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How the Polytechnic Institute of Porto Promotes I4.0

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Polytechnic Institute of Porto
P.PORTO

One of the largest Higher Education Institution in Portugal
(5th in dimension and 4th in candidates)

More than 18 000 students in 46 BSc and 62 MSc programs

International cooperation

- ✓ 600 international students
- ✓ International protocols with more than 700 institutions in five continents

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Polytechnic Institute of Porto
P.PORTO

Eight schools

Porto (5), Vila do Conde/Póvoa do Varzim (2) and Felgueiras (1)
Programs spread in 7 other cities around Porto

- ✓Engineering
- ✓Health
- ✓Technology and Management
- ✓Business Sciences
- ✓Education
- ✓Hospitality and Tourism
- ✓Music and performing arts
- ✓Media arts and design

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Research and Innovation at P.PORTO

Generating knowledge to meet society's great challenges of local, regional or international nature

- ✓ 24 research centres and groups in areas of technology, health, business sciences, education, arts, culture, ...
- ✓ 8 research centres recognized by FCT, the Portuguese R&D agency
- ✓ More than 100 research projects ongoing, with +40 international and +30 with industrial partners

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Research and Innovation at P.PORTO

FCT recognized centers:

- ✓ CISTER – Real-time and embedded computing systems
  - ✓ Real-time systems, smart embedded systems, cyber-physical systems, IoT
- ✓ GECAD – Intelligent Engineering and Computing
  - ✓ Intelligent systems, Power energy systems, cybersecurity
- ✓ CIETI – Industrial Engineering and Technology
  - ✓ Biomaterials and nanotechnologies and process, energy and environment and remote laboratories
- ✓ GILT – Games Interaction and Learning Technologies
  - ✓ Analysis, design and development in the fields of Virtual Reality, Multimedia and Learning-Technologies

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Research and Innovation at P.PORTO

FCT recognized centers:

- ✓ CIR – Health Rehabilitation
  - ✓ Physical movement and activity, social insertion and quality of life of people with psychiatric disabilities
- ✓ CEOS – Organization and social studies
  - ✓ Business and Legal Sciences, Language Sciences, Communication and Education.
- ✓ CIICESI – Business sciences and information systems
  - ✓ Regional and Local Development, Business and Organizational Strategy, Data Analytics, Industrial Engineering
- ✓ InED – Education research
  - ✓ Art and Heritage Studies, Artistic and Literary Studies, Philosophy with Children and the Communication Office.

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Research and Innovation at P.PORTO

P.PORTO Branches of external research centers:

- ✓ Chemical reactions
  - ✓ Chemical Engineering and Green Chemistry, branch of REQUIMTE
- ✓ Autonomous systems
  - ✓ Autonomous systems, navigation, control and coordination of multiple robots, branch of INESC TEC
- ✓ BIOMARK Sensor Research
  - ✓ (Bio) nanomaterials with application in Medical and Industrial areas, branch of Centre of Biological Engineering

- ✓ ...

