University of BRISTOL

Department of Mechanical Engineering

VIRTUAL PRODUCT DEVELOPMENT (MENGM6049) - Lecture 1 Introduction to VPD & PLM

2017-2018

Dr Kazem Alemzadeh

The Purpose of the Lecture

- Introduction to Product Lifecycle Management (PLM).
- Introduction to manufacturing strategies such as CIMS for PLM integration.
- Virtual Product Development (VPD) or Integrated CAD/CAM or Digital Manufacturing
- The User Groups in VPD such as CAD, CAM & CAE & its Benefits.
- Examples of Complex Engineering & Bio-inspired Products.
- PLM Industrial Example: Through-life Engineering Services (TES).
- TES & its Applications in Renewable Energy.

Intended Learning Outcomes

After taking the unit the students would be able to:

1. Draw, manipulate and analyse advanced engineering curves including splines and Bezier curves on a Computer Aided Design system.

2. Create a machining process plan for a part and perform virtual machining of the product based on this process plan on a Computer Aided Manufacturing system.

3. Design and optimise a mechanical product from concept to full digital prototype in an integrated Product Lifecycle Management environment.

Å To complement the unit, 9 lectures with a series of laboratories (24 hours) are provided to support the unit.

Unit – Supporting Lectures

- Lecture 0 Introduction to coursework/assignment;
- Lecture 1 Introduction to VPD and PLM.
- Lecture 2 CAD Overview & Intro. to Engineering Curve.
- Lecture 3 Reverse Engineering.
- Lecture 4 Curve Analysis.
- Lecture 5 Interrogation of Solids.
- Lecture 6 Design for Machining & CNC Machining.
- Lecture 7 Process Planning for Machining.
- Lecture 8 Virtual Machining.
- Lecture 9 Iterative design, analysis and Optimisation in PLM.

Product Lifecycle Management (PLM)

Introduction

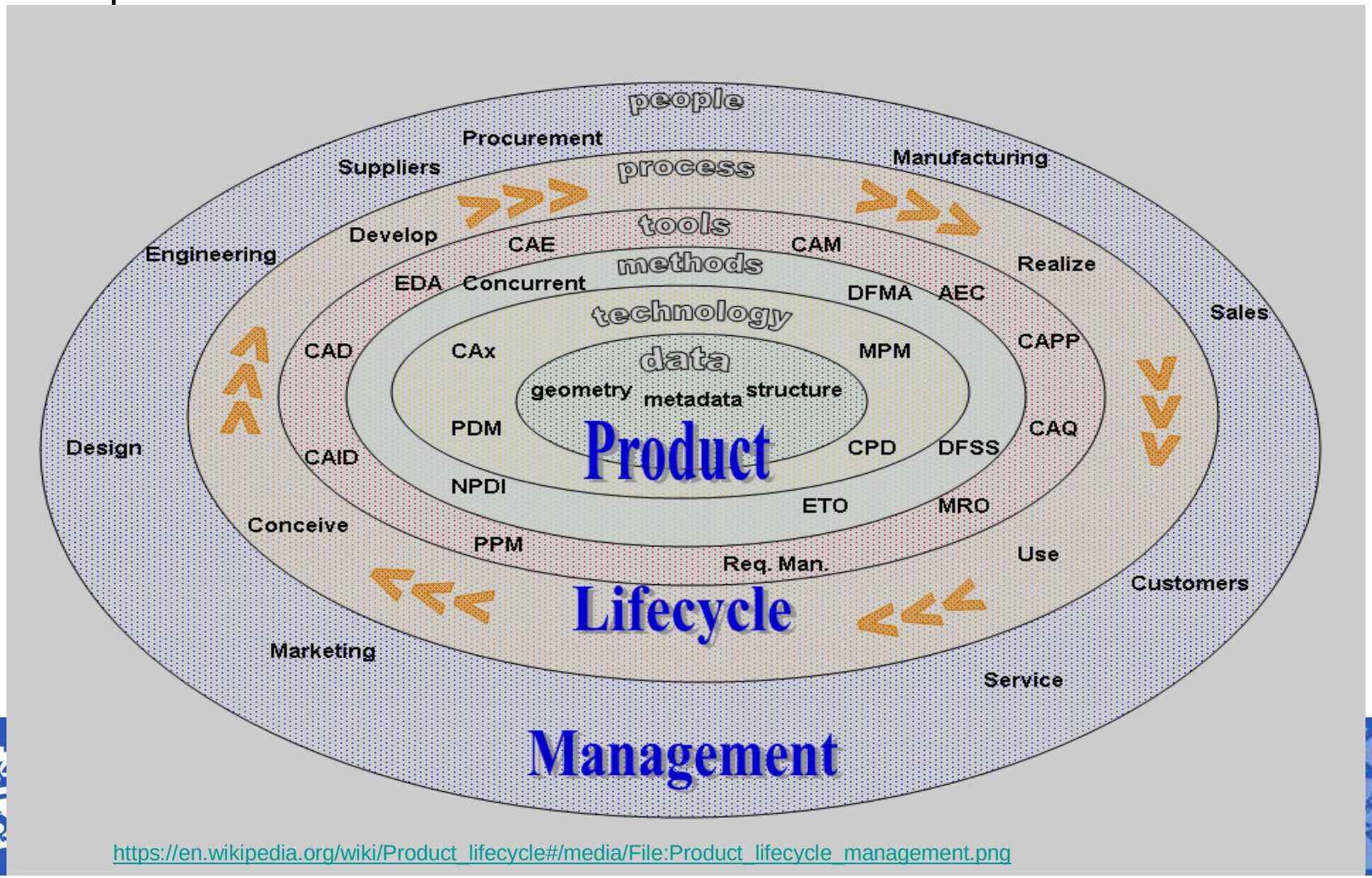
- PLM is an information management system that integrates all the design and manufacturing activities of a company to bring a product from concept through manufacturing to the end of its life. (from concept planning to production and support)

