

# **HI4 – INDUSTRY 4.0 IN HEALTHCARE**

**O5 Guidelines for “Industry 4.0 in Healthcare” trainers**

**O5/A2 Trainer guideline development and evaluation**

The purpose of the document is to present the useful guidelines for the trainers wanting to train health personal using the learning materials developed in the frame of HI4.0 project with previous intellectual outputs.

## Contents

[Forward](#)

[Introduction](#)

[Using the Guidelines](#)

[Module 1 Introduction to Industry 4.0](#)

[Module 2 Industry 4.0 concepts and technologies relevant for healthcare](#)

[Module 3 Internet of things for Medical applications](#)

[Module 4 3D printing in Medical applications](#)

[Module 5 3D simulation in medical applications](#)

[Module 6 Robotics for Medical applications](#)

[Module 7 Virtual and augmented reality for medical applications](#)

[Module 8 Impact of Industry 4.0 on the healthcare jobs](#)

[Module 9 Trends in using Industry 4.0 in Medical applications](#)

[Module 10 Data and Systems Security for medical applications](#)

# Foreward

It is a pleasure to share with you these Guidelines for teachers and professionals in the Healthcare sector. This Guidelines are part of the Erasmus+ Project 2020-1-PL01-KA202-081387 HI4- Industry 4.0 in Healthcare and its rollout marks a vital step in acquiring the most updated knowledge on how Industry 4.0 is entering the health sector.

With the guidance and support of health professionals and educators, we collectively contribute to helping our students to be able to know and interact with what technology brings us in the healthcare sector, we also contribute to helping them to think critically and ethically on the advances of this new technology. Teachers and educators play a vital role in shaping the digital skills and competences of young people.

The commitment of this project is reflected in the pages that follow. These Guidelines are intended to be used in both face-to-face and online lessons across Europe and to inspire teaching practices.

Our intention with these guidelines is to provide health educators and teachers with learning objectives, pedagogical practices and hands-on activities in one user-friendly document.

It is young people's aspirations and hopes for the future what inspire us. The guidelines are complemented with a final report by the expert group, which highlights important insights revealed during the development of the Guidelines.

# Introduction

Industry 4.0 (IND4.0), often dubbed as “4th Industrial Revolution”, is expected to impact all disciplines, industries, and economies in EU and around the world. Through its Digital Single Market Strategy, the European Commission encourages all sectors to exploit new technologies and manage a transition to smart, IND4.0 industrial systems. Under the impact of IND4.0, the healthcare system is undergoing a rapid transformation that will accelerate in the following years and must be accompanied by an appropriate personnel preparation. Technology is very important but, even more critical, is the ability of the personnel to catch up with its rapid advances and to stay updated.

The needs identified from the context analysis that are:

1. Suitable trained personnel is required in the healthcare sector in order to keep up with technology advancements and sector transformation towards Industry 4.0.
2. Both initial and continuous professional development of personnel is needed, given the dynamic evolution of the healthcare sector under the Industry 4.0 revolution.
3. There is an urgent need for VET teachers, trainers and mentors able to train healthcare personnel in the field of IND4.0 applications in their activities, in both school and work-based settings.
4. There is an urgent need for strengthening the VET curricula with key competences related to IND4.0 applications in healthcare.
5. Relevant new learning tools dedicated to healthcare personnel training in the view of IND4.0 transformation of the healthcare sector are needed.

So, the main specific results dealing with this project will be:

- increased awareness among healthcare professionals concerning new technological trends in their sector and increased use of these technologies;
- increased knowledge of health professionals, managers, authorities and policy makers concerning the advantages offered by the implementation of Industry 4.0 in Healthcare;
- knowledge gained by partners’ staff in new areas, good practice exchange among them;
- extended educational offer of universities and training providers;
- better understanding of the jobs transformation in the transformation in the healthcare sector and of the impact of IND4.0;
- new national and European multi-sectoral cooperation among project partners and stakeholders

## Using the Guidelines

The Guidelines offer concrete, hands-on guidance for teachers/educators. With this in mind, they provide practical support for teaching in classrooms and in similar educational settings.

These Guidelines do not offer solutions to all the issues that you may face in your classroom but focus on contributing to the following objectives:

1. Know the aim, objectives and learning outcomes of each module.
2. Know what educators will need when preparing each module
3. Be ware of course delivery guidelines
4. Know what educators will need for post-training activities
5. Know the different steps and duration
6. Get to know the methodology and resources for each module
7. Know how to evaluate each module
8. Find extra resources

## Using the materials

In order to carry out the course, the project participants have prepared a series of materials that are collected on the following website: <https://sites.google.com/view/hi40/home>

The website has different sections where you can find:

Information about the project and general information about the Intellectual outputs: <https://sites.google.com/view/hi40/about>

Information about the partners that have participated in the project: <https://sites.google.com/view/hi40/about/partners>

Project newsletters and posts: <https://sites.google.com/view/hi40/news>

Results of each Intellectual output: <https://sites.google.com/view/hi40/results>

E-learning platform: courses in each partner's language for distance learning but also for face-to-face support. <https://sites.google.com/view/hi40/results/lms>

Before starting the course, students have to complete a pre survey in order to be aware of what they already know about Industry 4.0 in Healthcare.

See Annex 1.

After the course, students have to complete a post-survey to be aware of what they knew before doing the course and what they know now.

See Annex 2

Attendants to the face-to-face course will have to sign a list of attendance. See Annex 3

# Module 1

## Introduction to Industry 4.0

Aim	The general aim of these activities is to lay the foundations of what Industry 4.0 is, what its evolution has been, knowing how to recognize what type of technologies are associated and what their benefits are, as well as their implementation in the real world.
Objectives	<ul style="list-style-type: none"><li>● Explain the concept of industry 4.0, design principles, and goals.</li><li>● Explain the history of the development of the Industrial Revolutions</li><li>● List and compare the benefits of Industry 4.0 technologies</li></ul> Analyze the challenges in the implementation of Industry 4.0
Learning outcomes	By the end of the module, participants will be able to: <ul style="list-style-type: none"><li>● Explain the concept of industry 4.0, design principles, and goals.</li><li>● Explain the history of the development of the Industrial Revolutions</li><li>● List and compare the benefits of Industry 4.0 technologies</li></ul> Analyze the challenges in the implementation of Industry 4.0

*Expected Impact for the participants:* they will be able to understand better the concept of Industry 4.0 .

*Expected Impact for the participant organisations:* members of staff that are not aware of any new technologies in healthcare will now be better equipped to understand this technology due to the training activity which will serve as an introduction to the topic.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

**Guidelines for pre-training preparation of face-to-face / online module training:**

- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates
- Outline the goals and objectives of the training
- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

**Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project brief before starting
- Provide a project leaflet so that the participants can understand better the goals
- Hand over the pre-training survey
- For quicker response and easier analysis a tool such as Google Forms can be used to collect data from the pre and post training surveys
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask each participant to fill in the post-training survey
- Ask the participants to provide feedback on the module and its delivery

**Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre and post training surveys should be used to improve and modify (if necessary) the course content and delivery

- The data collected from the surveys should be compiled to form the final training report
- The final report should include the following:
  - Number of participants in the face to face or online course
  - Number of participants completing the online e-learning course
  - Analysis of pre and post training surveys
  - Comments on the results
- Any necessary modifications should be made to the curriculum or training course based on the results.

Modules	Steps and duration
Module 1 90 minutes	Step 1 Brainstorming about 4.0 Industry (15 minutes)
	Step 2 Timeline creation (30 minutes)
	Step 3 Gaming activities (30 minutes)
	Step 4 Consolidation (20 minutes)

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 1	Face to face: Power point presentation, lecture, videos, group discussions, self study Online: Power point 1 presentation, lecture (online), videos, group discussions (using tools such as Zoom meeting rooms), self study

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 1	<ul style="list-style-type: none"> <li>• Laptop (for presenter), monitor/projector, white board and markers, presentation - <b>Industry4.0</b>, Internet connection for online videos</li> <li>• For online (additional resources): each participant must have a laptop/pc/tablet together with an internet connection</li> </ul>

**Evaluation of the module for face-to-face / online module training:**



Modules	Evaluation
Module 2	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module.

