	**T** **F**
Q3	Bioprinting is used to create living tissues and potential organs for transplantation.	**T** **F**
Q4	3D printing in manufacturing is only useful for creating final products, not for prototyping.	**T** **F**
Q5	Artists and designers do not use 3D printing because it limits their creative freedom.	**T** **F**
Q6	3D-printed models are not used in the medical field for preoperative planning.	**T** **F**
Q7	3D printing can be used to create custom tools and jigs for manufacturing processes.	**T** **F**
Q8	3D printing is increasingly being used in fashion to create unique, customizable garments and accessories.	**T** **F**

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3.3 Robotics

Definition and Core Functions

Robots are programmable machines designed to carry out a series of actions autonomously or semi-autonomously, using algorithms and software to guide their actions. These tasks can range from simple, repetitive actions to complex decision-making processes, with the robots performing tasks with high precision and consistency, and their core functions include sensing, processing information, and executing actions. Sensors allow robots to perceive their environment, while processors analyse this data and make decisions, also, actuators execute physical actions based on these decisions, enabling robots to interact with the world around them.

Basic Components of Robots

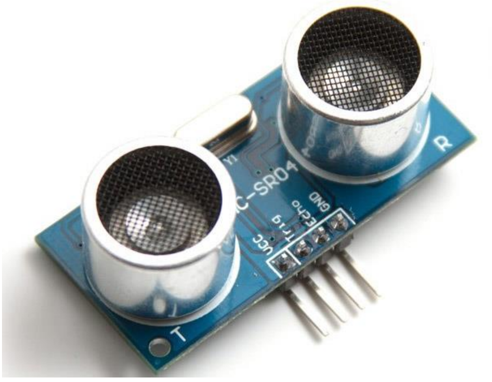
<table>
<tr><th colspan="2">Sensors</th></tr>
<tr><td rowspan="2">These devices collect data from the robot's environment, such as cameras, infrared sensors, and tactile sensors, enabling robots to perceive their surroundings and gather necessary information to perform their tasks accurately.</td><th>Examples</th></tr>
<tr><td>
Figure 5 - Atmega 8 based Bluetooth (HC-05) Controlled Robot. Source: Robosapiens on https://www.robosapi.com/robot-sensor

Figure 6 - Robosapiens AT89S52 IBOT Mini V 3.0. Source: Robosapiens on https://www.robosapi.com/robot-sensor</td></tr>
</table>

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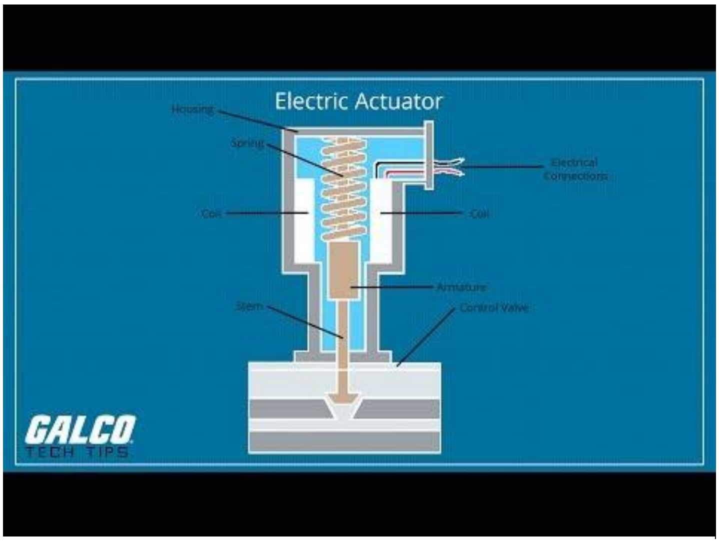
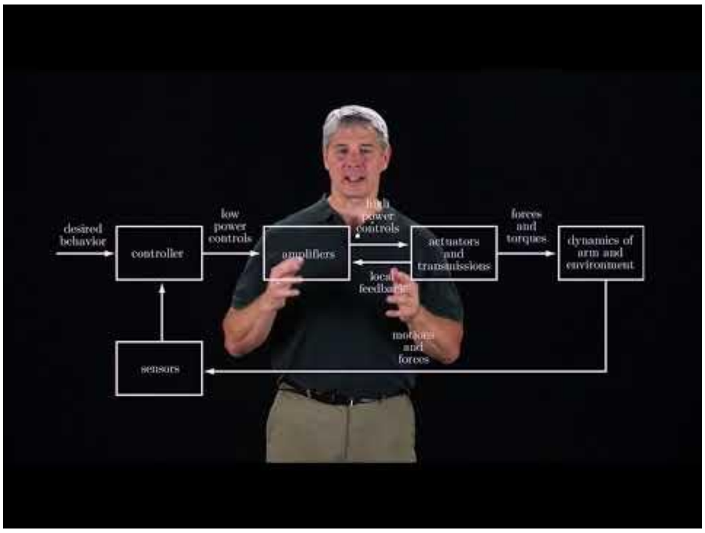
<table>
<tr><th colspan="2">Actuators</th></tr>
<tr><td rowspan="2">Actuators convert electrical energy into mechanical movement, allowing robots to manipulate objects, move around, or perform specific functions.</td><th>Examples</th></tr>
<tr><td>