https://www.plm.automation.siemens.com/en_gb/

Product Lifecycle Management (PLM)

Introduction

- The PLM allows fast and efficient use of people, processes, tools, methods and technology to develop new products for the global competitive markets.

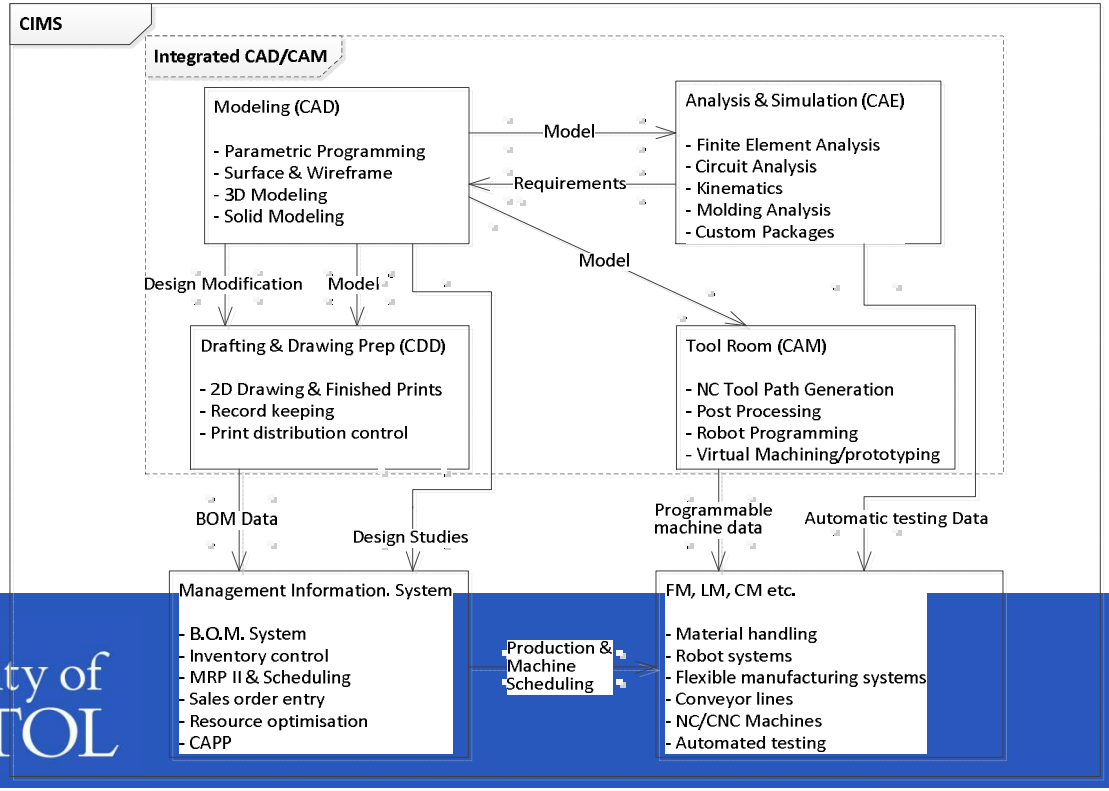


https://en.wikipedia.org/wiki/Product_lifecycle#/media/File:Product_lifecycle_management.png

Product Lifecycle Management (PLM)

Introduction