**Further resources supporting the realization of face-to-face / online module training:**

**Online videos:**

<https://www.youtube.com/watch?v=yKPrJJSv94M>

<https://www.youtube.com/watch?v=HPRURtORnis>

<https://www.youtube.com/watch?v=b9mJrzdIfR8>

<https://www.youtube.com/watch?v=RPC7yo99Nxs>

**Websites:**

[https://www.feedspot.com/infiniterss.php?\\_src=feed\\_title&followfeedid=5297054&q=site:https%3A%2F%2Findustry4o.com%2Ffeed%2F](https://www.feedspot.com/infiniterss.php?_src=feed_title&followfeedid=5297054&q=site:https%3A%2F%2Findustry4o.com%2Ffeed%2F)

<https://www.machinemetrics.com/blog/industry-4-0-technologies>

<https://iot-analytics.com/the-leading-industry-4-0-companies-2019/>

<https://www.i-scoop.eu/industry-4-0/>

<https://www.sap.com/insights/what-is-industry-4-0.html>

# Module 2

## Industry 4.0 concepts and technologies relevant for healthcare

Aim	The main aim of this module is to introduce the wide variety of fields in which industry 4.0 technology is used in the healthcare industry. This technology may be to help both the patient as well as the healthcare workers.
Objectives	<ul style="list-style-type: none"><li>• To make healthcare workers aware of the technology available that can be used in their favour</li><li>• To introduce healthcare workers to technology that can be applied to make the patient's healthcare experience better</li><li>• To introduce new and upcoming technologies that will be used in the near future</li></ul>
Learning outcomes	By the end of the module, participants will be able to: <ul style="list-style-type: none"><li>• Obtain a good understanding on the concept of Health 4.0</li><li>• Understand the digital skills required in healthcare and healthcare professionals' digital competencies</li><li>• Differentiate and understand the the technologies and concepts that make up Health 4.0</li><li>• Understand different Industry 4.0 terminology</li></ul>

*Expected Impact for the participants:* they will be able to understand better the concept of Industry 4.0 technology and its benefits to healthcare. Also, they will be better prepared when new technology is implemented in the workplace.

*Expected Impact for the participant organisations:* members of staff that are not aware of any new technologies in healthcare will now be better equipped to understand this technology due to the training activity which will serve as an introduction to the topic.

For the delivery of module 2, it is advised that the student completes the previous module, which is an introduction to Industry 4.0 technology. It is also recommended that the delivery of the lesson is given by someone who is knowledgeable on the subject.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

The module is divided into 5 sections each covering different topics.

**Guidelines for pre-training preparation of face-to-face / online module training:**

- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates
- Outline the goals and objectives of the training
- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

**Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project brief before starting
- Provide a project leaflet so that the participants can understand better the goals
- Hand over the pre-training survey
- For quicker response and easier analysis a tool such as Google Forms can be used to collect data from the pre and post training surveys
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask each participant to fill in the post-training survey
- Ask the participants to provide feedback on the module and its delivery

**Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre and post training surveys should be used to improve and modify (if necessary) the course content and delivery
- The data collected from the surveys should be compiled to form the final training report
- The final report should include the following:
  - Number of participants in the face to face or online course
  - Number of participants completing the online e-learning course
  - Analysis of pre and post training surveys
  - Comments on the results
- Any necessary modifications should be made to the curriculum or training course based on the results.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 2 90 minutes	Section 1 - (15 minutes) Introduction to Industry 4.0 Technology and healthcare
	Section 2 - (15 minutes) Skills required for Ind4.0 technology
	Section 3 - (30 minutes) Emerging technology in healthcare
	Section 4 - (15 minutes) Remote healthcare
	Section 5 – (15 minutes) AI and Robotics

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 2	Face to face: Power point presentation, lecture, videos, group discussions, self study Online: Power point presentation, lecture (online), videos, group discussions (using tools such as Zoom meeting rooms), self study

**Resources needed for face-to-face / online module training:**

Modules	Resources
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Module 2	<ul style="list-style-type: none"> <li>• Laptop (for presenter), monitor/projector, white board and markers, presentation - <b>Industry4.0 Concepts and Technologies</b> relevant to Healthcare, Internet connection for online videos</li> <li>• For online (additional resources): each participant must have a laptop/pc/tablet together with an internet connection</li> </ul>
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**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 2	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module.

**Further resources supporting the realization of face-to-face / online module training:**

**Online videos:**

- Video 1 [https://www.youtube.com/watch?v=W0li-Pl6yWo&t=73s&ab\\_channel=DeloitteUS](https://www.youtube.com/watch?v=W0li-Pl6yWo&t=73s&ab_channel=DeloitteUS)
- Video 2 [https://www.youtube.com/watch?v=cM4aep7VXb8&t=59s&ab\\_channel=WorldGovernmentSummit](https://www.youtube.com/watch?v=cM4aep7VXb8&t=59s&ab_channel=WorldGovernmentSummit)
- Video 3 [https://www.youtube.com/watch?v=bAyrObI7TYE&ab\\_channel=Simplilearn](https://www.youtube.com/watch?v=bAyrObI7TYE&ab_channel=Simplilearn)
- Video 4 <https://www.youtube.com/watch?v=7C7zAXf2EI0>
- Video 5 [https://www.youtube.com/watch?v=0diO\\_ncnpNs&ab\\_channel=PhilipsHealthcare](https://www.youtube.com/watch?v=0diO_ncnpNs&ab_channel=PhilipsHealthcare)

**References and further reading:**

- J. A. Martin, "What is shadow IoT? How to mitigate the risk," CSO, 5 March 2019. [Online]. Available: <https://www.csoonline.com/article/3346082/what-is-shadow-iot-how-to-mitigate-the-risk.html>.
- C. Draw, "Cloud Computing Architecture Diagrams," Concept Draw, 2019. [Online]. Available: <https://www.conceptdraw.com/How-To-Guide/cloud-computing-architecture-diagrams>.
- T. E. o. E. Britannica, "Industrial Revolution," Encyclopædia Britannica, 4 September 2019. [Online]. Available: <https://www.britannica.com/event/Industrial-Revolution>
- M.Thomas, "SIX WAYS CLOUD COMPUTING IS IMPROVING HEALTHCARE", 8 April 2020. [Online] Available: <https://builtin.com/cloud-computing/cloud-computing-in-healthcare>
- S.Durcevic, "18 Examples Of Big Data Analytics In Healthcare That Can Save People", 21 October 2020 [Online] Available: <https://www.datapine.com/blog/big-data-examples-in-healthcare/#:~:text=Big%20data%20in%20healthcare%20is,and%20complex%20for%20traditional%20technologies>

- **Medical Device Network, “Bringing the Internet of Things to healthcare”, 20 February 2020 [Online]. Available: <https://www.medicaldevice-network.com/comment/bringing-internet-things-healthcare/#:~:text=The%20IoT%20is%20described%20as,enable%20the%20exchange%20of%20data.&text=Tasks%20such%20as%20remote%20patient,medical%20devices%20with%20integrated%20IoT>**

