About the Impact of European Academies of Engineering in European social, economic and technological development

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Dean of Engineering, University of Porto (2010-2014)

Head of the Chemical Engineering Department, University of Porto (2001-2010)

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To say what I am going to say

1. A few notes about the **Portuguese Academy of Engineering, Euro-CASE and SAPEA**
2. About Fundamentals of Science and **Scientific Fundamentals**
3. Life Today - "Quelques **Verités de La Palisse**"
4. **The future of Europe - cooperation,** using Euro-CASE as example
5. A few notes on **substance for research** - Chemical Engineering as Case Study
6. **Epilogue** - take home some ideas

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ACADEMY OF ENGINEERING, PORTUGAL
PRO HOMINIS DIGNITATE INGENIUM

- Founded in 1995
- Today, 151 Members – References of Portuguese Engineering
  - 3 Honorary Members
  - 76 Effective Members
  - 67 Emeritus Members(aged 76+)
  - 5 Corresponding Members
  - 67 Members in Perpetuum

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ACADEMY OF ENGINEERING, PORTUGAL
MEMBERS THAT ARE REFERENCES OF PORTUGUESE ENGINEERING, JUST TO NAME A FEW…

- Adélio Mendes – High level researcher and entrepreneur, Career Award Winner 2025
- António Costa Silva – former Minister of Industry
- António Guterres – General Secretary, United Nations
- Arlindo Oliveira – Former Dean of IST Lisbon, Specialist AI, Career Award Winner 2024
- Carlos Moedas – former EU Commissioner, currently Mayor of Lisbon
- Eduardo Marçal Grilo – former Minister of Education and Science (on the days of the launching of the Bologna Process)
- Elvira Fortunato – former Minister of Education and Science, high level researcher
- Maria da Graça Carvalho, former Minister of Education and Science, currently Minister of Energy and Environment
- Rodrigo Martins – EURASC President

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ACADEMY OF ENGINEERING, PORTUGAL MISSION

- To contribute to the valorization of Engineering in Society and to encourage the development of research
- To promote cooperation in the field of Engineering in Portugal, the European Union and other countries
- To advise Government bodies, whenever requested to do so
- To cooperate with Euro-Case (European Council of Academies of Applied Sciences, Technologies and Engineering), the Portuguese Academy of Sciences and other similar academies;
- To cooperate with the Professional Association of Engineers (Ordem dos Engenheiros), with a view to the enhancement and development of Engineering and the profession of Engineer;
- To serve the country in other aspects related to important issues in the field of Engineering and Technology;
- To recognize contributions of great merit rendered to the country.....

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ABOUT EURO-CASE AND SAPEA (SCIENCE ADVICE FOR POLICY BY EUROPEAN ACADEMIES) – (I)

- Euro-CASE represents the European Academies of Engineering Sciences and was founded in 1992 in Paris.
- It is an independent non-profit organisation of national academies of engineering and technologies from 22 European countries.
- Through its Member academies, Euro-CASE has access to top European expertise from over 6,000 experts and engages stakeholders such as European Institutions, national Governments, companies and private organisations to enrich the debate on the benefits of technological progress, in a balanced and equitable manner.
- Euro-CASE also provides impartial, independent and balanced advice on technological issues with a clear European dimension, and along with other Academy networks Euro-CASE delivers evidence-based advice to policy makers and society.
- The aim of Euro-CASE is to foster European excellence in technology and engineering, sciences and practice, for the benefit of European Society.

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ABOUT EURO-CASE AND SAPEA – (II)

- The SAPEA project is part of the European Scientific Advisory Mechanism and is funded by the European Union
- SAPEA is a consortium of networks of Academies, including the Euro-CASE Network, through which it brings together knowledge from the natural sciences, engineering and technology, medicine, health, agricultural and social sciences, and the humanities.
- SAPEA is based on and articulates with more than a hundred academies, youth academies and scientific societies in more than 40 countries across Europe.
- The Scientific Advisory Mechanism provides independent scientific evidence and policy recommendations to the European institutions, at the request of the College of Commissioners, with the aim of supporting their decision-making.
- SAPEA also works to increase the awareness of the relevance of advice and scientific evidence in policy-making and to stimulate debate in Europe on these issues.