Video 16 - What is a Actuator? - A Galco TV Tech Tip | Galco. Source: GalcoTV on YouTube

</td></tr>
</table>

<table>
<tr><th colspan="2">Control Systems</th></tr>
<tr><td rowspan="2">These systems consist of algorithms and software that process sensory data and control actuators, enabling the robot to make decisions based on the data received from the sensors.</td><th>Examples</th></tr>
<tr><td>



Video 17 - Modern Robotics, Chapter 11.1: Control System Overview. Source: Northwestern Robotics on YouTube

</td></tr>
</table>

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Power Supply	
	Examples
The power supply is crucial for the robot's operation, ensuring that all components receive the energy needed to function effectively (e.g. batteries and solar cells)	 *Figure 7 - 24V 20Ah Robot Battery | AMR AGV Battery. Source: ELB on* *https://www.ecolithiumbattery.com/product/robot-battery/*  *Figure 6 - Robot powered by solar cells. Source: SolarQuotes on* *https://www.solarquotes.com.au/blog/solar-agricultural-robot-mb2505/*

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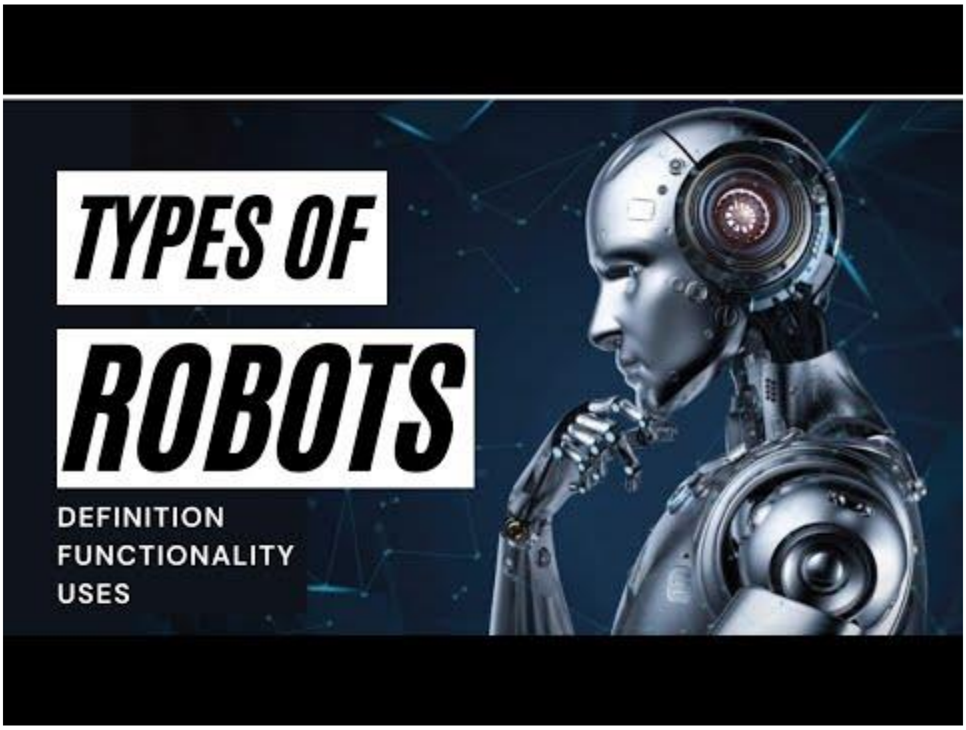
Types of Robots and Their Uses