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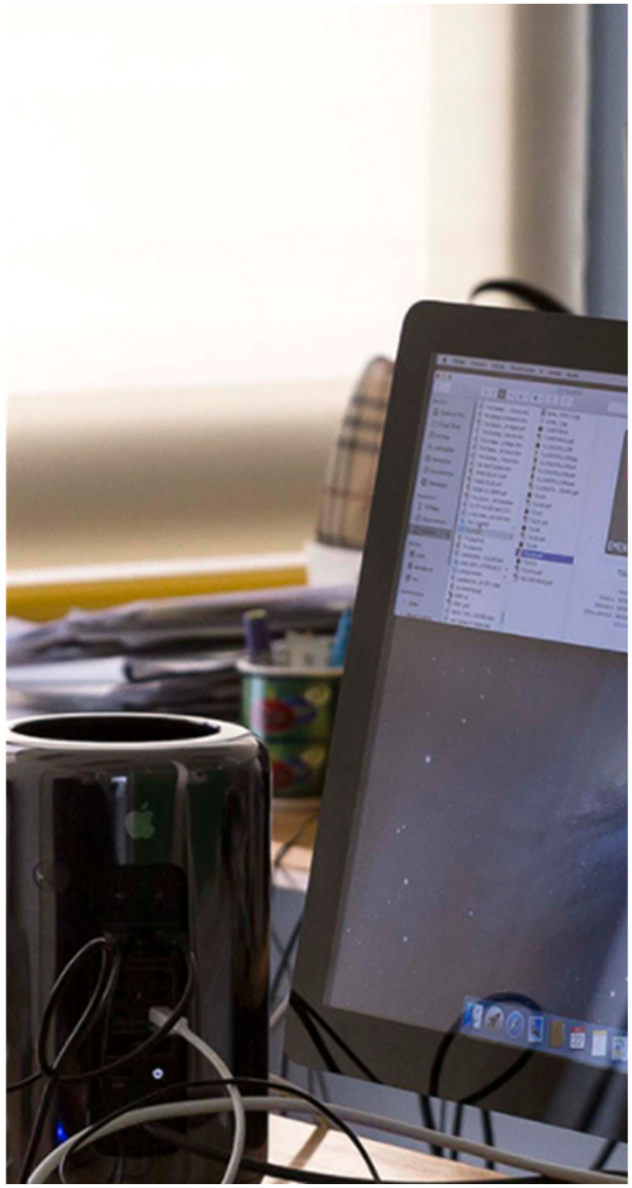
Innovation and Entrepreneurship at P.PORTO

Porto Global Hub

- ✓ Porto Design Factory
  - ✓ Lab of co-creation, applied research and industrial collaboration .
- ✓ Startup Porto
  - ✓ Foster the emergence of a new generation of business by promoting entrepreneurship programs
- ✓ Porto Business Innovation
  - ✓ To promote new business opportunities and develop new products and services to reach the market quickly



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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Curricula of some courses** oriented for the I4.0 paradigm, namely:

(1) Bachelor degrees in
- Informatic Engineering
- Electrotechnical Engineering and Computers
- Industrial Engineering
- Mechanical Engineering

(2) Master degrees in
- Informatic Engineering
- Industrial Engineering
- Mechanical Engineering
- Electrotechnical Engineering and Computers – Automation and Systems
- Artificial Intelligence Engineering
- Critical Computing Systems Engineering

- Curricular Plan of - Electrotechnical Engineering and Computers – Automation and Systems

https://www.isep.ipp.pt/Course/Course/38

1st YEAR | 1st SEMESTER

- Technology and Embedded Systems Laboratory

OPTIONAL - :

- Advanced Dynamics
- Advanced Vision Topics for Robotics
- Applied Estimation
- Artificial Intelligence and Planning
- Automotive Systems
- Computer Architecture
- Control of Autonomous Systems
- Control of Non-linear Systems
- Digital Signal Processing
- Discrete and Hybrid Systems
- Embedded Systems

1st YEAR | 2nd SEMESTER

- Professional Training
- Robotic Systems Laboratory

OPTIONAL - :

- Advanced Dynamics
- Advanced Vision Topics for Robotics
- Applied Estimation
- Artificial Intelligence and Planning
- Automotive Systems
- Control of Autonomous Systems
- Control of Non-linear Systems
- Digital Signal Processing
- Discrete and Hybrid Systems
- Embedded Systems
- Flexible Manufacturing Systems

- Curricular Plan of - Electrotechnical Engineering and Computers – Automation and Systems
  https://www.isep.ipp.pt/Course/Course/38

2nd YEAR | 1st SEMESTER

- Multi-Robot Systems Laboratory

OPTIONAL - :

- Automotive Systems
- Computer Architecture
- Genetic Algorithms
- Industrial Robotics
- Motion and Time Analysis
- Multi-Robot Systems
- Multi-sensorial Information Fusion
- Project of Embedded Systems

2nd YEAR | ANNUAL

- Thesis

- Curricular Plan of Artificial Intelligence Engineering
  https://www.isep.ipp.pt/Course/Course/462