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JUST AN EXAMPLE OF A RECENT (RELEVANT) STUDY, APRIL 2024

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FUNDAMENTALS OF SCIENCE AND SCIENTIFIC FUNDAMENTALS

- A discussion that could lead us through several academic stimulating routes
  - Scientific Method – how to conduct scientific work; Theory and Experiment ("measure what is measurable and make measurable what is not so", Galileo Galilei…)
  - Major scientific concepts – the Atomic Theory; the Periodic Law, The Big Bang Theory… the Evolution…
  - The Tenets of Science – objectivity, replicability, curiosity, scientific method for evidence-based…
  - …….
  - **Basic Sciences and Disciplines**

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FUNDAMENTAL SCIENTIFIC AREAS/DISCIPLINES - A BROAD VIEW

- Transversal Formal Disciplines
  - Mathematics; Statistics; Logic / Reasoning (globally Philosophy); Today – Computer Science, AI wide issues
- Natural Sciences
  - Physics; Chemistry; Biology; Earth Sciences; Astronomy
- Complementary Major Areas and Disciplines
  - Social Sciences, namely Psychology, Sociology, Anthropology and Economics
  - Applied Sciences, namely Engineering and Medicine
- A most relevant fact
  - The great advances in our World, possibly coming or apparently coming from the Applied Sciences are completely supported by the KNOWLEDGE RELATED TO, OUR COMING FROM, THE FUNDAMENTALS

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- Eh bien, et dans la suite, je vous laisse avec quelques diapositives qui sont en effet des Vrais Vérités de La Palisse, mais qu'il est important de garder en tête

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STATING THE CASE - DRIVING FORCES OF CHANGE THAT WE ALL FEEL, IN EUROPE AND AROUND THE WORLD

- Last quarter of the XX century - intense search for new paths in the world, motivated by
- Developments and progress in Science and Technology, namely -
  - In digital systems and communications
  - In the Health and Life Sciences
- Important political changes in Europe - the fall of the Berlin Wall on 9 November 1989
- Expectations and requirements of modern society
  - Education for all - UNESCO's cry
  - Quality requirements - the 'Comfort Society'

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STATING THE CASE - LIFE TODAY

- The Age of Computers and Communications – Dramatic Changes in the Concepts of Time and Space – Globalization
- Increasing life expectancy – the problem of the sustainability of the Social System
- The half-life of knowledge has decreased drastically – back to School
- Economy and Market Rules: Driving Forces of Today's Society
- Exponential increase in quality requirements and competitiveness – both in Europe and globally
  - ✓ The emergence of the Dragon and the Asian Tigers
  - ✓ Opportunities in the labour market – Open like never before
- Evolution of individual professional management concepts

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STATING THE CASE - NEW PARADIGMS

- With digital and transportation evolution, the world is effectively 'shrinking'
- A global world that lives with and within a new paradigm of coexistence
  - COOPETITION = COOPERATION + COMPETITION
- The need to understand other cultures and ways of life
- The need to THINK GLOBAL, especially in large companies – think 24/7 – when Asia goes to sleep we get to work, when we go to sleep America does its job
- The need to promote mobility and cooperation, promote TRUST
  - Through quality systems recognized and accepted by stakeholders