Video 18 - TYPES OF ROBOTS | Robots Classification. Tech Might on YouTube

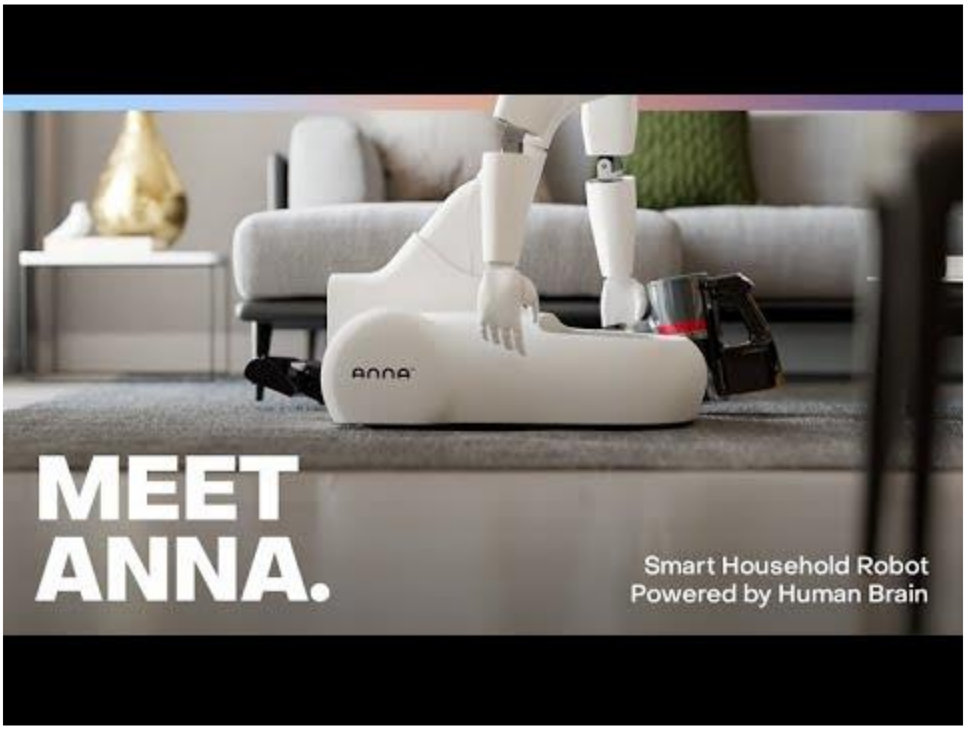
Industrial robots

Video 19 - Industrial Robots have Transformed the Manufacturing Industry - A Galco TV Tech Tip | Galco. Source: GalcoTV on YouTube

Industrial robots are designed to perform repetitive tasks in manufacturing and production environments. They excel in assembly, welding, painting, and material handling tasks, and these robots promote an increase in efficiency, accuracy, and safety in factories by taking over labour-intensive and potentially dangerous tasks from human workers. For example, robotic arms in automobile manufacturing plants assemble parts with high precision and speed, reducing production time and improving product quality.

Service Robots

Service robots assist humans by performing useful tasks in various environments, including households, healthcare settings, and public spaces. Some common examples of service robots are robotic vacuum cleaners like Roomba, elder care robots that help the elderly with daily activities, and customer service robots in stores and hotels that guide customers and provide information. Through them, it is possible to enhance convenience, improve quality of life, and support human workers by handling mundane or physically demanding tasks.



Video 20 - Meet Anna™ – The Smart Household Robot. Source: Anna on YouTube

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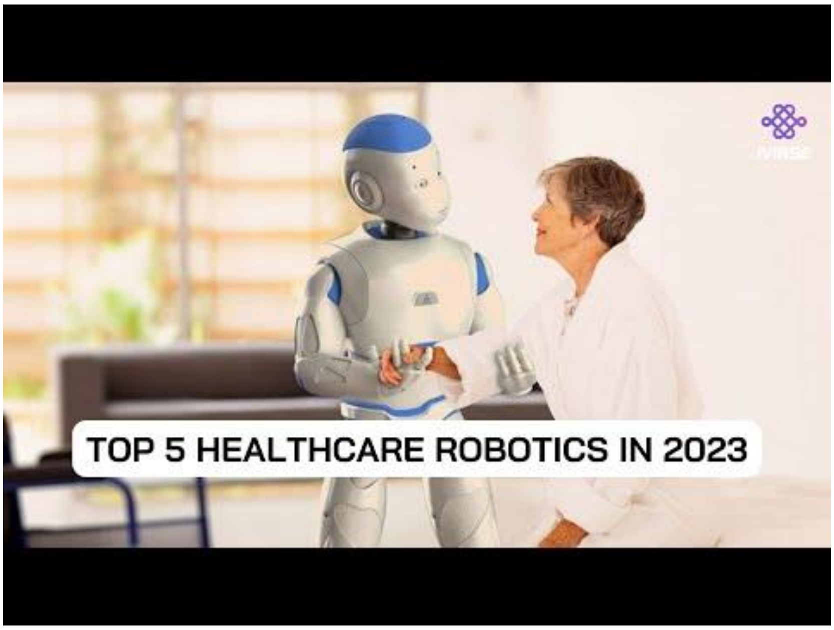
Medical Robots



Video 21 - Top 5 Healthcare Robotics in 2023. Source: IVIRSE on YouTube

Medical robots are used in healthcare for surgery, rehabilitation, and diagnostics, providing surgeons with enhanced precision and control during minimally invasive procedures, reducing patient recovery times and improving outcomes. Rehabilitation robots assist patients in regaining mobility and strength after injuries or surgeries, and diagnostic robots help in imaging and diagnosing medical conditions, improving accuracy and efficiency.

Exploration Robots

Video 22 - Robots for Lunar Exploration. Source: ETH Zurich on YouTube

These types of robots are designed for environments that are difficult or hazardous for humans, such as space, underwater, or disaster-stricken areas, enabling scientific research and exploration. NASA uses robots to explore other planets, conducting experiments and sending data back to Earth. Additionally, underwater robots explore deep-sea environments, gathering information about marine life and underwater geology.

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Checkpoint

Here, you can verify the level of knowledge acquired in the Unit. You are invited to check the previous pages and come back here as many times as needed.