1st YEAR | 1st SEMESTER

- Knowledge Engineering
- Machine Learninig 1
- Planning and Decision Support
- Programming Paradigms in Artificial Intelligence

1st YEAR | 2nd SEMESTER

- Intelligent Environments
- Machine Learninig 2
- Multi-Agent Systems
- Natural Language and Conversational Systems

2nd YEAR | 1st SEMESTER

- Applied Artificial Intelligence
- Preparatory Work of Project/Dissertation/Internship
- Resarch and Innovation in Artificial Intelligence
- Social Aspects of Artificial Intelligence

2nd YEAR | 2nd SEMESTER

- Project/Dissertation/Internship

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- Curricular Plan of Critical Computing Systems Engineering
  https://www.isep.ipp.pt/Course/Course/461

1st YEAR | 1st SEMESTER

- Communication Technologies for Critical Systems
- Critical Computer Systems Architectures
- Critical Systems Lab
- Real-time & Embedded Systems
- Requirements and Model-driven Engineering

1st YEAR | 2nd SEMESTER

- Formal Verification of Critical Applications
- Industry-Driven Use-Case Engineering
- Project Management and Development
- Real-Time Operating Systems Programming
- Systems of Systems

2nd YEAR | 1st SEMESTER

- Advanced Programming Paradigms
- Application Scenarios and Case Studies
- Dependability and Cybersecurity
- Intelligent, Autonomous, Cooperative Systems
- Thesis Research Plan Development

2nd YEAR | 2nd SEMESTER

- Project/Thesis/Internship

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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Curricula of some courses** oriented for the I4.0 paradigm, namely:

(3) Postgraduate courses in

- Post-Graduation in Big Data & Decision Making
- Internet of Things
- Industry 4.0 - Digital Transformation

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- Curricular Plan of - Big Data & Decision Making
  https://www.isep.ipp.pt/Course/Course/325

1º ANO | ANUAL

- Big Data Analytics
- Big Data Architecture
- Big Data Tools I
- Big Data Tools II
- Business Intelligence
- Data Mining
- Data Security & Privacy
- Datawarehousing
- Seminars

- Curricular Plan of - Internet of Things
  https://www.isep.ipp.pt/Course/Course/625

1ST YEAR | YEARLY

Data Communication and IoT Protocols
Development of Embedded Systems for IoT
Fundamentals of IoT Systems
Integration of Systems and Services in the Cloud
Data Processing and AI in IoT
Advanced IoT Systems Programming
Security and Privacy
Real-Time Operating Systems

- Curricular Plan of - Industry 4.0 - Digital Transformation

https://www.isep.ipp.pt/Course/Course/530

1ST YEAR | 1ST SEMESTER

Big Data Analytics
Process Digitization and IOT
Circular Economy and Sustainability
Integration of Information Systems in I4.0
Artificial Intelligence and Machine Learning
Logistics & SCM in 4.0
Production 4.0
Co-creation Project & Transferable Skills
Advanced Simulation and Digital Twins

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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Seminars** uttered by the staff of companies or by colleagues of others Universities, namely some of them organized with our collaboration:

  - INDUSTRY 4.0 – FROM SENSOR TO CLOUD
  - INDUSTRY 4.0 AS A DRIVER OF CHANGE IN MANUFACTURING SYSTEMS
  - TYPES OF ADITIVE MANUFACTURING
  - CHALLENGES OF RPA - ROBOTIC PROCESS AUTOMATION
  - OPEN DESIGN: An approach to a new Industrialization

Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Technical/Scientific Publications**, namely, with our collaboration:

  Edited books

Ferreira, L., Lopes, N., Silva, J., Putnik, G. D., Cruz-Cunha, M. M., & Ávila, P. S. (Eds.) (2019) **Technological Developments in Industry 4.0 for Business Applications** (pp. 1-451). Hershey, PA: IGI Global. (doi:10.4018/978-1-5225-4936-9)

Shatokha, V., Ávila, P., De Lepeleer, G., Kordas, V., Melnychuk, M., Nyenno, I., Pedrosa, R., Petrenko, A., Saey, P., Silva, J.F., Shvets, I., V. Truba, V. (Eds.) (2021) **Higher education towards fourth industrial revolution: European and Ukrainian cases**, Monograph, Dnipro, ISBN 978-966-2394-53-5.