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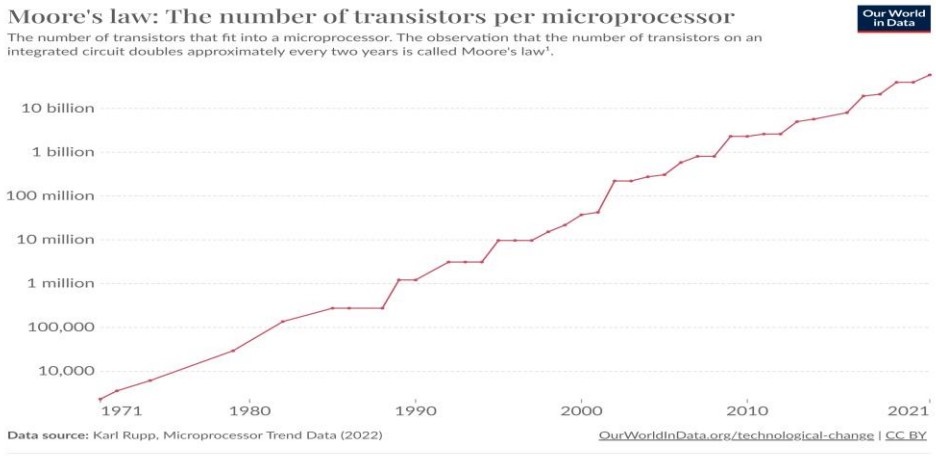
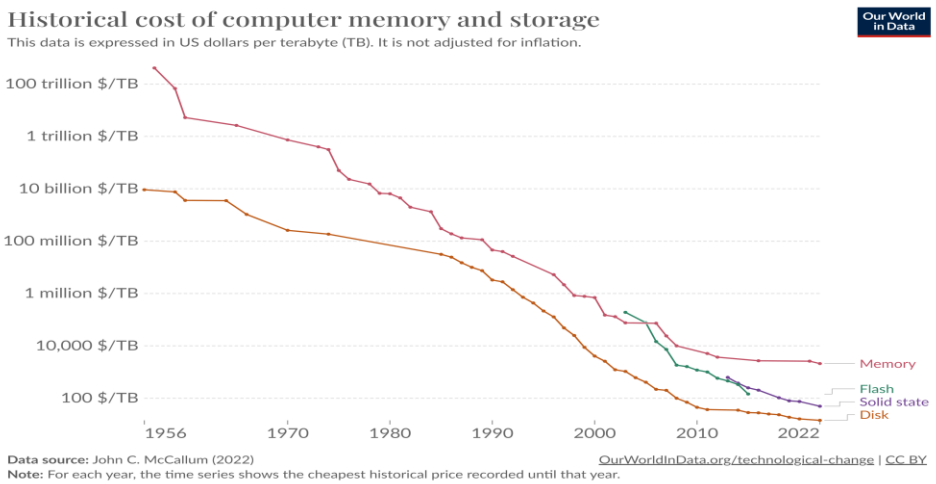
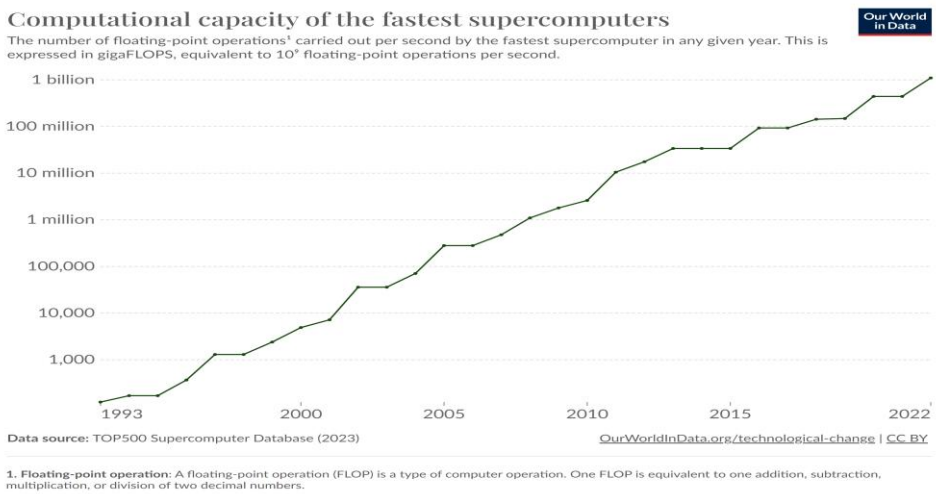
INDICATORS OF THE FOURTH INDUSTRIAL REVOLUTION - I



INDICATORS OF THE FOURTH INDUSTRIAL REVOLUTION - II



INDICATORS OF THE FOURTH INDUSTRIAL REVOLUTION - III



AND A PROVOCATION
LIFE IN 2100 - UNDER THE UMBRELA OF ARTIFICIAL INTELLIGENCE

The Guardian, 6 September, 2019

OUR BIG PROBLEMS TODAY
A SUGGESTIVE PICTURE OF EUROPE'S CHALLENGES

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THE FUTURE OF THIS LAND OF SMALLHOLDINGS (MINIFUNDIOS)

- ☞ **European Cooperation is the (only) way forward – in education, in research…. in all areas**
  - ➢ **Cohesion through Cooperation**
  - ➢ **Cooperation through TRUST**
  - ➢ **TRUST through quality assurance**
  - ➢ **The Bologna Process is related to and had as objective to address this concern**
    - ✓ **The EHEA – European Higher Education Area**
    - ✓ **The ERA – European Research Area**

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ACADEMY OF ENGINEERING, PORTUGAL
PRIORITY OF COOPERATION WITHIN EURO-CASE

- For the Academy of Engineering Portugal, cooperation with Euro-CASE, and at European Level through SAPEA, is on top of our priorities – in Working Groups, supporting initiatives…
  - Advising about policies concerning AI
  - Being active in the WG on Critical Raw Materials
  - Promoting reflection and public policies concerning toxic PFAs - Perfluoroalkyl and Polyfluoroalkyl Substances
  - Participating in efforts to build an European Innovation Platform, promoting entrepreneurship
  - Being available to participate in the new Working Group "Soils: Synergizing Climate Protection and Climate Adaptation"
  - ….

