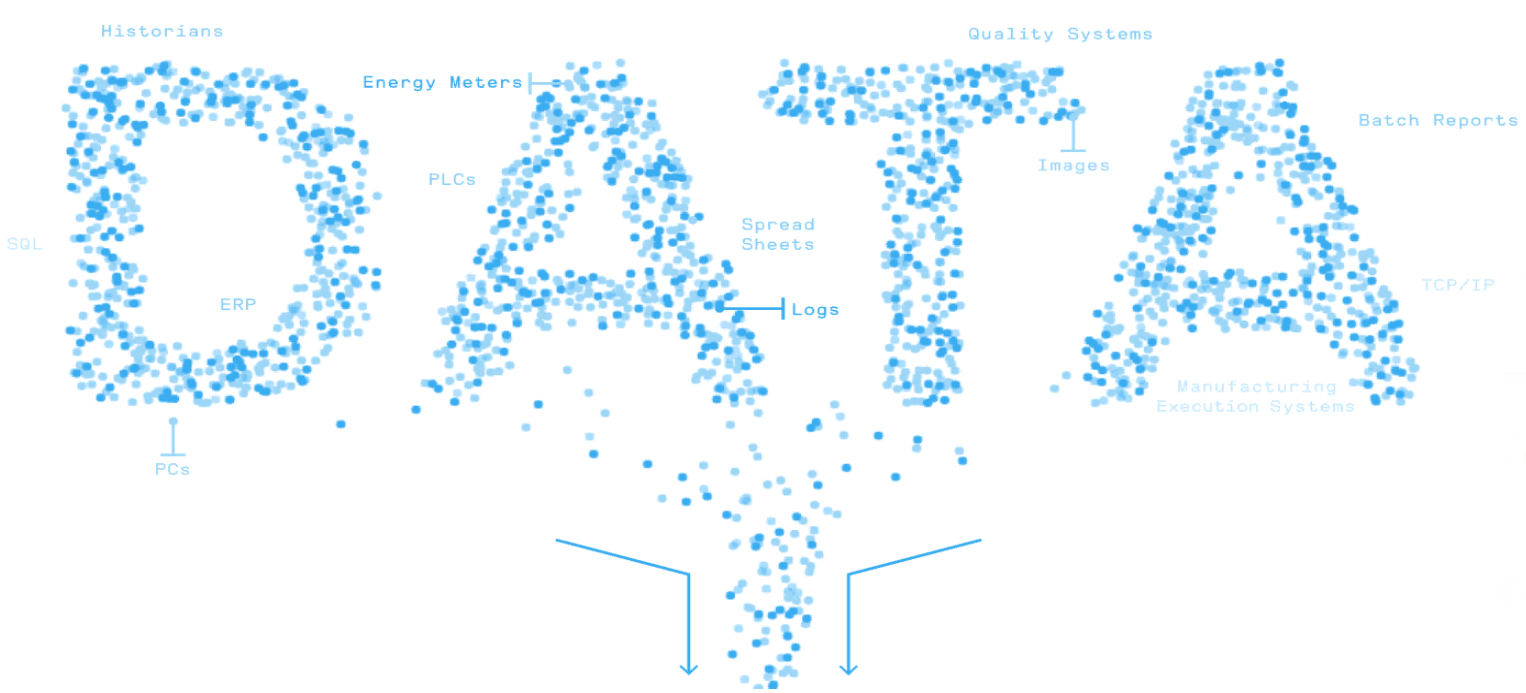

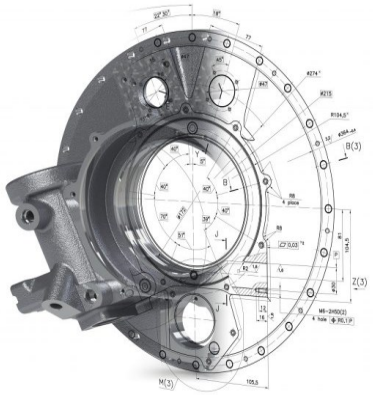

What is Industry 4.0?