Ferreira, L., Ávila, P., Bastos, J., Silva, F., Sá, J., Brito, M. (2023) **Lean Manufacturing and Industry 4.0** (pp. 1-235), reprint of articles from the Special Issue published online in the open access journal Machines, MDPI, ISBN 978-3-0365-7717-3, e-ISBN 978-3-0365-7716-6.

Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Technical/Scientific Publications**, namely, with our collaboration:

  Papers

Patrício, L., Ávila, P., Varela, M. L. R., Romero, F., Putnik, G. D., Castro, H., & Fonseca, L. (2022) **Key Enabling Technologies, Methodologies, Frameworks, Tools and Techniques of Smart and Sustainable Systems**, *Smart and Sustainable Manufacturing Systems for Industry 4.0*, CRC Press, Taylor & Francis group, pp. 25-44.

Varela, L., Araújo, A., Ávila, P., Castro, H., Putnik, G. (2019) **Evaluation of the Relation Between Lean Manufacturing, Industry 4.0, and Sustainability**, *Sustainability*, Vol. 11, No. 5, Switzerland, ISSN 2071-1050.

Costa, J., Ávila, P., Bastos, J., Pinto-Ferreira, L. (2021) **A New Simple, Flexible and Low-Cost Machine Monitoring System**, *Dyna*, Vol. 96, No. 6, pp. 640-646, Emerald Insight. https://doi.org/10.6036/10075

Putnik, G., Ávila, P. (2021) **Manufacturing System and Enterprise Management for Industry 4.0** (Editorial), FME Transactions, Vol. 49, No. 4, pp. 769-772.

Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Technical/Scientific Publications**, namely, with our collaboration:

  Papers

Ávila, P., Pires, A., Putnik, G., Bastos, J., Cruz-Cunha, M. (2021) **Value Analysis as a Mechanism to Reduce the Complexity of the Selection of the Resources System for Agile/Virtual Enterprises in the Context of Industry 4.0**, *FME Transactions*, Vol. 49, No. 4, pp. 806-816.

Varela, L., Ávila, P., Castro, H., Putnik, G.D., Fonseca, L., Ferreira, L. (2022) **Manufacturing and Management Paradigms, Methods and Tools for Sustainable Industry 4.0 - Oriented Manufacturing Systems** (Editorial), *Sustainability*, MDPI, Vol. 14, 1574.

Castro, H., Costa, F., Ferreira, T., Ávila, P., Cruz-Cunha, M., Ferreira, L., Putnik, G., Bastos, J. (2023) **Data Science for Industry 4.0 and Sustainability: A survey and analysis based on Open Data**, *Machines*, Vol. 11, 452.

Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Technical/Scientific Publications**, namely, with our collaboration:

  Papers

  Carneiro, J.; Soares, M.; Esfandiari, P.; Silva, J.F.; Magalhães, A.G. (2022) **Production of Pre-Impregnated Thermoplastic Tapes by Melt Impregnation**. Mater. Proc., 8, 91.

  Esfandiari P, Silva JF, Novo PJ, Nunes JP, Marques AT. (2022) **Production and processing of pre-impregnated thermoplastic tapes by pultrusion and compression moulding**. Journal of Composite Materials. 56(11):1667-1676.

  Isidoro, J.; Póvoas, D.; Esfandiari, P.; Silva, J.F.; Magalhães, A.G. (2022) **Correlations between Process Parameters, Geometric Parameters and Microstructure of Fe-Co-Cr-Mo Parts Produced by 3DPMD**. Mater. Proc. 2022, 8, 85.