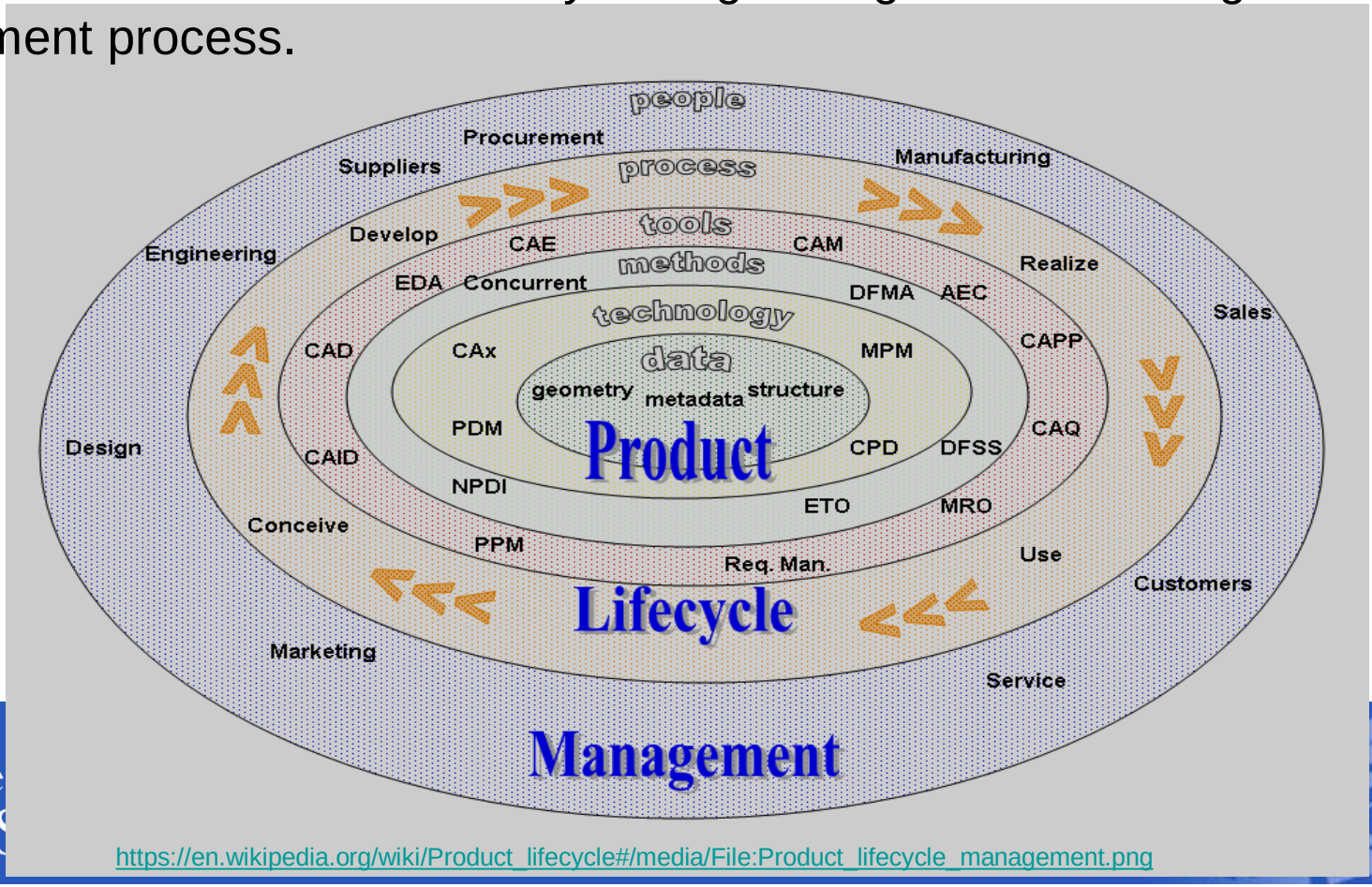
- The PLM helps automation of the entire production process more efficiently through manufacturing strategies such as Computer-Integrated Manufacturing Systems (CIMS) for accelerating a new product development.
- CIMS integrates engineering tools such as CAD, CAM, CAE with management, production planning and machine shop control activities to form a single engineering design information database.