- An Introduction to Industry 4.0

Dr Leo Chen

leo.chen@ieee.org

07/Jun/2020

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- Traditional vs Digital Manufacturing
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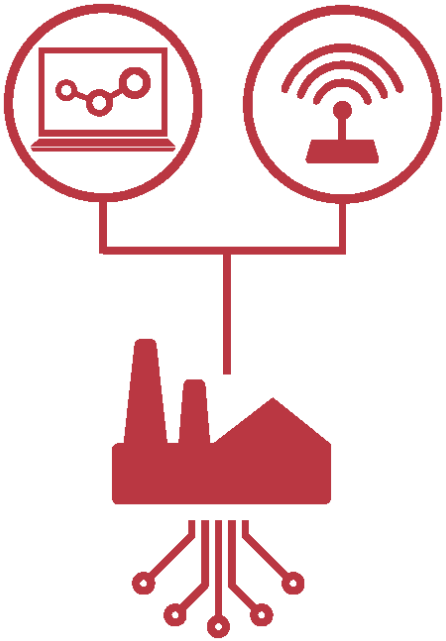

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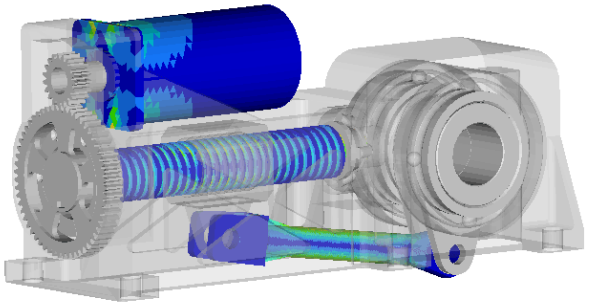
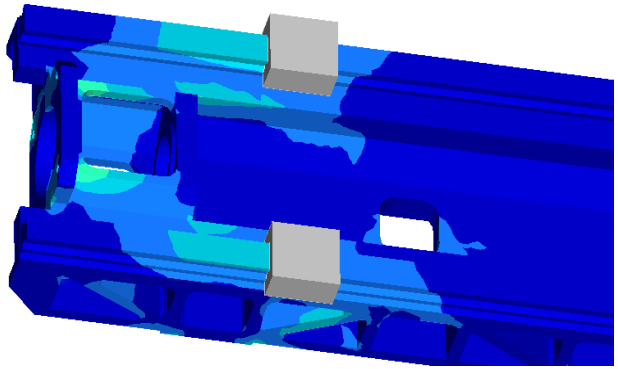
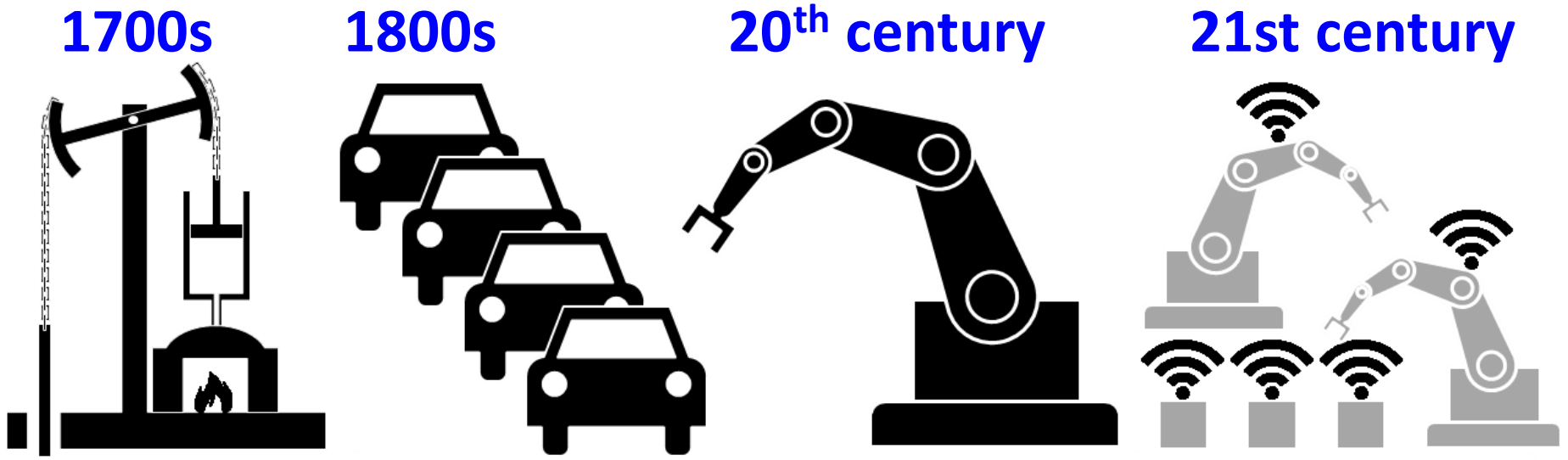