# Module 3

## Internet of things for Medical applications

Aim	Understand the principles and characteristics of use of Internet of Things concepts/tools/devices in Medical applications as well as the benefits of their use
Objectives	<ul style="list-style-type: none"><li>• to present the benefits of IoT application in healthcare</li><li>• to explain the challenges and threats possessed by IoT use</li><li>• to indicate the variety of applications of IoT in healthcare</li><li>• to address the advantages of IoT in healthcare</li></ul>
Learning outcomes	<p>By the end of the module, trainees will be able to:</p> <ul style="list-style-type: none"><li>• Describe the benefits of IoT application in healthcare: IoT application for simultaneous reporting and monitoring of health status, IoT: end-to-end connectivity and affordability, IoT application for data assortment and analysis, IoT for tracking and alerting in life-threatening circumstances, IoT application for remote medical assistance.</li><li>• Identify the challenges and threats possessed by IoT use: Data security and privacy, Integration of multiple devices and protocols, Data overload and accuracy.</li><li>• Understand the variety of applications of IoT in healthcare: Variety of wearable devices, Hearables, Ingestible sensors, Computer vision technology, Healthcare charting.</li><li>• Recognize the advantages of IoT in healthcare: Cost reduction analysis, Evidence of improved quality of treatment, Increased possibilities to diagnose diseases at early stages, Proactive treatment as continuous health monitoring, Drugs and equipment management, Reduction of medical errors waste and system costs.</li></ul>

*Expected Impact for the participants* are increased knowledge on the topics of use of Internet of Things in medical applications, enhanced skills regarding the training and recognition of users with low new Industry 4.0 technology literacy, i.e. Internet of Things.

*Expected Impact for the participant organisations* are the trained staff regarding the Industry 4.0, e.g. Internet of Things literacy topic and blended training and the learning outcomes acquired by the short-term teaching activity, the availability of new tools for the training of nursing students and nurses on these skills as well as fruitful collaborations.

### **Guidelines for pre-training preparation of face-to-face / online module training:**

- trainers' preparation (select the trainers and prepare them for the training),

- selection of appropriate learning environment for online training,
- setting the time of training,
- setting the training goals and objective,
- selection of participants and sending them the invitation with programme of training
- preparation of all needed materials in national language (presentation, technical equipment, online list of attendance),
- preparation of evaluation pre- and post- surveys in national language,
- preparation of knowledge quiz in national languages,
- preparation the certificate for participants.

**Guidelines for course delivery during piloting:**

- register the participant before starting the training,
- provide basic information about the project,
- hand over a project leaflet to the participants,
- each participant has to fill the pre-survey before starting the course,
- the the pre-survey could be filled in online
- it is recommended to have time for discussion and networking after realization of the module,
- it is recommended to have a break after realization of the module,
- needed equipments and internet access are required,
- inform participants that after realization of the course and completing the knowledge quizzes and post-survey they can receive/download the certificate,
- actively involve participants in training,
- apply an individual approach in training,
- each participant has to fill the post-survey after finishing the course
- allow participants to provide feedback at the end of training.

**Guidelines for post-training activities of face-to-face / online training:**

- feedback from learners collected in the form of pre- and post-surveys will give the information evaluation about the use of online and face to face training; this feedback will help to identify areas that could be improved during future training sessions,
- participants have to realize all activities, especially the knowledge quiz and post-survey before receiving the certificates,
- next the collected data should be analyzed and registred to prepare the training report(s),
- the report has to contain the following data:
  - number of participants of the face to face / online learning,
  - number of participant completing the e-learning course,



- aggregate results of each question from the surveys, presenting the progress, so results of pre-survey comparing to the results of post-survey,
- conclusions and comments depending of the level of results,
- based of the obtained results the necessary modifications of the curriculum should be done in each module.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 3 90 minutes	Step 1 – Introduction to Internet of Things and its applications (duration – 25 minutes)
	Step 2 – Internet of Things solutions in Healthcare (duration – 25 minutes)
	Step 3 – Applications of Internet of Things in Healthcare and Medicine (duration – 30 minutes)
	Step 4 – Benefits and challenges of Internet of Things in Medicine + Closing activity (duration – 10 min)

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 3	lectures, presentations, self-study, group discussion, discussions based on case cases, educational videos, self-assessment

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 3	Computer (Wi-Fi network). Access to scientific data bases (PubMed, EBSCO, etc.), online platforms/ applications.

**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 3	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module. Evaluation of student's activities and quizzes given by the teacher.

**Further resources supporting the realization of face-to-face / online module training:**

Books:

1. “Internet of Medical Things: Remote Healthcare Systems and Applications” (Internet of Things) 1st ed. 2021 Edition by D. Jude Hemanth (Editor), J. Anitha (Editor), George A. Tsihrintzis (Editor)

Research papers to read:

1. I. Chiuchisan and M. Dimian, "Internet of Things for e-Health: An approach to medical applications," *2015 International Workshop on Computational Intelligence for Multimedia Understanding (IWCIM)*, 2015, pp. 1-5, doi: 10.1109/IWCIM.2015.7347091.

2. Yuehong YIN, Yan Zeng, Xing Chen, Yuanjie Fan, The internet of things in healthcare: An overview, *Journal of Industrial Information Integration*, Volume 1, 2016, pp. 3-13, ISSN 2452-414X.
3. Maksimović, M., Vujović, V., & Perišić, B. (2015, June). A custom Internet of Things healthcare system. In *2015 10th Iberian conference on information systems and technologies (CISTI)* (pp. 1-6). IEEE.
4. Luo, Jingran, et al. "Remote monitoring information system and its applications based on the Internet of Things." *2009 international conference on future biomedical information engineering (FBIE)*. IEEE, 2009.

Web pages:

1. <https://www.peerbits.com/blog/internet-of-things-healthcare-applications-benefits-and-challenges.html>
2. <https://www.igor-tech.com/news-and-insights/articles/iot-in-healthcare-enhancing-medical-environments-with-innovative-solutions>
3. <https://www.iotforall.com/iot-healthcare-advantages-disadvantages>
4. <https://www.digiteum.com/iot-benefits-healthcare-industry/>

**Exercises and practical activities supporting the realization of face-to-face / online module training:**

- use of additional presentations, videos about the topic of Internet of Things for Medical applications
- reading of research papers on the use of Internet of Things concepts in medical applications

# Module 4

## 3D printing in Medical applications

Aim	The general aim of the activity is to equip learners with <b>basic understanding of 3D printing in medical applications.</b>
Objectives	<ul style="list-style-type: none"><li>• To make healthcare workers aware of the basic features of 3D printing terminology, specific software capabilities and workflow</li><li>• To introduce healthcare workers to the role of 3D printing in medical applications, including relevant examples, technologies, and applications</li><li>• To make healthcare workers understand the advantages and limitations of 3D printing in different medical applications</li></ul>
Learning outcomes	By the end of the module, participants will be able to: <ul style="list-style-type: none"><li>• Describe the basic features of 3D printing software</li><li>• Explain the capabilities of 3D printing software Ultimaker Cura</li><li>• Describe the process of files preparation for 3D printing</li><li>• Give example of 3D Printing uses in medical applications</li><li>• Explain basic 3D Printing terminology</li><li>• Explain the role of 3D printing in medical applications</li><li>• Recognize the most relevant 3D printing technologies for the healthcare sector</li><li>• Identify the main applications of 3D printing in different medical areas</li><li>• Understand the advantages and limitations of 3D printing in different medical applications</li></ul>

*Expected Impact for the participants:* they will be able to understand better the concept of 3D Printing and its benefits to healthcare. Also, they will be better prepared when this technology is implemented in the workplace.

*Expected Impact for the participant organisations:* members of staff that are not aware of 3D Printing use in healthcare will now be better equipped to understand this technology due to the training activity which will serve as an introduction to the topic.