Q1	Robots can perform tasks autonomously or semi-autonomously.	**T** / **F**
Q2	Sensing is not a core function of robots.	**T** / **F**
Q3	Industrial robots are commonly used in automotive manufacturing.	**T** / **F**
Q4	Service robots are only used in healthcare settings.	**T** / **F**
Q5	Medical robots can assist in surgery and rehabilitation.	**T** / **F**
Q6	Exploration robots are designed for environments that are easy for humans to access.	**T** / **F**
Q7	Automated warehouses use robots to sort, pick, and transport items.	**T** / **F**
Q8	Exploration robots have been used in space missions by NASA.	**T** / **F**

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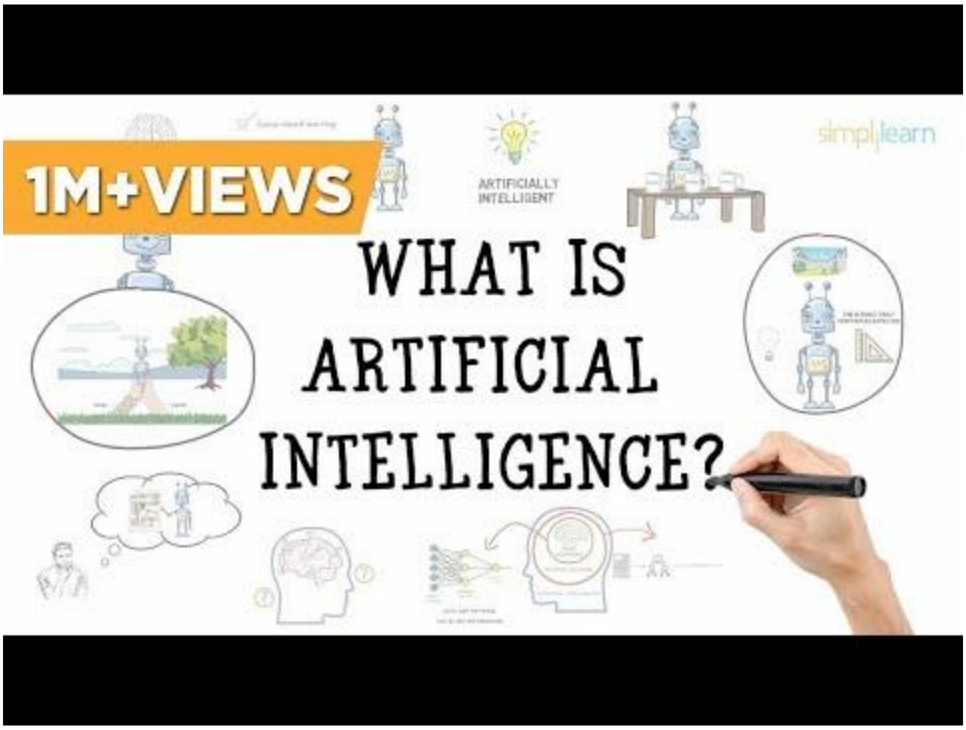
3.4 Artificial Intelligence (AI) Integration

Artificial Intelligence Definition

Artificial Intelligence (AI) is a multidisciplinary field of computer science focused on creating machines capable of performing tasks that typically require human intelligence – such as learning, reasoning, problem-solving, perception, and language understanding. AI systems mimic cognitive functions like pattern recognition, decision-making, and predicting outcomes based on data.

By learning from data generated through digital technologies, AI can adapt to new inputs and perform human-like tasks with growing accuracy and efficiency. Once a theoretical concept, AI now impacts nearly every aspect of modern life – from virtual assistants like Siri and Alexa to powerful systems that analyse vast datasets for insights and predictions. Thanks to advances in machine learning and deep learning, AI can even outperform humans in specific tasks like image and speech recognition.



Video 23 - What Is AI? | Artificial Intelligence | What is Artificial Intelligence? | AI In 5 Mins |Simplilearn. Source: Simplilearn on YouTube

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Deep Learning

Deep Learning is a specialized branch of Machine Learning that uses artificial neural networks with multiple layers to model complex patterns in data. Deep Learning has been particularly successful in areas such as image and speech recognition, natural language processing, and even playing complex games like Go and chess.

Deep Learning models require significant computational resources and large amounts of data for training, but they have set new benchmarks in several AI fields. Its power comes from its ability to automatically learn hierarchical representations of data, making it possible to achieve high levels of accuracy in tasks that involve large and complex datasets.

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Key Components of AI	
Data	In the context of AI, data refers to the vast amounts of information that are collected, stored, and analysed to train AI models. This data can be structured, like databases of customer information, or unstructured, such as text, images, and videos. AI systems depend on high-quality, large datasets to identify patterns, learn from examples, and make informed decisions.
Algorithms	Algorithms are used to process data, recognize patterns, and make decisions. Machine learning algorithms, for instance, allow AI systems to learn from data without being explicitly programmed for every possible scenario, and as these algorithms are exposed to more data, their performance improves.
Computational Power	AI systems require substantial computational resources to process large datasets and perform complex calculations. Advances in hardware, such as GPUs (Graphics Processing Units) and cloud computing, allow more efficient and cost-effective training of large AI models. These technological advancements have accelerated the development and deployment of AI in various fields, enabling real-time data processing and the execution of sophisticated algorithms that were previously impossible.
Model Training	Model training is a critical phase in AI development, where an AI system learns to perform a specific task by being exposed to data. During training, the AI model adjusts its internal parameters to minimise errors and improve accuracy. The quality of the training data, the choice of algorithm, and the amount of computational power all contribute to the effectiveness of the trained model. Once trained, the AI model can make predictions or decisions based on new data, often with remarkable accuracy.