What is industry 4.0

Industry 4.0 (**i4**) is commonly referred to as **the fourth industrial revolution (4IR)**[1]



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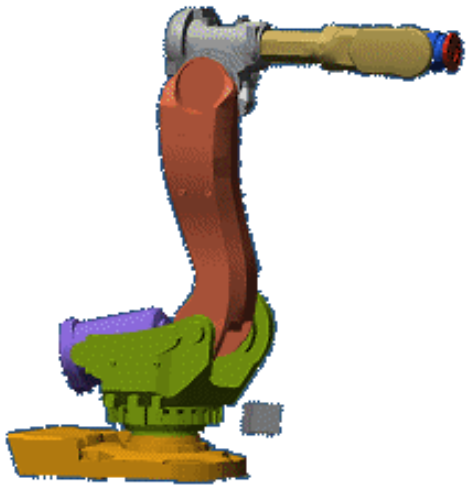
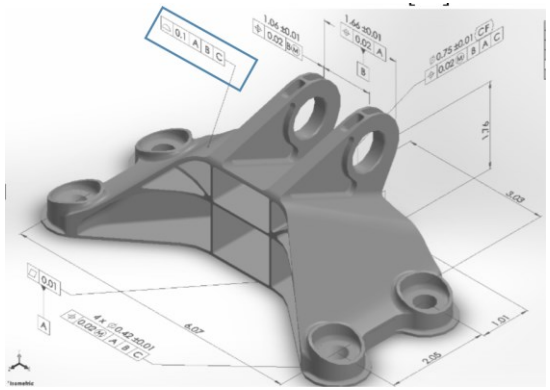
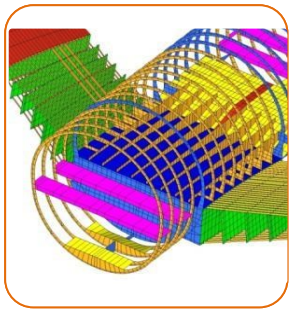


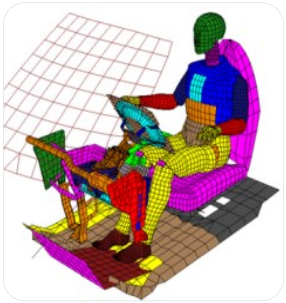
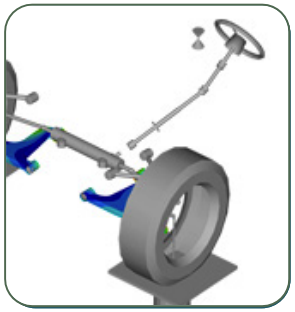
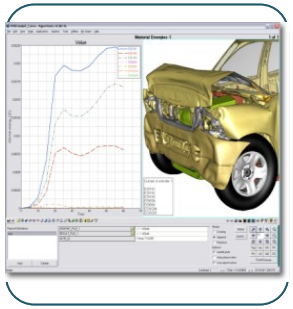
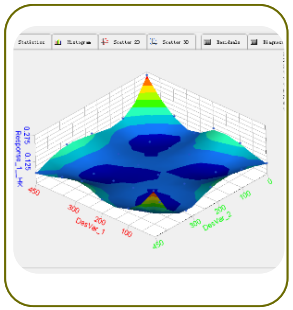
Basic Steps

Basically, 4IR can be summarised as the following steps:

1. **Virtual Prototype** (e.g. Digital Design)
2. **Digital Manufacturing**
3. **Physical Prototype** or Products
4. **Intelligent Service (**e.g. Product Lifecycle Management**)**





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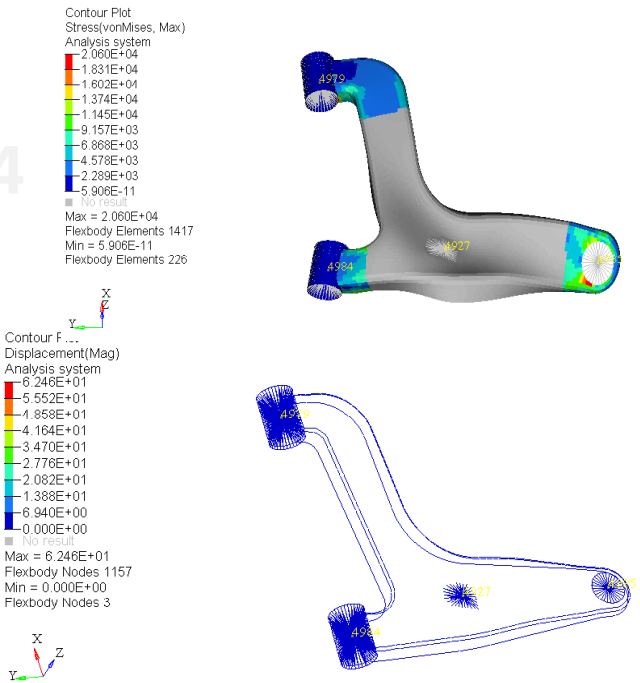