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A FEW BRIEF NOTES ON SUBSTANCE FOR RESEARCH
SETTING THE SCENE

- How do we expect industry/research to evolve in the next… twenty-five years?
  - Think of developments between the seventies and this century… and between 2008 and today…
- The role of traditional core areas of expertise, necessarily augmented and in articulation with new expertises…
- And, no doubt, education to pave the way and strengthen the research of the future
  - ….

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A FEW BRIEF NOTES ON SUBSTANCE FOR RESEARCH
CASE STUDY OF RELEVANT FIELDS IN CHEMICAL ENGINEERING

- Energy
- Biotechnologies – namely, but not only, Health related
- Computing and Big Data
- Processing and products – science, manufacturing and sustainability
- Education objectives and approaches

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A FEW BRIEF NOTES ON SUBSTANCE FOR RESEARCH
ENERGY

- Coal for fuel will keep decreasing (fast)
- Abundant natural gas… BUT
- Point for the emerging renewable energy - price of electricity being generated from solar energy is now lower than that of other forms of electricity generation
- Significant attention to the storage of electric energy
- Future need for electric grids with much greater penetration of cheap renewable (and variable) sources
- **Need to look beyond lithium – a wide field of research**

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A FEW BRIEF NOTES ON SUBSTANCE FOR RESEARCH
BIOTECHNOLOGIES – NAMELY, BUT NOT ONLY, HEALTH RELATED

- Major progress over the past 15 years
  - CRISPR/Cas9/Cas12 tools for gene editing
  - Affordable, practical gene analyses
  - Data science and informatics
- Hybrid modelling and approaches for complex processes – First-principles and mechanism-based thinking + Statistical data mining and other Big Data approaches
- Future – Synthetic biology (?) + improved modelling of systems biology and systems pharmacology

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A FEW BRIEF NOTES ON SUBSTANCE FOR RESEARCH COMPUTING AND BIG DATA

- In 1973, Slide Rule, not even pocket calculators!
- XXI Century – Artificial Intelligence, with major impact in all areas
  - Modelling of complex systems
  - Data Analytics – dramatic impact on many aspects of Chemical Engineering – material discovery, process design, process operations, supply chain management
  - Process monitoring – Sensors, namely Software Sensors
- Computational science already plays a major role in CE… in fact in all areas

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ACADEMIC RECOGNITION OF THE NEED TO MAINTAIN FUNDAMENTAL SCIENCE IN THE CORE CURRICULUM IN ENGINEERING EDUCATION - I

- European Working Groups (Parties) on Education and Research generally fully recognize fundamental sciences as foundation for knowledge and development
- The Reference Text of the Working Party on Education, European Federation of Chemical Engineering –
  - EFCE Bologna Recommendations 2020 highlight as core curriculum:
    - ✓ Basic sciences, enlarged with life sciences
    - ✓ Chemical engineering sciences
    - ✓ Chemical engineering core - with engineering design, with a dissertation for training R&D&I and with diverse profiles through electives and external training

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ACADEMIC RECOGNITION OF THE NEED TO MAINTAIN FUNDAMENTAL SCIENCE IN THE CORE CURRICULUM IN ENGINEERING EDUCATION - II

- BUT… comparing these Recommendations with those published in 2010, it is most relevant to note that the Working Party recognized the need to adapt to the times
- Fundamentals are all relevant in a different paradigm that includes specialization, such as –
  - Interdisciplinarity with other disciplines
  - Strengthening Systems Biology
  - Bringing in Analytics and Machine Learning; Nano Engineering; Sustainability; Ethics; Entrepreneurship; Globalization; 3-D printing....

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EPILOGUE - TAKE HOME SOME IDEAS

- Fundamental Science is, clearly, key to the sustainable and fair development of Humanity
- Scientific development of a Country is totally related to its competitive capacity in this Global World, as it is closely related to the well being of its people
- Europe must proceed with policies of cooperation to strengthen the European Research Area in key subjects for development
- This necessary increase of cooperation is clearly linked, for social, economic and political reasons, to the necessary promotion of valuation of knowledge
- Cooperation with Industry, with the productive market of tradable goods, is absolutely necessary
- **And… YES, European Academies are most suitable forms of association and of networking to lead Europe on the path of progress that we all desire**

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Many thanks for the attention you cared to pay to this talk