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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Technical/Scientific Projects** with companies and/or others Universities, namely some of them with our participation:
  - ADD.CompFiber (POCI-01-0247-FEDER-069603)

To develop an equipment that allows the deposition of continuous pre-impregnated fibers in thermoplastics on high-dimensional molding

Consortium

3 Polytechnic institutions:
- CDRSP – IPL
- ISEP
- ESTIA

2 Portuguese companies:
- VERSO MOVE (produto composito)
- DREAMPLAST (injecção)
- LCR (compostos)
- AGIX

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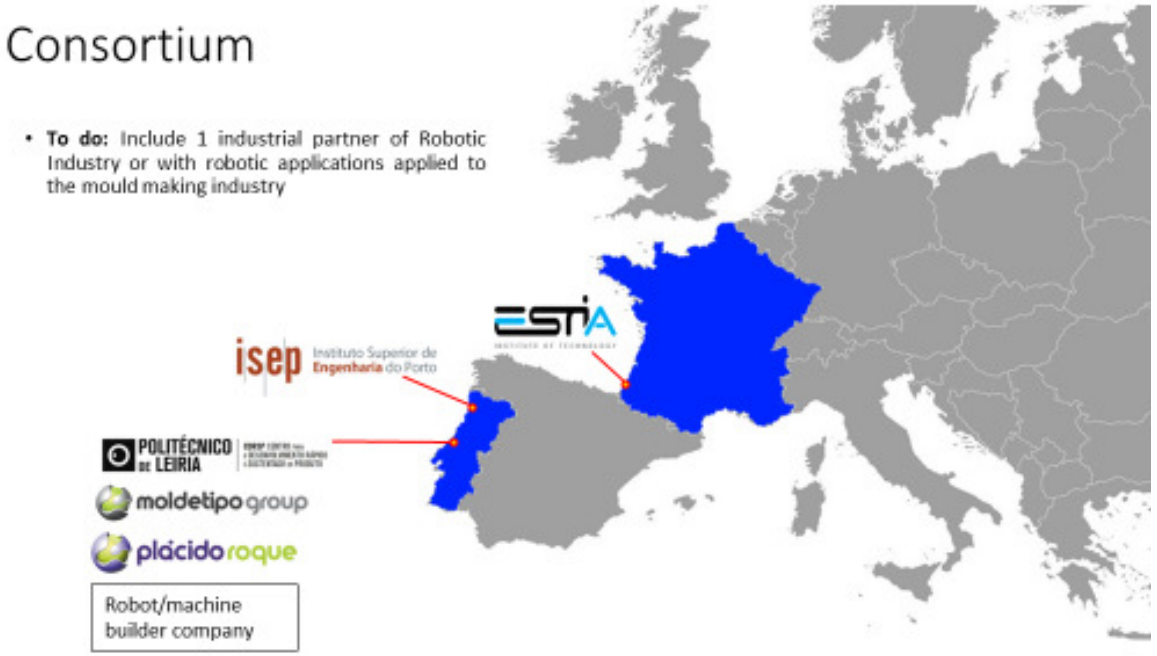
Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Technical/Scientific Projects** with companies and/or others Universities, namely some of them with our participation:
  - Metal.BOT (POCI-01-0247-FEDER-069600)

Molds repair for the automotive industry, using a robotic arm to probe defects in molds, and carry out the appropriate repair using metal additive manufacturing



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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

- **Technical/Scientific Projects** with companies and/or others Universities, namely some of them with our participation:
  - B_Remote - A NEW SIMPLE, FLEXIBLE AND LOW-COST MACHINE MONITORING SYSTEM