Table 2 - Key Components of AI

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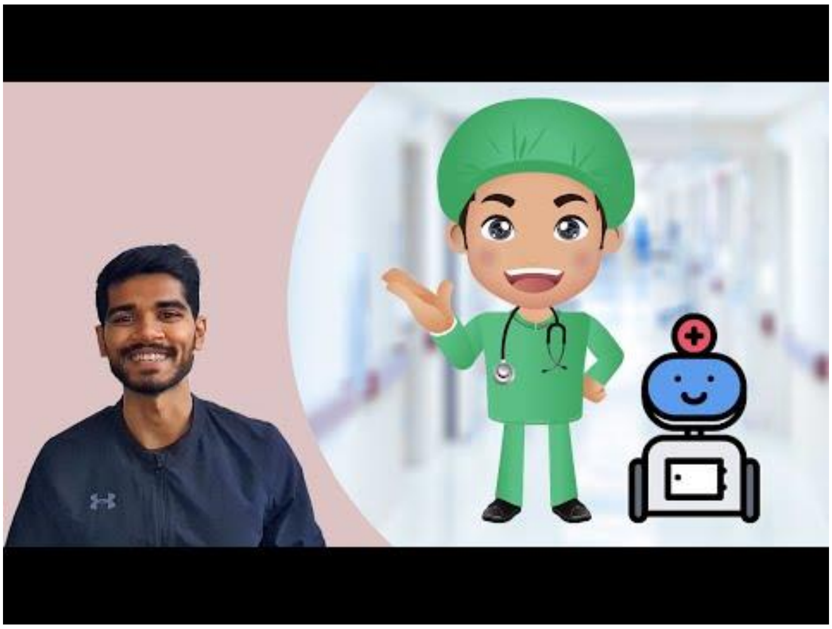
AI in Everyday Applications and Industries

Healthcare



Video 24 - 5 Uses of AI in Healthcare! | 5 Mins 5 Ideas. Samanvay Karambhe on YouTube

Finance

Video 25 - The Future of AI in FINANCE - A Riveting Story. Source: Everything in Cosmos on YouTube

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Retail

Video 26 - Top 7 Priorities: - How AI is transforming Retail Industry? Source: Artificial Intelligence on YouTube

Autonomous Vehicles

Video 27 - How AI is Transforming Transportation: An Inside Look at Autonomous Vehicles! Source: The Artificial Mind on YouTube

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Checkpoint

Here, you can verify the level of knowledge acquired in the Unit. You are invited to check the previous pages and come back here as many times as needed.

Q1	Artificial Intelligence (AI) is solely about creating machines that can perform human-like tasks.	**T**
		F
Q2	Machine Learning is a subset of Artificial Intelligence that focuses on teaching machines to learn from data.	**T**
		F
Q3	Artificial Intelligence has no practical applications in the healthcare industry.	**T**
		F
Q4	Deep Learning is a form of AI that uses neural networks to process complex data inputs.	**T**
		F
Q5	AI is only useful in the field of technology and has limited applications in other industries like finance and retail.	**T**
		F
Q6	One of the challenges of integrating AI into autonomous vehicles is ensuring they can safely navigate and make real-time decisions in complex environments.	**T**
		F
Q7	AI in finance is primarily used for managing social media accounts.	**T**
		F
Q8	AI-driven chatbots can provide real-time customer support and handle a variety of tasks, including processing transactions and answering queries.	**T**
		F

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3.5 Machine Learning: Applying AI and ML in Business

Machine Learning and the differences from General AI

Machine Learning (ML) is a branch of AI focused on developing algorithms that allow computers to learn from data and improve over time without explicit programming. It powers many common AI applications today, such as recommendation systems, speech recognition, and autonomous vehicles.

ML models identify patterns, make decisions based on data, and adapt as they process more information – becoming more accurate with use. While AI broadly aims to create systems that mimic or enhance human intelligence, machine learning is specifically about enabling machines to learn autonomously from data.

Most current AI systems are narrow AI, meaning they are designed to perform specific tasks—like translating languages or predicting consumer behaviour. Machine learning is the engine behind this, making such systems adaptive and efficient.

Machine Learning in Business Contexts

Supervised Learning

- The model is trained with input that is paired with its correct output. This allows it to make predictions on new and unseen data. It is commonly seen in tasks such as image classification, spam detection, and predictive analytics.

Unsupervised Learning

- The model is trained with unlabeled data, and it must find patterns or structures in the data without orevious guidance. This is used in tasks where the goal is to identify relationships between different items.

Reinforcement Learning

- The model learns by interacting with its environment and receiving feedback in the form of rewards or penalties. The more favourable outcomes, the biggest the reward. This is used in robotics, and autonomous systems, where the model must make decisions in real-time based on its experiences.

Illustration 1 - Main types of Learning in ML

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Machine learning is transforming various business sectors by enabling companies to analyse large volumes of data, automate processes, and make data-driven decisions. Here are some key applications of machine learning in business:

Customer Insights and Personalisation

Analysing customer data allows us to understand preferences, predict future behaviour, and deliver personalised experiences. For example, e-commerce platforms use recommendation engines to suggest products based on previous purchases and browsing history, increasing sales and customer satisfaction.

Fraud Detection

In the finance industry, machine learning models are used to detect fraudulent transactions through the analysis of patterns in transaction data, quickly identifying anomalies and suspicious activities, thus protecting companies and customers from fraud.

Predictive Maintenance

In manufacturing, machine learning is applied to predictive maintenance, where data from machinery and equipment is analysed to predict when maintenance is needed. This approach helps prevent unexpected breakdowns, reduce downtime, and optimize maintenance schedules, leading to cost savings and increased efficiency.