For the delivery of module 4, it is recommended that the delivery of the lesson is given by someone who is knowledgeable on the subject.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

**Guidelines for pre-training preparation of face-to-face / online module training:**

- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates
- Outline the goals and objectives of the training
- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

**Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project brief before starting
- Provide a project leaflet so that the participants can understand better the goals
- Hand over the pre-training survey
- For quicker response and easier analysis a tool such as Google Forms can be used to collect data from the pre and post training surveys
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask each participant to fill in the post-training survey
- Ask the participants to provide feedback on the module and its delivery

**Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre and post training surveys should be used to improve and modify (if necessary) the course content and delivery

- The data collected from the surveys should be compiled to form the final training report
- The final report should include the following:
  - Number of participants in the face to face or online course
  - Number of participants completing the online e-learning course
  - Analysis of pre and post training surveys
  - Comments on the results
- Any necessary modifications should be made to the curriculum or training course based on the results.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 4 90 minutes	Section 1 - (15 minutes) Introduction to file preparation for 3D printing
	Section 2 - (15 minutes) Introduction to Cura slicer
	Section 3 - (20 minutes) Practical exercise with Cura
	Section 4 - (20 minutes) Discussion on the role of 3D printing in medical applications
	Section 5 – (20 minutes) Discussion on the 3D printing technologies relevant for the healthcare sector

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 4	Face to face: Power point presentation, lecture, videos, group discussions, collaborative learning Online: Power point presentation, lecture (online), videos, group discussions (using tools such as Zoom meeting rooms), self study

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 4	<ul style="list-style-type: none"> <li>• The PowerPoint presentation <b>Exercise on preparing a</b></li> </ul>

	<p><b>medical model for 3D printing</b>, a computer with the free software Ultimaker Cura installed, the 3D medical model file bone.stl, paper, flipchart, markers, laptop (for presentation), monitor/projector, Internet connection for online videos, useful links</p> <ul style="list-style-type: none"> <li>• For online (additional resources): each participant must have a laptop/pc/tablet together with an internet connection</li> </ul>
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**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 4	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module.

**Further resources supporting the realization of face-to-face / online module training:**

- **Teaching Material Module 4 “3D printing in medical applications”**
- **Video 1 [https://youtu.be/zVS\\_CmuyOxE](https://youtu.be/zVS_CmuyOxE)**
- **Video 2 <https://youtu.be/nZZ2mwe6gkM>**
- **The PowerPoint presentation "Exercise on preparing a medical model for 3D printing" (15 slides) and the 3D medical model file bone.stl**

**References and further reading:**

- **Cura learning materials, <https://ultimaker.com/learn>**
- **The Ultimaker Cura workflow explained <https://support.ultimaker.com/hc/en-us/articles/360011733980-The-Ultimaker-Cura-workflow-explained>**
- **3D Printing Infill: The Basics – Simply Explained, <https://all3dp.com/2/infill-3d-printing-what-it-means-and-how-to-use-it/>**
- **3D Printing Supports – The Ultimate Guide, <https://all3dp.com/1/3d-printing-support-structures>**
- **Think-Pair-Share technique <https://kpcrossacademy.org/techniques/think-pair-share/>**

# Module 5

## 3D simulation in medical applications

Aim	The general goal of this module is that the trainees understand the principles and characteristics of 3D simulation in medical applications and also the benefits and innovation potential of their utilization.
Objectives	<ul style="list-style-type: none"><li>• Get to know the basic principles and main characteristics of 3D simulation in medical applications</li><li>• Understand the advantages of applying 3D simulation in medical applications</li><li>• Be able to compare using 3D simulation in different areas</li><li>• Demonstrate understanding of the use of 3D simulation in medical applications to foster innovation.</li></ul>
Learning outcomes	<ul style="list-style-type: none"><li>• Describe the basic features of 3D simulation</li><li>• Explain the capabilities of 3D simulation</li><li>• Describe the process of 3D simulation</li><li>• Give example of 3D simulation in medical applications</li><li>• Explain basic 3D simulation terminology</li><li>• Recognize the most relevant 3D simulation technologies for the healthcare sector</li><li>• Identify the main applications of 3D simulation in different medical areas</li></ul>

*Expected Impact for the participants:* they will be able to understand better the concept of 3D Simulation and its benefits to healthcare. Also, they will be better prepared when this technology is implemented in the workplace.

*Expected Impact for the participant organisations:* members of staff that are not aware of 3D simulation use in healthcare will now be better equipped to understand this technology due to the training activity which will serve as an introduction to the topic.

For the delivery of module 5, it is recommended that the delivery of the lesson is given by someone who is knowledgeable on the subject.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

### **Guidelines for pre-training preparation of face-to-face / online module training:**

- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates
- Outline the goals and objectives of the training
- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

### **Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project brief before starting
- Provide a project leaflet so that the participants can understand better the goals
- Hand over the pre-training survey
- For quicker response and easier analysis a tool such as Google Forms can be used to collect data from the pre and post training surveys
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask each participant to fill in the post-training survey
- Ask the participants to provide feedback on the module and its delivery

### **Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre and post training surveys should be used to improve and modify (if necessary) the course content and delivery
- The data collected from the surveys should be compiled to form the final training report
- The final report should include the following:



- Number of participants in the face to face or online course
- Number of participants completing the online e-learning course
- Analysis of pre and post training surveys
- Comments on the results
- Any necessary modifications should be made to the curriculum or training course based on the results.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 5 90 minutes	<p>Section 1 - <b>Activity 0:</b> Icebreaking- let us know each other better.</p> <p><b>Activity 1:</b> The trainer presents the basic terminology and the main characteristics of 3D simulation in medical applications, using theoretical materials for this section</p> <p><b>Activity 2:</b> Participants watch a film about 3D simulation to identify the examples of applications and the main characteristics</p> <p><b>Activity 3:</b> The trainer divides participants into small groups and ask them to discuss and briefly, then presents three definitions and three main characteristics of 3D simulations used in medical applications to the other groups.</p> <p><b>Supplementary Game:</b> The trainer divides participants into three groups and shares a series of cards with definitions (from the addendum- Healthcare Simulation Dictionary) and images (with the name on the back) of examples. The participants should find the</p>
	<p>Section 2</p> <p><b>Activity 1:</b> The trainer presents the advantages of 3D simulation in medical applications, using theoretical materials for this section.</p> <p><b>Activity 2:</b> The trainer divides participants into small groups and asks them to discuss and briefly, present the utilization of 3D simulations at their workplace to the other groups.</p> <p><b>Activity 3:</b> Participants watch interactive videos with 3D simulation in medical applications and discuss what applications could be used in their workplace/ area of expertise (advantages, disadvantages, barriers to implementation).</p>
	<p>Section 3</p> <p><b>Activity 1:</b> The trainer presents examples of 3D simulation</p>

	<p>in different Health care areas, using theoretical materials for this section.</p> <p><b>Activity 2:</b> Participants watch interactive videos with 3D simulation in medical applications and select at least two of them to compare. The trainer divides participants into groups and asks them to discuss the 3D simulations already chosen. The groups have to analyze and compare the instances, highlight the benefits of using them, and briefly present the conclusions to the other groups.</p>
	<p>Section 4 - <b>Activity 1:</b> The trainer presents the modern approach to 3D simulation in medical applications of investments, using theoretical materials for this section.</p> <p><b>Activity 2:</b> Grup discussion with trainees about scientific research analysis. Access to scientific databases (PubMed, EBSCO, etc.), research methods, and techniques.</p> <p><b>Activity 3:</b> The trainer asks the participants to reflect on using 3D simulation in medical applications to drive innovation – Brainstorming session. Group discussion.</p>

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 5	<p>The combined learning strategies used are <i>communication-based methods</i> (icebreaking or heating), lectures, presentations, <i>activity-based methods</i> (case studies, discussions based on case studies, games), <i>socially oriented methods</i> (group discussions and exchange of ideas, brainstorming), <i>self-directed methods</i> (watching expert courses on YouTube (educational videos)/ film analysis, self-study, reflection), <i>evaluation</i> (self-assessment and online assessment).</p>