Partners

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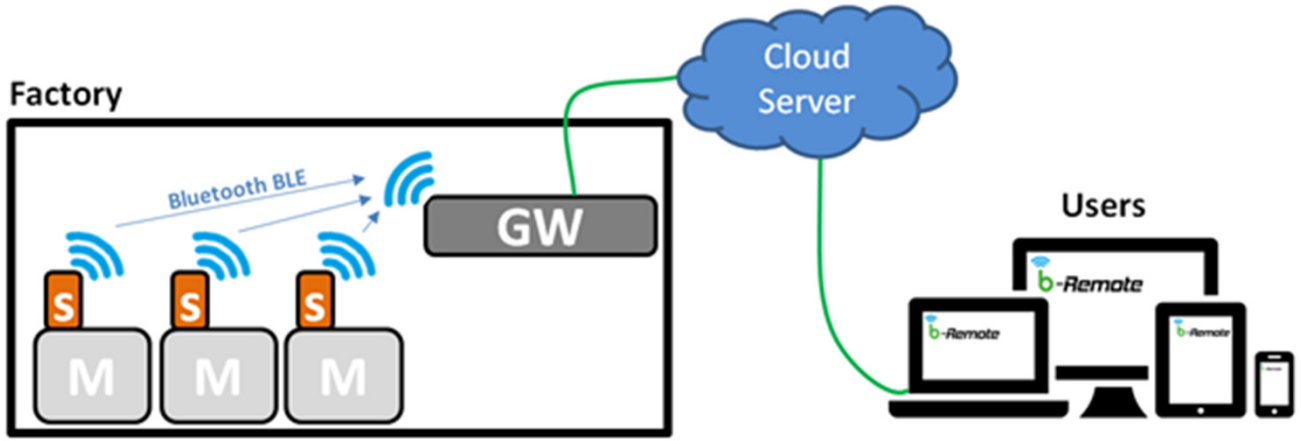
[IN²]
INNOVATOR_INSTITUT

opais



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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

PORTIC
PORTO
RESEARCH,
TECHNOLOGY
& INNOVATION
CENTER

P.PORTO

PORTIC

I4.0 Examples

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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

FERROVIA40

Project information

- **Name**: Research, Development and Demonstration of Advanced Solutions for Railway
- **Area**: Cybersecurity
- **Partners**: EFACEC (coordinator), PFP, Evoleo, ISQ, IP, NomadTech, AlmaDesign, PORTIC/P.PORTO and others.
- **Overall Budget**: 869355385 € (PORTIC: 37481 €)
- **Description**: The overall objective of the project is to develop different components, tools and systems, to be tested on rolling stock and real infrastructures. It is also the ambition of the project to ensure that cybersecurity technologies and methodologies are incorporated into the structure of information and communication technologies of the railway system, in order to avoid unwanted intrusions. The solutions devised are oriented towards the economic and ecological sustainability of the railway system, to reduce operating and maintenance costs; for reliable information systems to support decision-making in asset management and for the creation of security systems capable of monitoring the infrastructure