Supply Chain Optimization

Machine learning is also used to optimise supply chains by forecasting demand, managing inventory levels, and optimizing logistics. By analysing historical sales data, weather patterns, and other factors, machine learning models can predict demand more accurately, ensuring that companies have the right products in the right place at the right time.

Human Resources

HR processes can be streamlined with the introduction of machine learning by automating tasks such as resume screening, employee performance evaluation, and talent management.

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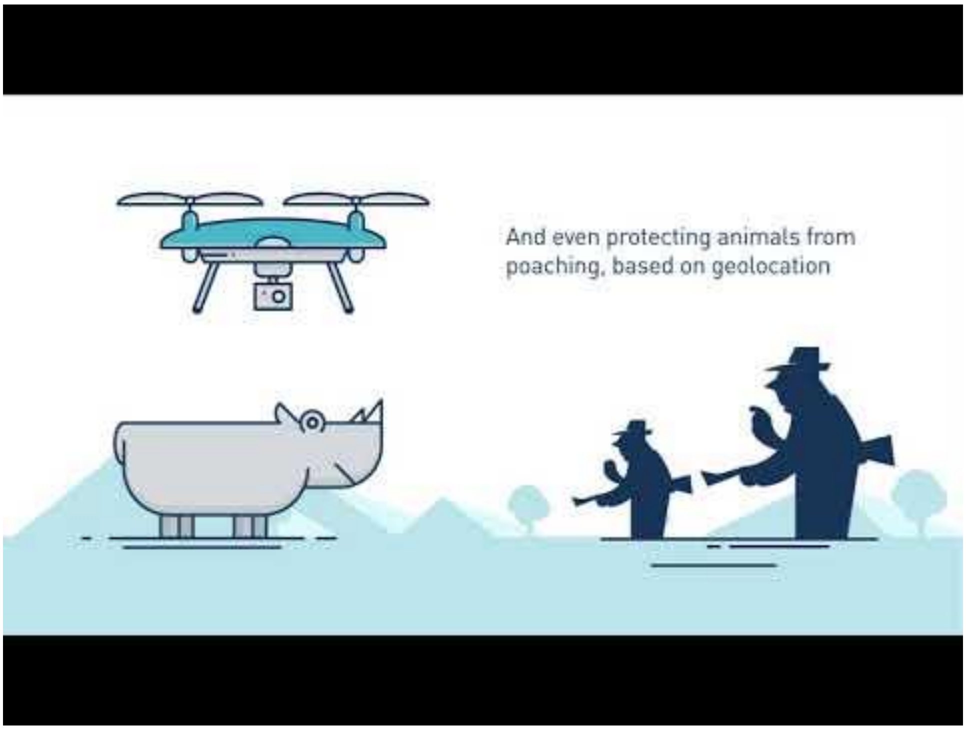

Video 28 - How Machine Learning Can Help Businesses. Source: Trend Micro on YouTube

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Checkpoint

Here, you can verify the level of knowledge acquired in the Unit. You are invited to check the previous pages and come back here as many times as needed.

Q1	Machine Learning (ML) is the same as general Artificial Intelligence (AI).	**T**
		F
Q2	Supervised learning in ML involves training models on labelled data to predict outcomes for new, unseen data.	**T**
		F
Q3	Unsupervised learning requires labelled data to find patterns and relationships in data.	**T**
		F
Q4	Reinforcement learning involves training a model through rewards and penalties as it interacts with its environment.	**T**
		F
Q5	Machine Learning has no significant applications in the finance industry.	**T**
		F
Q6	Predictive maintenance in manufacturing uses machine learning to forecast when equipment needs maintenance to prevent unexpected failures.	**T**
		F
Q7	Recommendation engines, used by e-commerce platforms to suggest products to customers, are an application of machine learning.	**T**
		F
Q8	Machine learning models can improve their performance over time as they are exposed to more data.	**T**
		F

References & further readings

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3.6 Web Development

Web development refers to the creation and maintenance of websites and web applications, and it encompasses a variety of tasks, including web design, web content development, client-side/server-side scripting, and network security configuration. The process of web development can go from the creation of a simple static webpage to complex web-based applications, social network services, and e-commerce platforms.

Websites serve as the primary interface between businesses and their customers, making web development a crucial skill for businesses seeking to establish an online presence. Its importance relies on the development of functional, user-friendly, visually appealing, and optimized performance websites. It also plays a critical role in ensuring accessibility and responsiveness, allowing users to access content seamlessly across different devices, such as smartphones, tablets, and desktops.

Basics of Fundamental Programming Languages

Web development relies heavily on several core programming languages, each serving a specific purpose in the creation and management of websites and web applications.

Programming languages	
Hypertext Markup Language (HTML)	This is the standard language used to create the structure and content of web pages. It defines elements such as headings, paragraphs, links, images, and other multimedia. It provides the basic building blocks for web pages, allowing developers to organise content and create a foundation for further styling and functionality.
Cascading Style Sheets (CSS)	CSS is used to control the visual appearance of a website. It allows developers to apply styles to HTML elements, including colours, fonts, spacing, and layout. CSS enhances the user experience by making web pages aesthetically pleasing and consistent across different devices.