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 5	<ul style="list-style-type: none"> <li>• The PowerPoint presentation, paper, flipchart, markers, laptop (for presentation), monitor/projector, Internet connection for online videos, useful links</li> <li>• For online (additional resources): each participant must have a laptop/pc/tablet together with an internet connection</li> </ul>

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**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 5	<p>The assessment method is a way in which the teacher “offers students the ability to present their acquired knowledge, the skills they master, measured with a variety of instruments appropriate to the purpose.” The assessment tool is a constituent element of the method through which the student becomes aware of the assessed task.</p> <p>During the course, the trainer will assess using different tasks that the trainees correctly performed the steps involved. She/he will ask questions to check that trainees have acquired the knowledge presented during the course. The trainer can also use different apps for evaluation (Quizziz, Kahoot, etc.).</p> <p>The teacher also evaluates the students’ activities/contributions to group work.</p>

**References and useful links:**

- **Australian Society for Simulation in Healthcare: Healthcare Simulation Dictionary (property of The Society for Simulation in Healthcare (SSH), disseminate by Agency for Healthcare, research, and quality)**
- **Lopreiato J O. Healthcare Simulation Dictionary. Rockville, MD: Agency for Healthcare Research and Quality; October 2016. AHRQ Publication No. 16(17)-0043**
- **<https://www.ahrq.gov/sites/default/files/publications/files/sim-dictionary.pdf>**
- **<https://www.healthysimulation.com>**
- **<https://www.anatamage.com/table/>**
- **<https://www.ncbi.nlm.nih.gov>**
- **<https://www.holoxica.com>**

# Module 6

## Robotics for Medical applications

Aim	Understand the principles and characteristics of use of Robotics tools and devices in Medical applications as well as the benefits of their use. The understanding will be measured by the practical activities and the test/quiz.
Objectives	<ul style="list-style-type: none"><li>• to present the benefits and possibilities of using robotic for medical applications</li><li>• to explain the advantages of using the robotics in medical applications</li><li>• to indicate the prospects for the application of robots in medicine</li></ul>
Learning outcomes	By the end of the module, trainees will be able to: <ul style="list-style-type: none"><li>• Get to know the benefits and possibilities of using robotic for medical applications: robotic cons and pros, specifics of the use of robots in medicine, possibilities and restrictions.</li><li>• List and compare the advantages of using the Robotic in Medical applications: using robots in medical applications as: telepresence, surgical assistants, rehabilitation robots, medical transportation robots, sanitation and disinfection robots, robotic prescription dispensing systems, psychological aid tools.</li><li>• Understand the prospects for the application of robots in medicine: possibilities of Robotics integration into medical daily activities, possibilities of medical process automation.</li></ul>

*Expected Impact for the participans* are increased knowledge on the topics of use of Robotics in medical applications, enhanced skills regarding the training and recognition of users with low new Industry 4.0 technology literacy, i.e. robotics.

*Expected Impact for the participant organisations* are the trained staff regarding the Industry 4.0, e.g. robotics literacy topic and blended training and the learning outcomes acquired by the short-term teaching activity, the availability of new tools for the training of nursing students and nurses on these skills as well as fruitful collaborations.

### **Guidelines for pre-training preparation of face-to-face / online module training:**

- trainers´ preparation (select the trainers and prepare them for the training),
- selection of appopriate learning environment for online training,
- setting the time of training,

- setting the training goals and objective,
- selection of participants and sending them the invitation with programme of training
- preparation of all needed materials in national language (presentation, technical equipment, online list of attendance),
- preparation of evaluation pre- and post- surveys in national language,
- preparation of knowledge quiz in national languages,
- preparation the certificate for participants.

**Guidelines for course delivery during piloting:**

- register the participant before starting the training,
- provide basic information about the project,
- hand over a project leaflet to the participants,
- each participant has to fill the pre-survey before starting the course,
- the the pre-survey could be filled in online
- it is recommended to have time for discussion and networking after realization of the module,
- it is recommended to have a break after realization of the module,
- needed equipments and internet access are required,
- inform participants that after realization of the course and completing the knowledge quizzes and post-survey they can receive/download the certificate,
- actively involve participants in training,
- apply an individual approach in training,
- each participant has to fill the post-survey after finishing the course
- allow participants to provide feedback at the end of training.

**Guidelines for post-training activities of face-to-face / online training:**

- feedback from learners collected in the form of pre- and post-surveys will give the information evaluation about the use of online and face to face training; this feedback will help to identify areas that could be improved during future training sessions,
- participants have to realize all activities, especially the knowledge quiz and post-survey before receiving the certificates,
- next the collected data should be analyzed and registered to prepare the training report(s),
- the report has to contain the following data:
  - number of participants of the face to face / online learning,
  - number of participant completing the e-learning course,
  - aggregate results of each question from the surveys, presenting the progress, so results of pre-survey comparing to the results of post-survey,

- conclusions and comments depending of the level of results,
- based of the obtained results the necessary modifications of the curriculum should be done in each module.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 6 90 minutes	Step 1 – Introduction to Robotics and its applications (duration – 25 minutes)
	Step 2 – Robotics solutions in Healthcare (duration – 25 minutes)
	Step 3 – Applications of Robotics in Healthcare and Medicine (duration – 30 minutes)
	Step 4 – Benefits and challenges of Robotics in Medicine + Closing activities (duration – 10 min)

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 6	lectures, presentations, self-study, group discussion, discussions based on case cases, educational videos, self-assessment

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 6	Multimedia, paper, flipchart, markers. Computer (Wi-Fi network). Access to scientific data bases (PubMed, EBSCO, etc.), online platforms/ applications.

**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 6	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module. Evaluation of student's activities and quizzes given by the teacher.

**Further resources supporting the realization of face-to-face / online module training:**

Books:

- **Yamamoto, Ikuo. *Practical robotics and mechatronics: marine, space and medical applications*. ISBN: 9781849199681, 2016.**

**Research papers to read:**

- **Tse, Z. T. H., Chen, Y., Hovet, S., Ren, H., Cleary, K., Xu, S., & Monfaredi, R. (2018). Soft robotics in medical applications. *Journal of Medical Robotics Research*, 3(03n04), 1841006.**
- **P. Dario, E. Guglielmelli, B. Allotta and M. C. Carrozza, "Robotics for medical applications," in *IEEE Robotics & Automation Magazine*, vol. 3, no. 3, pp. 44-56, Sept. 1996, doi: 10.1109/100.540149.**

- Suthakorn, Jackrit. "Robotics in Medical Applications." *Bangkok: ISBME* (2004).
- Burgner-Kahrs, J., Rucker, D. C., & Choset, H. (2015). Continuum robots for medical applications: A survey. *IEEE Transactions on Robotics*, 31(6), 1261-1280.
- Hsiao, Jen-Hsuan, Jen-Yuan Chang, and Chao-Min Cheng. "Soft medical robotics: clinical and biomedical applications, challenges, and future directions." *Advanced Robotics* 33.21 (2019): 1099-1111.
- Web pages:
- <https://ifr.org/blog>
- <https://www.intel.com/content/www/us/en/healthcare-it/robotics-in-healthcare.html>
- <https://medicalfuturist.com/robotics-healthcare/>
- <https://www.healthcare-administration-degree.net/faq/how-are-robots-changing-healthcare/>
- <https://www.medicaldevice-network.com/comment/what-are-the-main-types-of-robots-used-in-healthcare/>

**Exercises and practical activities supporting the realization of face-to-face / online module training:**

- use of additional presentations, videos about the topic of Robotics for Medical applications
- reading of research papers on the use of Robotics concepts and tools in medical applications

# Module 7

## Virtual and augmented reality for medical applications

Aim	The main aim of this module is to introduce VR and AR technology as well as its use in the healthcare industry.
Objectives	<ul style="list-style-type: none"><li>• To make healthcare workers aware of the AR and VR technology available</li><li>• To introduce healthcare workers to AR and VR technology that can be applied to make the patient's healthcare experience better</li><li>• To introduce new and upcoming trends and uses of AR and VR technologies</li></ul>
Learning outcomes	By the end of the module, participants will be able to: <ul style="list-style-type: none"><li>• Differentiate between AR and VR</li><li>• Gain knowledge on different VR/AR technologies with respect to healthcare</li><li>• Understand the challenges related to VR/AR and its uses in clinical practice</li><li>• Understand how to make healthcare professionals' work more efficient and comfortable for patients using VR/AR</li><li>• Appreciate the benefits of this technology by seeing applications and examples of VR/AR in the healthcare sector</li></ul>

*Expected Impact for the participants:* they will be able to understand better the concept of AR and VR technology and its benefits to healthcare. By the end of this module they will perceive AR and VR technology more as a beneficial tool rather than a video game or gimmick.