Product Lifecycle Management (PLM)

Introduction

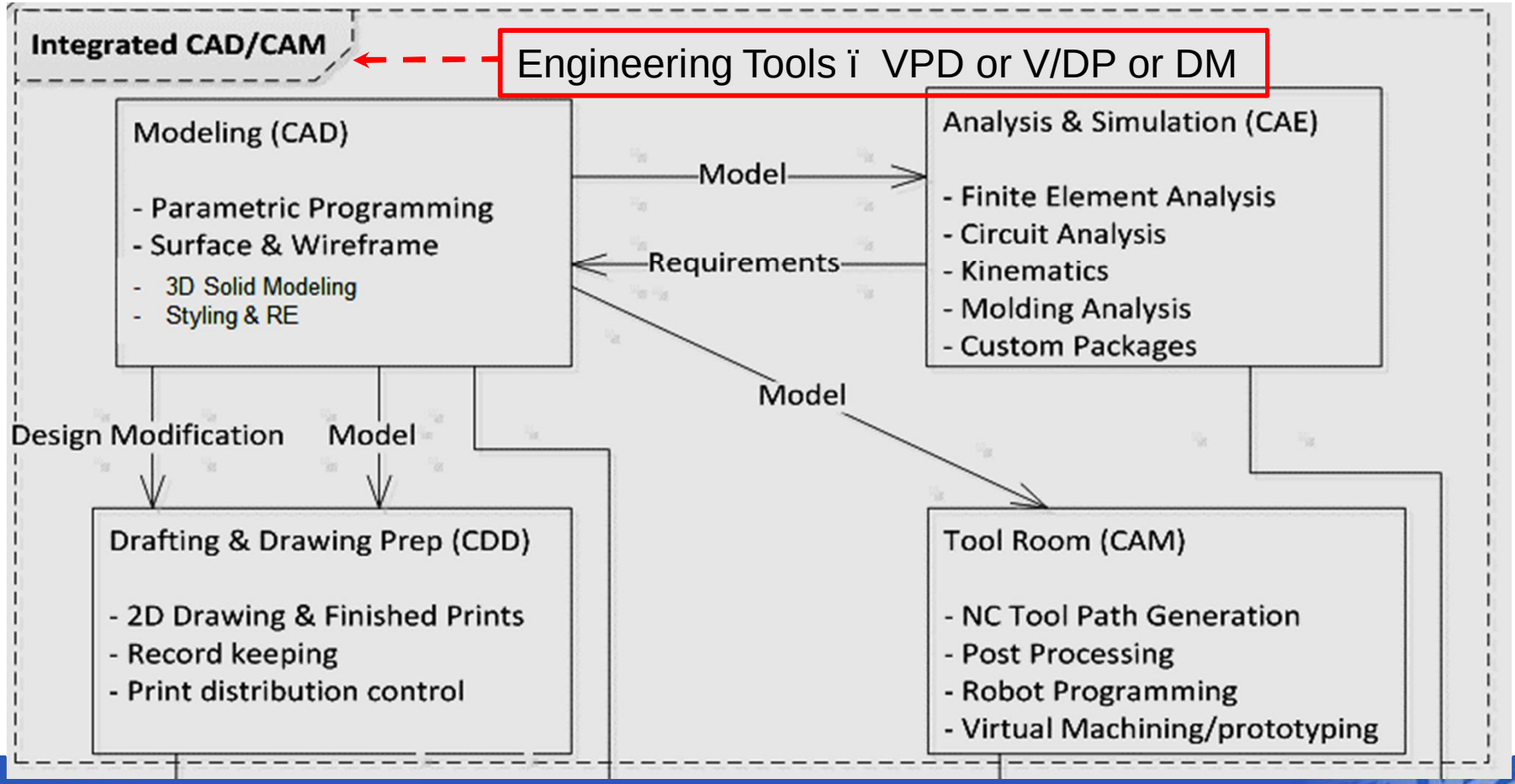
- CIMS allows a systematic method such as concurrent (simultaneous) engineering (CE) to integrate development of a product based on team work and customer relations.
- The aim of CE is performing tasks concurrently to optimize and distribute the resources in early design stages and during the development process.