Traditional vs Digital Manufacturing

Traditional

2D Prints are made manually

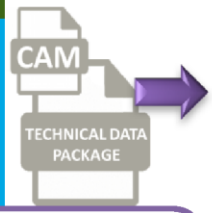
Prototype is constructed based on 2D prints

Testing takes place

Review and redesign

Generated data is stored physically

Digital

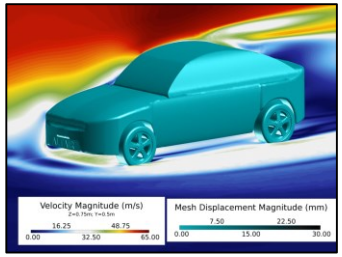


3D Model is created

Part is simulated in digital environment

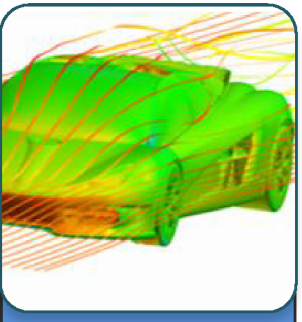
Part is optimized digitally

Generated data is stored digitally

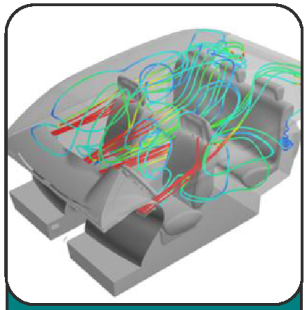


The Evolution of the Playstation Controller