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JavaScript	This powerful scripting language adds interactivity and dynamic behaviour to websites. It enables developers to create features such as form validation, interactive maps, and animated graphics. It is an essential tool for enhancing user engagement and creating rich, responsive web applications.
Structured Query Language (SQL)	SQL is used to manage and manipulate databases, allowing developers to store, retrieve, update, and delete data within a database. SQL is commonly used together with server-side languages like Python or PHP to create dynamic, data-driven websites.
Python	Python is a versatile programming language that is increasingly used in web development, particularly for backend development. Python's readability and simplicity make it a popular choice for both beginners and experienced developers, and its wide range of libraries and tools supports rapid development and integration with other technologies.

Table 3 - Programming languages

Video 29 - What is a Programming Language in 60 seconds! Source: Women Techmakers on YouTube

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Video 30 - What is HTML, CSS and JavaScript? What is Frontend and Backend Development? Source: IT-Made-Easy on YouTube

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Checkpoint

Here, you can verify the level of knowledge acquired in the Unit. You are invited to check the previous pages and come back here as many times as needed.

Q1	HTML is used to define the structure and content of a web page.	**T**
		F
Q2	CSS is primarily responsible for adding interactivity to web pages.	**T**
		F
Q3	JavaScript can only be used on the client side (in the browser).	**T**
		F
Q4	SQL is used to manage and interact with databases in web development.	**T**
		F
Q5	Python is only used for front-end web development tasks.	**T**
		F
Q6	HTML and CSS are both required to create a functional and visually appealing web page.	**T**
		F
Q7	Responsive web design ensures that websites look good on all devices, including smartphones and tablets.	**T**
		F
Q8	HTML, CSS, and JavaScript are all necessary to create a fully interactive and visually appealing website.	**T**
		F

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3.7 Impact on Daily Life

New technologies like 3D printing, robotics, and artificial intelligence (AI) are revolutionising our way of living, working, and interacting. These technologies are increasingly becoming part of our daily lives, influencing various aspects from healthcare and education to entertainment and communication.

3D Printing enables individuals and businesses to create custom products on demand, ranging from household items to complex medical devices. For example, consumers can now design and print personalised accessories or home decor, while in the medical field, 3D printing is used to create prosthetics and even bio-printed organs. This technology is democratising manufacturing, allowing more people to engage in the creation process.

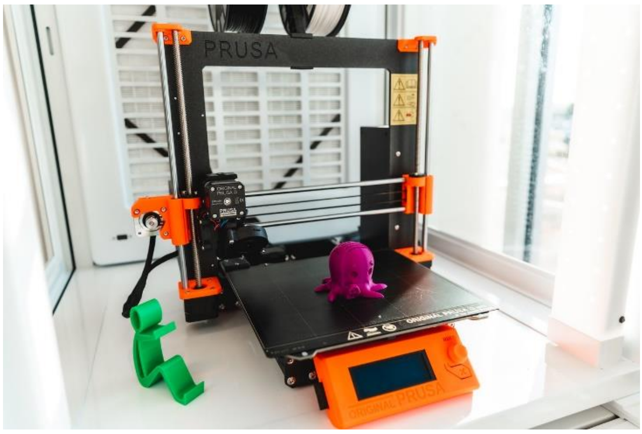

Figure 8 - Octupus printed on a 3D printer. Source: EPL on *https://www.epl.ca/makerspace/3d-printing/*

Robotics is transforming industries, as well as households, with the introduction of automated vacuum cleaners, robotic assistants, and smart home systems, which are becoming commonplace, simplifying tasks and improving convenience. In industries like manufacturing, robotics enhances efficiency and precision, leading to higher productivity and safety. As robots become more integrated into everyday life, they are not only performing repetitive tasks but also assisting in complex operations such as surgeries.

Figure 9 - Vacuum robot Roomba. Source iRobot on *https://www.irobotshop.mx/producto/robot-aspiradora-roomba-i4-evo-con-conexion-wi-fi-reacondicionado-certificado*

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Artificial Intelligence (AI) is perhaps the most pervasive, impacting everything from the way we shop to how we communicate. AI-driven virtual assistants like Siri and Alexa help manage our daily tasks, while AI algorithms personalise our online experiences, suggesting content or products based on our preferences. AI is also transforming healthcare, with applications in diagnostics, personalised medicine, and patient management, leading to better outcomes and more efficient care.

Figure 7 - All-new Echo Spot (2024 release) | Amazon Alexa. Source: Amazon Alexa on YouTube

Impact of New Technologies	
Social	AI and robotics are changing the nature of work, raising concerns about job displacement while also creating new opportunities. For instance, while automation may reduce the need for certain manual labor jobs, it also creates demand for tech-savvy professionals who can develop, manage, and maintain these systems. Moreover, these technologies are changing the way we interact, with AI-driven platforms facilitating new forms of communication and community building.
Economic	3D printing reduces production costs by enabling on-demand manufacturing and minimising waste, while AI and robotics improve efficiency and productivity across sectors. However, this rapid technological advancement can also exacerbate economic inequalities, as those with access to these

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	technologies can leverage them for significant gains, potentially widening the gap between different socioeconomic groups.
Cultural	New technologies are reshaping creative expression and access to information, with 3D printing influencing art and fashion by allowing the production of innovative designs that were previously impossible to produce. AI is changing how we consume and create media, from personalised content recommendations to AI-generated art and music. These changes challenge traditional cultural norms and raise questions about the future of creativity and originality in an era where machines can create alongside humans.