https://en.wikipedia.org/wiki/Product_lifecycle#/media/File:Product_lifecycle_management.png

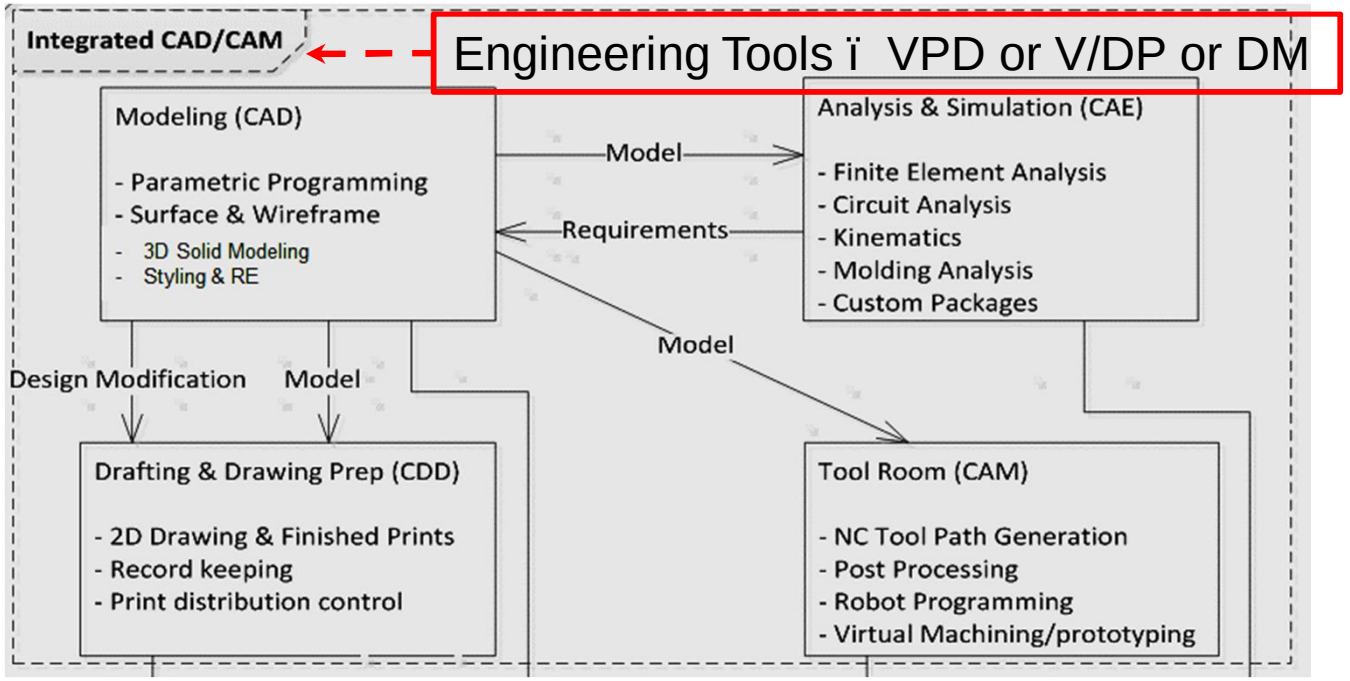
Product Lifecycle Management (PLM)

- Letôs briefly look at a PLM environment with CIMS components, specifically at integrated CAD/CAM or digital manufacturing (DM) and its relation to Virtual Product Development (VPD) or Virtual/Digital Prototyping (V/DP).