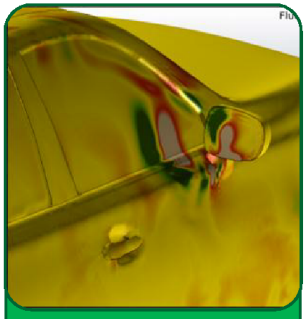
The Evolution of the Xbox Controller



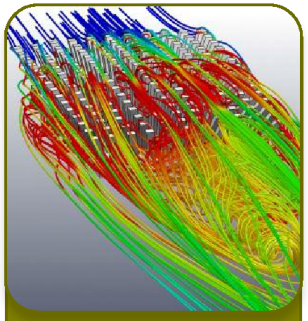
Aerodynamics



Thermal Management

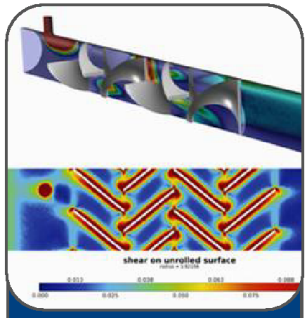


Computational Aero-acoustics



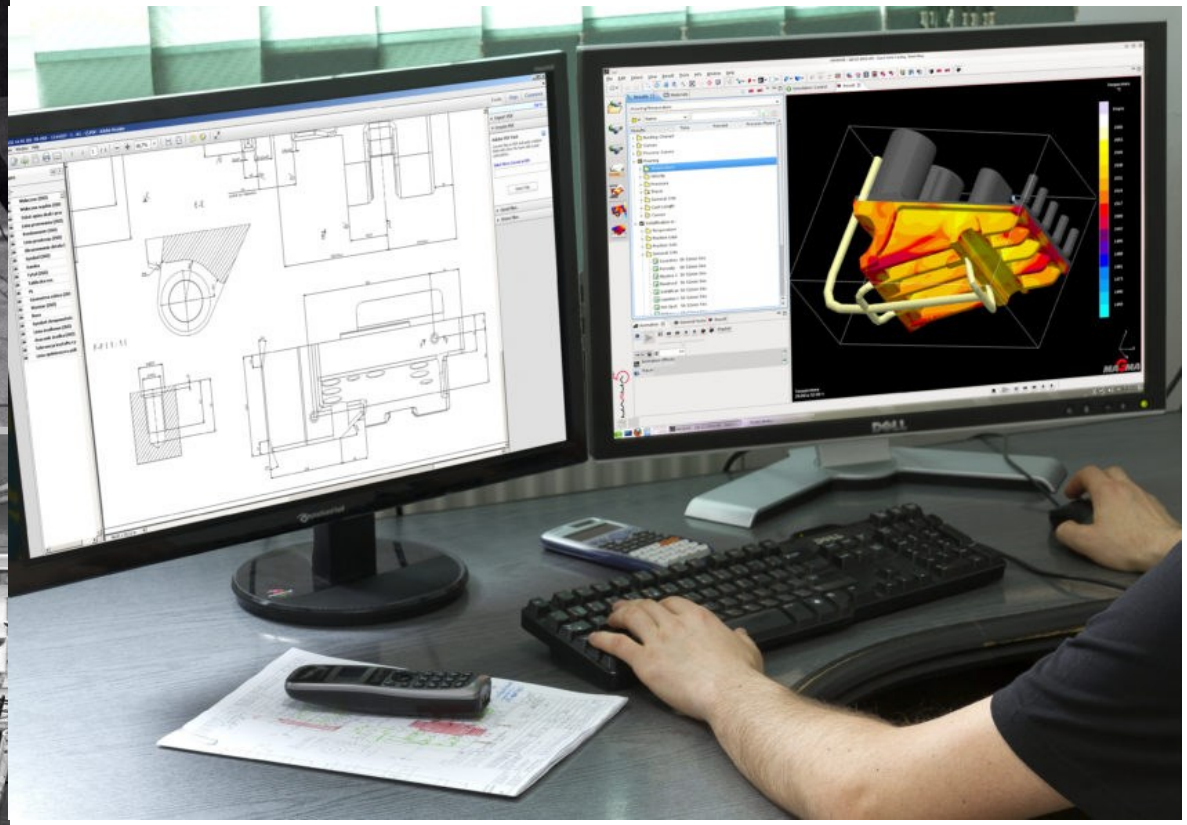
Electronic Cooling

Fluid-Structure Interaction



Non-Newtonian Flow Simulation

Traditional Design vs Digital Design



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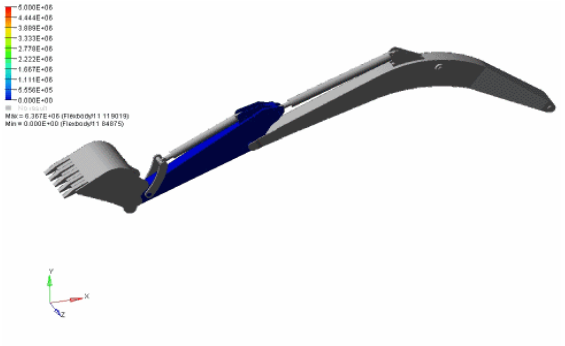
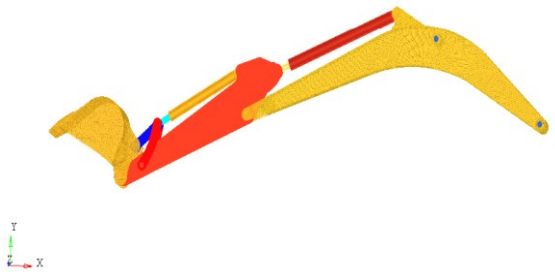
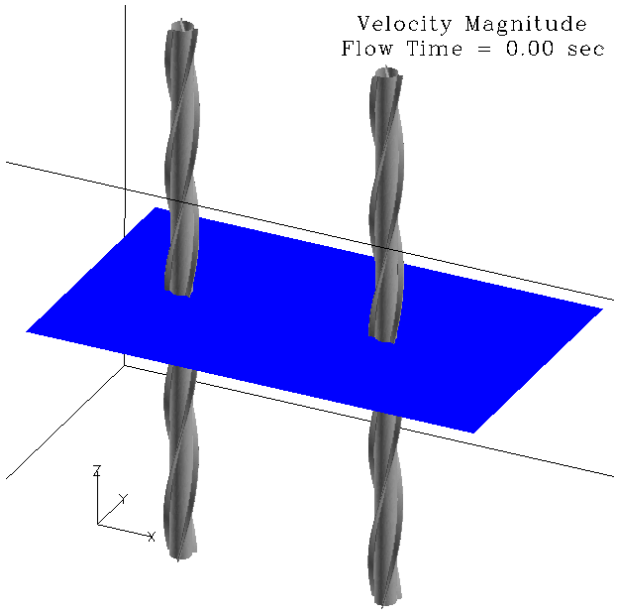