*Expected Impact for the participant organisations:* members of staff that are not aware of the benefits that AR and VR has to offer in the healthcare sector will have an overview of the technology and its uses.

It is recommended that the delivery of the lesson is given by someone who is knowledgeable on the subject.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

The module is divided into 5 sections each covering different topics.

**Guidelines for pre-training preparation of face-to-face / online module training:**



- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates
- Outline the goals and objectives of the training
- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

**Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project brief before starting
- Provide a project leaflet so that the participants can understand better the goals
- Hand over the pre-training survey
- For quicker response and easier analysis a tool such as Google Forms can be used to collect data from the pre and post training surveys
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask each participant to fill in the post-training survey
- Ask the participants to provide feedback on the module and its delivery

**Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre and post training surveys should be used to improve and modify (if necessary) the course content and delivery
- The data collected from the surveys should be compiled to form the final training report

- The final report should include the following:
  - Number of participants in the face to face or online course
  - Number of participants completing the online e-learning course
  - Analysis of pre and post training surveys
  - Comments on the results
- Any necessary modifications should be made to the curriculum or training course based on the results.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 7 90 minutes	Section 1 - (10 minutes) Introduction: What is AR and VR?
	Section 2 - (25 minutes) Virtual Reality and applications in healthcare
	Section 3 - (25 minutes) Augmented Reality in Healthcare
	Section 4 - (20 minutes) Advantages and Disadvantages of AR and VR
	Section 5 – (10 minutes) Case studies

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 7	Face to face: Power point presentation, lecture, videos, group discussions, self study Online: Power point presentation, lecture (online), videos, group discussions (using tools such as Zoom meeting rooms), self study

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 7	Laptop (for presenter), monitor/projector, white board and markers Presentation - <b>Virtual and Augmented Reality for Medical applications</b>

	Internet connection for online videos For online (additional resources): Each participant must have a laptop/pc/tablet together with an internet connection
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**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 7	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module.

**Further resources supporting the realization of face-to-face / online module training:**

**Online videos:**

Video 1 [https://www.youtube.com/watch?v=fxDCYmsw2M0&ab\\_channel=EyeonTech](https://www.youtube.com/watch?v=fxDCYmsw2M0&ab_channel=EyeonTech)

Video 2 [https://www.youtube.com/watch?v=567Eb-Gccn8&t=64s&ab\\_channel=CaseWesternReserveUniversity](https://www.youtube.com/watch?v=567Eb-Gccn8&t=64s&ab_channel=CaseWesternReserveUniversity)

Video 3 [https://www.youtube.com/watch?v=KGo7vdmW2G8&ab\\_channel=DefunctChannel](https://www.youtube.com/watch?v=KGo7vdmW2G8&ab_channel=DefunctChannel)

Video 4 [https://www.youtube.com/watch?v=yxZ77vD6r50&ab\\_channel=3D4MedicalFromElsevier](https://www.youtube.com/watch?v=yxZ77vD6r50&ab_channel=3D4MedicalFromElsevier)

**References and further reading:**

- Immersivetouch.com (2021) <https://www.immersivetouch.com/immersivesim-training>
- The Franklin Institute (2021) The History of Virtual Reality. <https://www.fi.edu/virtual-reality/history-of-virtual-reality>
- FDM Group (2020) 5 Exciting Uses for Virtual Reality. <https://www.fdmgroup.com/5-exciting-uses-for-virtual-reality/>
- The Mainstreaming of Augmented Reality: A Brief History (2016) Ana Javornik. <https://hbr.org/2016/10/the-mainstreaming-of-augmented-reality-a-brief-history>
- 3D4MEDICAL (2021) Elsevier, <https://3d4medical.com/support/complete-anatomy/ar>
- Key challenges to adopting VR/AR in healthcare (2017) Kris Kolo. <https://www.thevrara.com/blog2/2017/6/10/key-challenges-to-adoption-of-vrar-for-healthcare>
- Benefits of augmented reality in healthcare (2019) Yash Jay, <https://www.affinityvr.com/augmented-reality-in-healthcare/>



# Module 8

## Impact of Industry 4.0 on the healthcare jobs

Aim	The main aim of this module is <i>to realise the impact of Industry 4.0 on the healthcare jobs</i>
Objectives	<ul style="list-style-type: none"><li>• To introduce digital healthcare technologies (genomics, digital medicine, artificial intelligence, and robotics, etc.) as new tools to address healthcare challenges, including prevention area, as well as treatment and rehabilitation</li><li>• To increase the experience of health care professionals about the application of smart health care technologies in health care sector</li><li>• To evaluate the advantages and disadvantages of applying digital technologies in healthcare settings</li></ul>
Learning outcomes	By the end of the module, participants will be able to: <ul style="list-style-type: none"><li>• will be able to analyze the impact of Industry 4.0 on the healthcare workforce and organizations.</li><li>• will be able to select digital healthcare technologies as tools to address healthcare issues.</li><li>• will be able to evaluate the benefit of digital competencies on the improvement and development of healthcare.</li></ul>

*Expected Impact for the participants:* they will be able to better understand the impact of Industry 4.0 on healthcare workers and organizations. Also, they will be able to select digital healthcare technologies as tools to solve healthcare problems and will realize the benefits of digital competences for the improvement and development of healthcare.

*Expected Impact for the participant organisations:* members of staff will be able to better understand the impact of Industry 4.0 on organizations and will be motivated to select and apply digital healthcare technologies as tools to solve healthcare problems and for the improvement and development of healthcare.

For the delivery of module 8, it is advised that the student completes the previous modules, which are an introduction to Industry 4.0 technology and Industry 4.0 concepts and technologies relevant for healthare. It is also recommended that the delivery of the lesson is given by someone who is knowledgeable on the subject.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

The module is divided into 3 sections each covering different topics.

**Guidelines for pre-training preparation of face-to-face / online module training:**

- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates
- Outline the goals and objectives of the training
- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

**Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project leaflet so that the participants can understand better the goals
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask the participants to provide feedback on the module and its delivery

**Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre, and post training surveys should be used to improve and modify (if necessary) the course content and delivery

- The data collected from the surveys should be compiled to form the final training report
- The final report should include the following:
  - Number of participants in the face to face or online course
  - Number of participants completing the online e-learning course
  - Analysis of pre and post training surveys
  - Comments on the results
- Any necessary modifications should be made to the curriculum or training course based on the results.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 8 90 minutes	Section 1 - (20 minutes) Short Introduction to the module. Analysis the impact of Industry 4.0 on the healthcare workforce and organizations.
	Section 2 - (30 minutes) The top digital healthcare technologies impacting the workforce. The digital healthcare technologies as tools to address healthcare issues.
	Section 3 - (40 minutes) The importance of digital competences. The benefit of digital competencies on the improvement and development of healthcare.