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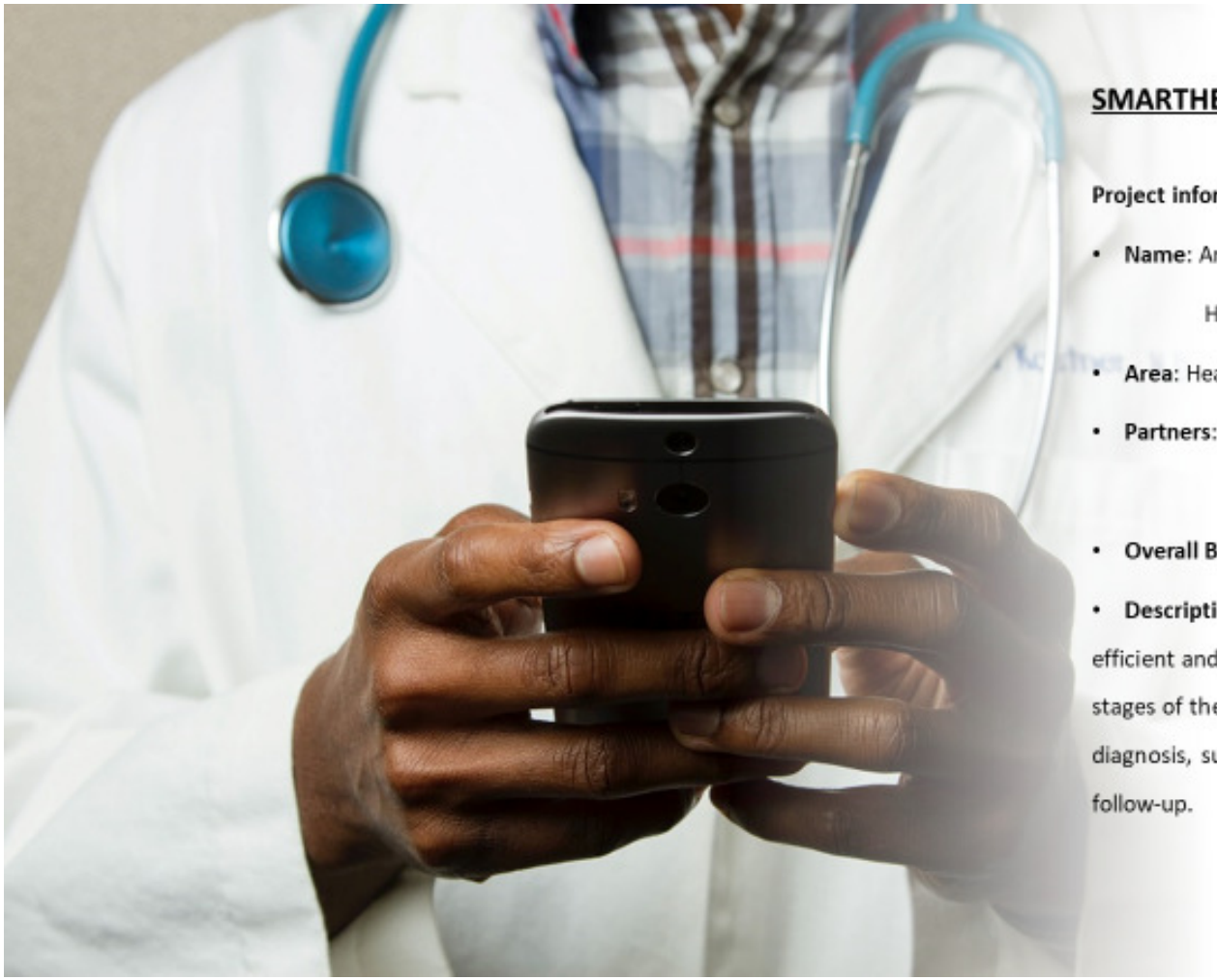

SMARTHEALTH

Project information

- **Name**: Artificial Intelligence for Personalized Lifelong Health Care
- **Area**: Health technologies
- **Partners**: IPCA (coordinator), PORTIC/P.PORTO, ISEP, IPB, IPVC
- **Overall Budget**: 1610812 € (PORTIC: 238458 €)
- **Description**: SmartHealthb intends to create new efficient and intelligent technologies to support different stages of the medical treatment, namely the prevention, diagnosis, surgical treatment, rehabilitation and patient follow-up.

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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

UoF – UNIVERSITIES OF THE FUTURE

Poject information

- **Name**: Universities of the Future
- **Area**: Industry 4.0
- **Status**: Closed
- **Partners**: PORTIC/P.PORTO (coordinator), IKEA, ANI, Aalto, Consair, TEK and others
- **Overall Budget**: 967010 € (PORTIC: 152925 €)
- **Background**:

By creating a community of practice, UoF will bring together actors from the quadruple helix (businesses, universities, public authorities and students) to address the existing gap in the current offer in Higher Education and co-create innovative and multidisciplinary solutions adjusted to the current and upcoming challenges of a digital era.

- **Description**:

The UoF is an Erasmus+ KA and addresses the gap between industries and higher education by developing new, innovative and multidisciplinary approaches to teaching and re-qualifying current workers. The University of the Future aims to stimulate entrepreneurship and digital skills of the teaching staff of higher education and the staff of the various companies facilitating the exchange, flow and co-creation of knowledge.

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Ways used to promote I4.0 by ISEP – Scholl of Engineering:

AI SMARTI

- **What:** AI AVATAR TRAINER (Real – Time Conversation)
- **GOAL**: To facilitate foreign language conversation practice for adults to progress from intermediate to advanced level safely.
- **HOW**
  - Recognize the users voice.
  - Focus in the “speach” problems:
    - Inhibition;
    - “Going Blank”;
    - Mixing with the mother tongue.
  - Create spontaneous, inlimited conversations for personalization of programs – feedback – progress reports.

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Thank you for your Attention!

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