Key Benefits

- **Fast** Production
- **High Performing** Prototypes and Productivity
- **Real-time** Inventory Monitoring
- **Cost** Reduction
- Close-to-reality **Testing**
- **Market** Success **Predictability**



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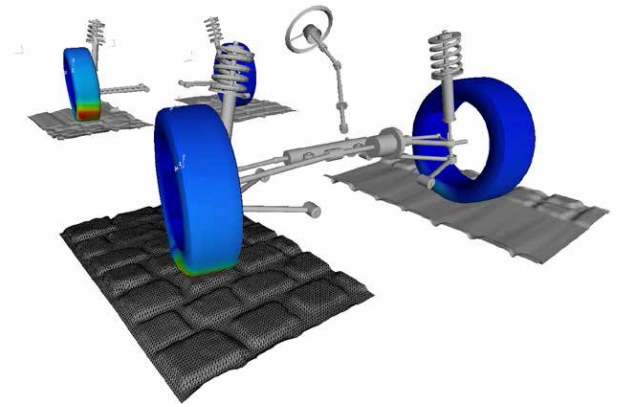

Supporting Technologies for I4

- Cyber-physical Systems (**CPS**)
- Internet of Things (**IoT**)
- **Big Data/Cloud**
- **Digital Twins**[3]

digital twin is a **real-time mapping** of all **components** in the product life cycle using **physical** data, **virtual** data and **interaction data** between them

- Artificial Intelligence (**AI**)
- High Performance Computing (**HPC**)
- **5G** Communication
- Virtual Reality (**VR**) and Augmented Reality (**AR**)

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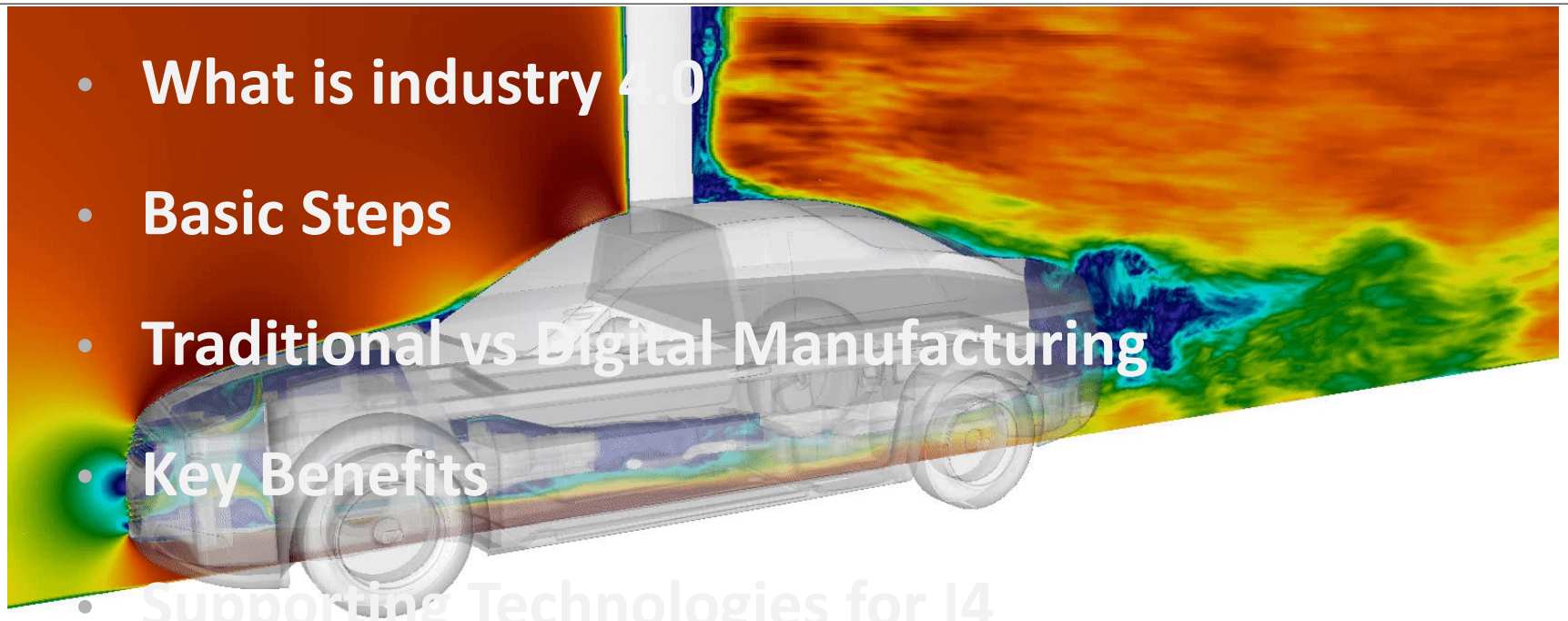