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 8	Face to face: Power point presentation, lecture, videos, group discussions, case study, brainstorming activity Online: power point presentation, lecture (online), videos, group discussions, case study

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 8	<ul style="list-style-type: none"> <li>• Laptop (for presenter), monitor/projector, white board and markers, presentation – <b>Impact of Industry 4.0 on the healthcare jobs</b>, Internet connection for online videos</li> <li>• For online (additional resources): each participant must have a laptop/pc/tablet together with an internet</li> </ul>

	connection
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**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 8	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module.

**Further resources supporting the realization of face-to-face / online module training:**

**Online videos:**

- Video 1 <https://www.youtube.com/watch?v=jh5U5BnpGN8&t=1s>
- Video 2 <https://vimeo.com/oxfordmedicalsimulation>
- Video 3 [https://www.youtube.com/watch?v=9c\\_lcliatjc](https://www.youtube.com/watch?v=9c_lcliatjc)

**References and further reading:**

- AI and the Health Care Workforce (2019), American Hospital Association (AHA). <https://www.aha.org/center/emerging-issues/market-insights/ai/ai-and-health-care-workforce>.
- Derakhshandeh, H., Kashaf, S. S., Aghabaglou, F., Ghanavati, I. O. And Tamayol, A. (2018). Smart Bandages: The Future of Wound Care. *Trends Biotechnol*, 36(12), 1259-1274. doi: 10.1016/j.tibtech.2018.07.007
- Elsherif, M., Alam, F., Salih, E. A., AlQattan, B., Yetisen, K. A., Butt, H. (2021). Wearable Bifocal Contact Lens for Continual Glucose Monitoring Integrated with Smartphone Readers. 17(51), 1-13.
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# Module 9

## Trends in using Industry 4.0 in Medical applications

Aim	<i>The general aim of the activity is to realize <b>the applications of 4.0 in the Health sector</b></i>
Objectives	<ul style="list-style-type: none"><li>- get to know the main activities in line with the AI policy, strategy, standards and regulations</li><li>- get to know the strategic recommendations in using Industry 4.0 in Medical applications</li><li>- demonstrate an understanding of digital skills development for self-improvement in using 4.0 in Medical applications</li></ul>
Learning outcomes	By the end of the module, participants will be able to: <ul style="list-style-type: none"><li>- get to know the main activities in line with the AI policy, strategy, standards and regulations</li><li>- get to know the strategic recommendations in using Industry 4.0 in Medical applications</li><li>- demonstrate an understanding of digital skills development for self-improvement in using 4.0 in Medical applications</li></ul>

*Expected Impact for the participants:* they will be able to understand better the concept of Industry 4.0 .

*Expected Impact for the participant organisations:* members of staff that are not aware of any new technologies in healthcare will now be better equipped to understand this technology due to the training activity which will serve as an introduction to the topic.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

### **Guidelines for pre-training preparation of face-to-face / online module training:**

- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates
- Outline the goals and objectives of the training

- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

**Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project brief before starting
- Provide a project leaflet so that the participants can understand better the goals
- Hand over the pre-training survey
- For quicker response and easier analysis a tool such as Google Forms can be used to collect data from the pre and post training surveys
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask each participant to fill in the post-training survey
- Ask the participants to provide feedback on the module and its delivery

**Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre and post training surveys should be used to improve and modify (if necessary) the course content and delivery
- The data collected from the surveys should be compiled to form the final training report
- The final report should include the following:
  - Number of participants in the face to face or online course
  - Number of participants completing the online e-learning course
  - Analysis of pre and post training surveys
  - Comments on the results
- Any necessary modifications should be made to the curriculum or training course based on the results.

Modules	Steps and duration
Module 9 90 minutes	Step 1 Padlet activity (30 minutes)
	Step 2 Video interaction (30 minutes)
	Step 3 Debate (30 minutes)

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 9	Face to face: Power point presentation, lecture, videos, group discussions, self study Online: Power point presentation, lecture (online), videos, group discussions (using tools such as Zoom meeting rooms), self study

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 9	<ul style="list-style-type: none"> <li>Laptop (for presenter), monitor/projector, white board and markers, presentation – <b>Module 9</b>, Internet connection for online videos</li> <li>For online (additional resources): each participant must have a laptop/pc/tablet together with an internet connection</li> </ul>

**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module9	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module.

**Further resources supporting the realization of face-to-face / online module training:**

**Online videos:**

- [https://www.youtube.com/watch?v=PhfgHgm\\_JDY](https://www.youtube.com/watch?v=PhfgHgm_JDY)
- <https://www.youtube.com/watch?v=lluxzzaeeYY>
- <https://www.youtube.com/watch?v=UX2MTJKeAhl>
- <https://www.youtube.com/watch?v=p6PS50dCoQk>

**Websites:**

- <https://www.sciencedirect.com/science/article/pii/S2667345222000104>
- [https://www.researchgate.net/publication/352927290\\_Industry\\_40\\_Applications\\_for\\_Medical\\_Healthcare\\_Services](https://www.researchgate.net/publication/352927290_Industry_40_Applications_for_Medical_Healthcare_Services)
- <https://www.mdpi.com/2224-2708/10/3/43>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8953130/>
- <https://dergipark.org.tr/en/download/article-file/1995952>

# Module 10

## Data and Systems Security for medical applications

Aim	The general aim of the activity is to realise the importance of data and systems security in the healthcare applications
Objectives	<ul style="list-style-type: none"><li>• Familiarize healthcare workers with the importance of data security in healthcare.</li><li>• Educate health care workers about the cybersecurity threats</li><li>• Familiarize healthcare workers with data protection methods</li></ul>
Learning outcomes	By the end of the module, participants will be able to: <ul style="list-style-type: none"><li>• describe the main activities in line with security policy, strategy, standards and regulations in medical applications</li><li>• give examples of sensitive data</li><li>• identify and find the best ways to avoid social engineering attacks.</li><li>• give examples skills related to the data and system security of the health system</li></ul>

*Expected Impact for the participants:* they will realise the importance of data and systems security in healthcare. Also, they will be better prepared when new technology is implemented in the workplace.

*Expected Impact for the participant organisations:* members of staff that are not aware of data security problems in healthcare will now be better equipped to understand this field of knowledge due to the training activity which will serve as an introduction to the topic.

For the delivery of module X, it is recommended that the delivery of the lesson is given by someone who is knowledgeable on the subject.

The module is designed in a way that can be delivered both as an online course or as a face-to-face course as no special resources are required.

The module is divided into 8 sections each covering different topics.

### **Guidelines for pre-training preparation of face-to-face / online module training:**

- Select the trainers that will be doing the course
- Give the trainers an introduction to the topics to be covered
- Select the online platform that will be used for training (MS Teams, Zoom, Google Meet etc.)
- Set-up training dates

- Outline the goals and objectives of the training
- Select the participants that will undergo the training program
- Select the venue (for face to face) and make sure it is adequate for the number of participants
- Prepare the attendance list

**Guidelines for course delivery during piloting:**

- Participant registration before starting
- Provide a project brief before starting
- Provide a project leaflet so that the participants can understand better the goals
- Hand over the pre-training survey
- For quicker response and easier analysis a some survey tool (such as Google Forms) can be used to collect data from the pre and post training surveys
- Trainers are encouraged to promote teamwork and sharing of ideas, both during the module delivery as well as during break time
- The recommended list of resources is provided in the table below. It is also suggested that the classroom has good internet connectivity
- Make the students aware of the quiz after each module and promote it by mentioning the certificate as an incentive
- Ask each participant to fill in the post-training survey
- Ask the participants to provide feedback on the module and its delivery

**Guidelines for post-training activities of face-to-face / online training:**

- The feedback collected during the pre and post training surveys should be used to improve and modify (if necessary) the course content and delivery
- The data collected from the surveys should be compiled to form the final training report
- The final report should include the following:
  - Number of participants in the face to face or online course
  - Number of participants completing the online e-learning course
  - Analysis of pre and post training surveys
  - Comments on the results

- Any necessary modifications should be made to the curriculum or training course based on the results.