Figure 8 – Social, Economic, and Cultural Impact of New Technologies

Future Trends and Implications

Video 31 - How will AI change the world? Source: TED-Ed on YouTube

Video 32 - Is 3D printing a revolution or just a trend? Source: Interesting Engineering on YouTube

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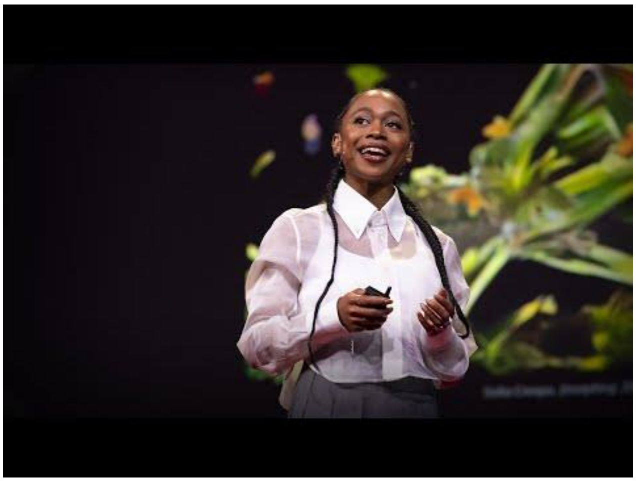

Video 33 - In the Age of AI Art, What Can Originality Look Like? | Eileen Isagon Skyers | TED. Source: TED on YouTube

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Checkpoint

Here, you can verify the level of knowledge acquired in the Unit. You are invited to check the previous pages and come back here as many times as needed.

Q1	3D printing allows for the mass production of standardised products with minimal customisation.	**T** **F**
Q2	Robotics is only used in industrial settings and has no applications in everyday life.	**T** **F**
Q3	AI-driven virtual assistants like Siri and Alexa help manage daily tasks and personalise user experiences.	**T** **F**
Q4	3D printing has the potential to revolutionise the construction industry by enabling the printing of large-scale structures like houses.	**T** **F**
Q5	Automation and AI are expected to decrease job opportunities across all sectors without creating new roles.	**T** **F**
Q6	Cultural impacts of new technologies include the democratisation of creative expression through tools like 3D printing and AI-generated content.	**T** **F**
Q7	Ethical considerations, such as privacy and bias, will become increasingly important as AI continues to develop.	**T** **F**
Q8	In the future, robots are expected to only perform repetitive tasks and will not be capable of complex human-like interactions.	**T** **F**

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3.8 Engaging with New Technologies

Engaging with new technologies like 3D printing, robotics, and AI offers a unique opportunity to foster creativity and innovation.

These tools empower individuals to bring their ideas to life – whether by designing custom objects with 3D printing, programming robots for specific tasks, or developing AI models to solve real-world problems relevant to their communities.

In 3D printing, for instance, Kenyan students can follow the example of local innovators at Ultra Red Technologies, who design functional prototypes and tools used in sectors like healthcare and architecture. Learners can design and print their own gadgets, spare parts, or educational models – merging creativity with practical, local impact.

Robotics opens up countless avenues for innovation, from basic programmable robots used in STEM clubs to advanced systems developed in Kenyan universities and innovation hubs like Gearbox and iHub. Students can take on hands-on robotics projects, such as building a robot that can sort recyclables or developing robotic arms to assist with agricultural tasks – encouraging critical thinking and tech-based problem-solving for real-life challenges.

When it comes to Artificial Intelligence (AI), Kenyan learners can take inspiration from startups like Fastagger, which uses AI to help small businesses analyse mobile money data, or Apollo Agriculture, which leverages AI to assist farmers. Through classroom AI projects, students can build chatbots to improve customer service, recommendation systems for local businesses, or AI-powered apps that help with challenges in areas like education, public health, or food security.

By working with these technologies, Kenyan students not only build technical skills but also gain the confidence to become innovators and change-makers in their communities and beyond.

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Video 34 - AI for Education | Using AI Critically in the Classroom. Source: IE University on YouTube

Video 35 - AI education tools are helping students learn, grow and gain confidence. Source: CBS News on YouTube

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Video 36 - NCCR Robotics - Educational robotics. Source: Robohub on YouTube

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Checkpoint

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Q1	3D printing enables individuals to design custom objects and bring their ideas to life.	**T** / **F**
Q2	Robotics projects primarily focus on teaching advanced coding techniques.	**T** / **F**
Q3	AI systems can learn, adapt, and make decisions independently.	**T** / **F**
Q4	Students can design tools and gadgets with 3D printing to combine creativity and practicality.	**T** / **F**
Q5	AI-driven projects are only relevant for the field of education.	**T** / **F**
Q6	Building and programming robots encourages critical thinking and problem-solving.	**T** / **F**
Q7	3D printing is limited to creating pre-designed objects rather than custom designs.	**T** / **F**
Q8	AI projects allow learners to create applications such as chatbots and recommendation systems.	**T** / **F**

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