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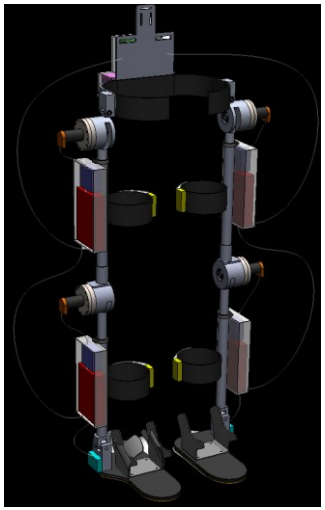
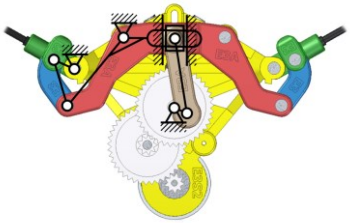
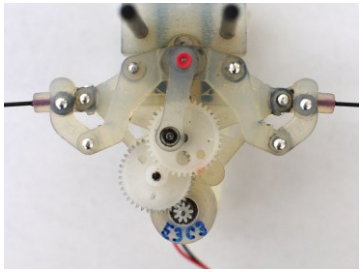
Tutorials and Courseworks

- **Tutorials**
- **Courseworks:** Intelligent Design for Robotics (**3** Case Studies)
  - **Virtual** Prototype (CAD Tools, Solideworks, Ansys, etc.,)
  - **Physical** Prototyping (3D Printing)







1 Exoskeleton **2** MAV **3** Social Service (CAD)

Courseworks

Students Coursework Guide

An Introduction to Industry 4.0

(3 Case Studies)

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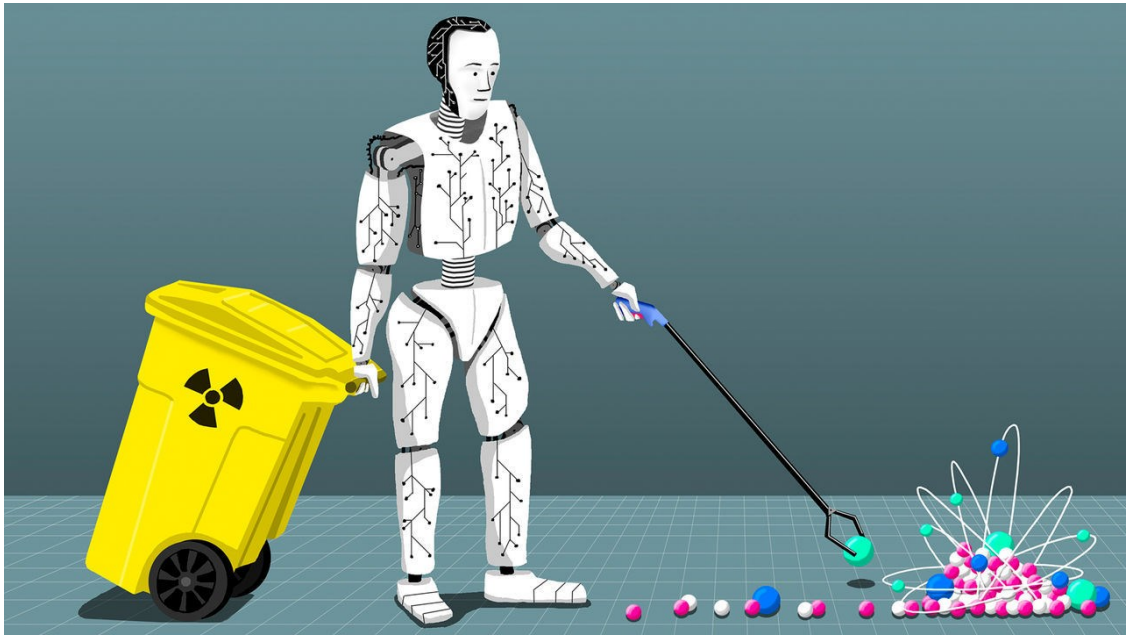