**Course module structure and course module content for face-to-face / online module training:**

Modules	Steps and duration
Module 10 90 minutes	1. (5 minutes) Introduction to data security
	2. (10 minutes) Security of personal data in my workplace.
	3. (10 minutes) Legal Regulation of Data Protection in the European Union.
	4. (10 minutes) Possible actions to increase data security.
	5. (15 minutes) Organizational-technical ways to increase data security.
	6. (15 minutes) "Is my password secure?".
	7. (15 minutes) Cyber attacks (include social engineering).
	8. (10 minutes) Digital skills to increase data and systems security in healthcare.

**Methods used for face-to-face / online module training:**

Modules	Resources
Module 10	Face to face: Power point presentation, Kahoot surveys, lecture, videos, group discussions, self study. Online: Power point presentation, Kahoot surveys, lecture (online), videos, group discussions (using tools such as Zoom meeting rooms), self study

**Resources needed for face-to-face / online module training:**

Modules	Resources
Module 10	<ul style="list-style-type: none"> <li>Computer (for presenter), monitor/projector, white board and markers, presentation - <b>Data and Systems Security for medical applications</b>, Internet connection for online videos and Kahoot surveys</li> <li>For online (additional resources): each participant must have a laptop/pc/tablet or mobile phone with an internet connection</li> </ul>

**Evaluation of the module for face-to-face / online module training:**

Modules	Evaluation
Module 10	A short evaluation questionnaire (quiz) will be used to assess participants' knowledge gained from the module.



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## Further resources supporting the realization of face-to-face / online module training:

### Online videos:

- Video 1 <https://youtu.be/F7pYHN9iC9I>
- Video 2 <https://youtu.be/lc7scxvKQOo>
- Video 3 <https://youtu.be/Pd7x2bHVSAs>
- Video 4 <https://youtu.be/Ls8jyO46bml>
- Video 5 <https://youtu.be/LrFarFrzbD4>

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## Conclusions

Industry 4.0 is a new modern reality, which is shown in the research results that are presented in this project. However, the strategic plans of development of Industry 4.0 were disturbed by an unexpected global socio-economic crisis caused by the Covid-19 pandemic in 2020. 4.0 Industry in the Healthcare sector has demonstrated that it is a powerful mechanism of innovative development of society and economy, has a large potential of crisis management and requires the top-priority practical implementation. All the interests of healthcare and social protection are increasing so cyber security and new technologies require a quick reaction with the international coordination of actions and cooperation.

In conclusion: Industry 4.0 arrives with both challenges and new opportunities. It is up to every individual and every business to adapt to Industry 4.0 as previous generations have had to adapt to industries 1.0, 2.0 and 3.0. Those who are able to adapt well can capitalise on all of the exciting new technologies.

The guidelines were developed by the partners on Erasmus+ Project 2020-1-PL01-KA202-081387 HI4-Industry 4.0 in Healthcare

# Annex 1

## PRE-SURVEY

### Knowledge about the use of Industry 4.0 elements in healthcare

On a scale from 1 (poor) to 5 (excellent) how would you evaluate your knowledge about:		1 Po or	2 Fa ir	3 Go od	4 Ver y goo d	5 Excele nt
Q1	The concepts of Industry 4.0?					
Q2	The benefits of Industry 4.0. technologies?					
Q3	The challenges in implementation of Industry 4.0?					
Q4	The concept of Health 4.0?					
Q5	The digital skills required in healthcare?					
Q6	The technologies that make up Health 4.0?					
Q7	Current applications of IoT in the healthcare sector?					
Q8	The benefits of IoT application in healthcare?					
Q9	The challenges and threats possessed by IoT use?					
Q10	Current applications of 3D printing in the healthcare sector?					
Q11	3D printing technologies relevant for the healthcare sector?					
Q12	Materials used in 3D printing?					
Q13	Current applications of 3D simulation in the healthcare sector?					

Q14	The advantages of applying 3D simulation in medical applications?					
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Q15	3D Telemedicine?					
Q16	Current applications of Robotics in the healthcare sector?					
Q17	The advantages of using Robotics in medical applications?					
Q18	The prospects for the application of robots in medicine?					
Q19	Current applications of Virtual Reality in the healthcare sector?					
Q20	Current applications of Augmented Reality in the healthcare sector?					
Q21	The challenges related to VR/AR and its uses in clinical practice?					
Q22	The impact of Industry 4.0 on the healthcare workforce?					
Q23	The benefit of digital competencies on the improvement and development of healthcare?					
Q24	How will Artificial Intelligence change the healthcare workforce?					
Q25	What is Artificial Intelligence?					
Q26	Artificial Intelligence public policies?					
Q27	Artificial Intelligence regulations in Medical applications?					
Q28	The skills related to the data and system security of the health system?					
Q29	Rules, laws and regulations governing Data and Systems Security for Medical Applications?					
Q30	Protection of personal data in Medical applications?					

## Impact of Industry 4.0 in healthcare

Q31. How do you think Industry 4.0 can improve the clinical settings and primary care?

Q32. How do you think Industry 4.0 can improve the jobs transformation in healthcare?

Q33. What are the Industry 4.0 effects on health services quality?

Q34. What are the Industry 4.0 effects on patients and personnel?

# Annex 2

## POST-SURVEY

### Knowledge about the use of Industry 4.0 elements in healthcare

On a scale from 1 (poor) to 5 (excellent) how would you evaluate your knowledge about:		1 Poor	2 Fair	3 Good	4 Very good	5 Excellent
Q1	The concepts of Industry 4.0?					
Q2	The benefits of Industry 4.0. technologies?					
Q3	The challenges in implementation of Industry 4.0?					
Q4	The concept of Health 4.0?					
Q5	The digital skills required in healthcare?					
Q6	The technologies that make up Health 4.0?					
Q7	Current applications of IoT in the healthcare sector?					
Q8	The benefits of IoT application in healthcare?					
Q9	The challenges and threats possessed by IoT use?					
Q10	Current applications of 3D printing in the healthcare sector?					
Q11	3D printing technologies relevant for the healthcare sector?					
Q12	Materials used in 3D printing?					
Q13	Current applications of 3D simulation in the healthcare sector?					



Q14	The advantages of applying 3D simulation in medical applications?					
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Q15	3D Telemedicine?					
Q16	Current applications of Robotics in the healthcare sector?					
Q17	The advantages of using Robotics in medical applications?					
Q18	The prospects for the application of robots in medicine?					
Q19	Current applications of Virtual Reality in the healthcare sector?					
Q20	Current applications of Augmented Reality in the healthcare sector?					
Q21	The challenges related to VR/AR and its uses in clinical practice?					
Q22	The impact of Industry 4.0 on the healthcare workforce?					
Q23	The benefit of digital competencies on the improvement and development of healthcare?					
Q24	How will Artificial Intelligence change the healthcare workforce?					
Q25	What is Artificial Intelligence?					
Q26	Artificial Intelligence public policies?					
Q27	Artificial Intelligence regulations in Medical applications?					
Q28	The skills related to the data and system security of the health system?					
Q29	Rules, laws and regulations governing Data and Systems Security for Medical Applications?					
Q30	Protection of personal data in Medical applications?					

## **Impact of Industry 4.0 in healthcare**

Q31. How do you think Industry 4.0 can improve the clinical settings and primary care?

Q32. How do you think Industry 4.0 can improve the jobs transformation in healthcare?



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## HI4 – INDUSTRY 4.0 IN HEALTHCARE

Q33. What are the Industry 4.0 effects on health services quality?

Q34. What are the Industry 4.0 effects on patients and personnel?

### Annex 3

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DATE : \_\_\_\_\_

Name and surname(s)	ID number	Signature

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