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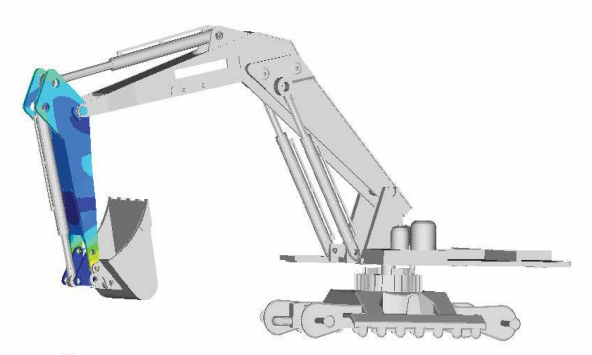


Reference

[1] https://en.wikipedia.org/wiki/Industry_4.0

[2] https://www.industryweek.com/technology/digital-manufacturing-factory-future-here-today

[3] https://en.wikipedia.org/wiki/Digital_twin

MANUFACTURING THE FUTURE

"And now think of where we need to go; an economy based not on consumption and debt but on savings and investment; not on government spending but on entrepreneurial dynamism; not on one industry in one corner of the country, but on all our businesses in all our regions, with a new emphasis on manufacturing, exports and trade." — *David Cameron, Prime Minister*

£1.2 billion
EPSRC portfolio relevant to manufacturing research

£381 million
investment by EPSRC's Manufacturing the Future theme

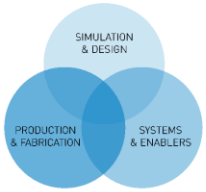
344
research grants supported

1,104
collaborating organisations contributing a further £162 million

£3.4 billion
overseas funding for R&D in the UK in 2009

2000
doctoral students

£400 million
investment planned to 2015



"EPSRC builds an intellectual powerhouse for manufacturing wealth"
—The Manufacturer, May 2011

EPSRC invests in the cutting-edge manufacturing research, and the highly-skilled people that will ensure that growth.

We have a portfolio of 350 live projects an investment of £380 million. 1100 companies work with our researchers adding a further £162 million. We support over 2000 doctoral students many of whom work on industrially related projects.

Modern Manufacturing

Manufacturing is:

- **Vital** to many industrial sectors, including aerospace, automotive & transport, pharmaceuticals, electronics, bulk materials, food & drink, fast-moving consumer goods, and construction.
- **More than production**. It is R&D, design, prototyping, production, distribution, service and support provision, and end-of-life repair, recycle or reuse. Value can be extracted from each stage of the process.[1]
- **Differentiated**. High or low volumes, long or short life-cycle, mass-market or customized production.
- **Highly-skilled**. It involves the inter-play of novel technologies, in-line analysis, dual working of people and automated systems, and precision engineered products and systems.

UK Manufacturing

Manufacturing is a key component of the *Government's Plan for Growth*,[2] as outlined in the *Growth Review Framework* for Manufacturing.[3] Manufacturing comprises 13% of the UK economy. The UK is the world's seventh-largest manufacturer, with manufacturing providing just over 50% of the UK's exports.[4]

Drivers for Global Manufacturing

The UK is not alone in placing increased emphasis on the importance of advanced manufacturing. Our international peers, including the US, Germany, Japan and China, are revitalising and focusing their research base on areas that enhance economic competitiveness.

The drivers include:

- Technological Change – high-value manufacturing processes are increasingly moving towards flexible, intelligent production systems that use advanced materials, incorporate modern ICT, require skilled technical knowledge, and co-located human and automated systems.
- Material and Energy Security – availability or scarcity of key material or energy resources is a competitive issue, driving investigation into alternative production routes for new and established products and processes.

INNOVATIVE MANUFACTURING RESEARCH CENTRES

Evolving from the EPSRC Innovative Manufacturing Initiative of the 1990s, the Innovative Manufacturing Research Centre (IMRC) portfolio comprised eighteen separate centres, largely based at single universities, each addressing a series of manufacturing challenges. A total EPSRC investment of £192 million was supplemented by £207 million of industrial support from over 700 collaborators. The IMRC programme has created over 1,300 doctoral level manufacturing engineers to support UK industry. An investigation of the economic impact of 10% of the IMRC programme (32 separate case studies) showed that this IMRC work had generated;

- £70 million of additional sales for industrial partners
- Cost-savings of at least £17 million to the public sector, and £10 million to the private sector
- 20 new technologies and products brought to market

Available:

[1] https://github.com/LeoYiChen/Industry4.0-An-Introduction

INDUSTRY4.0

AUTOMATION

CONNECTION

CLOUD COMPUTING

IOT

BIG DATA

SYSTEM INTEGRATION