Virtual Product Development (VPD); Virtual Prototyping (VP); Digital Prototyping (DP) or integrated CAD/CAM

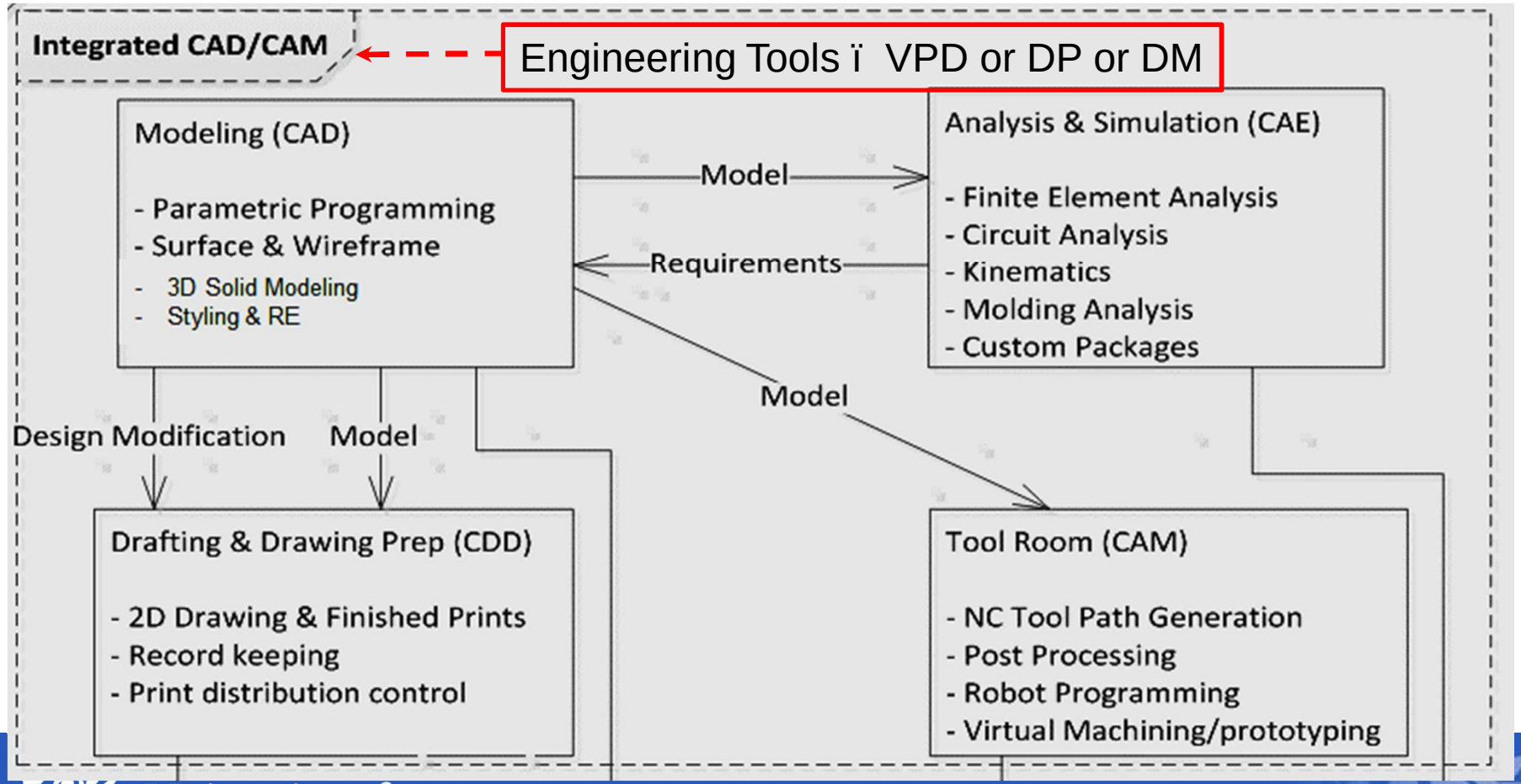
- VPD/VP/DP is a computer simulation process to design, simulate and test new products in a virtual environment before the physical prototype is made ï it is a multiple digital engineering tool in the PLM.
- Companies use VPD/VP/DP to design, iterate, optimize, validate and visualize their products virtually/digitally throughout the product development process.



VPD/VP/DP/DM or Integrated CAD/CAM

There are four user groups in VPD/VP/DP/DM

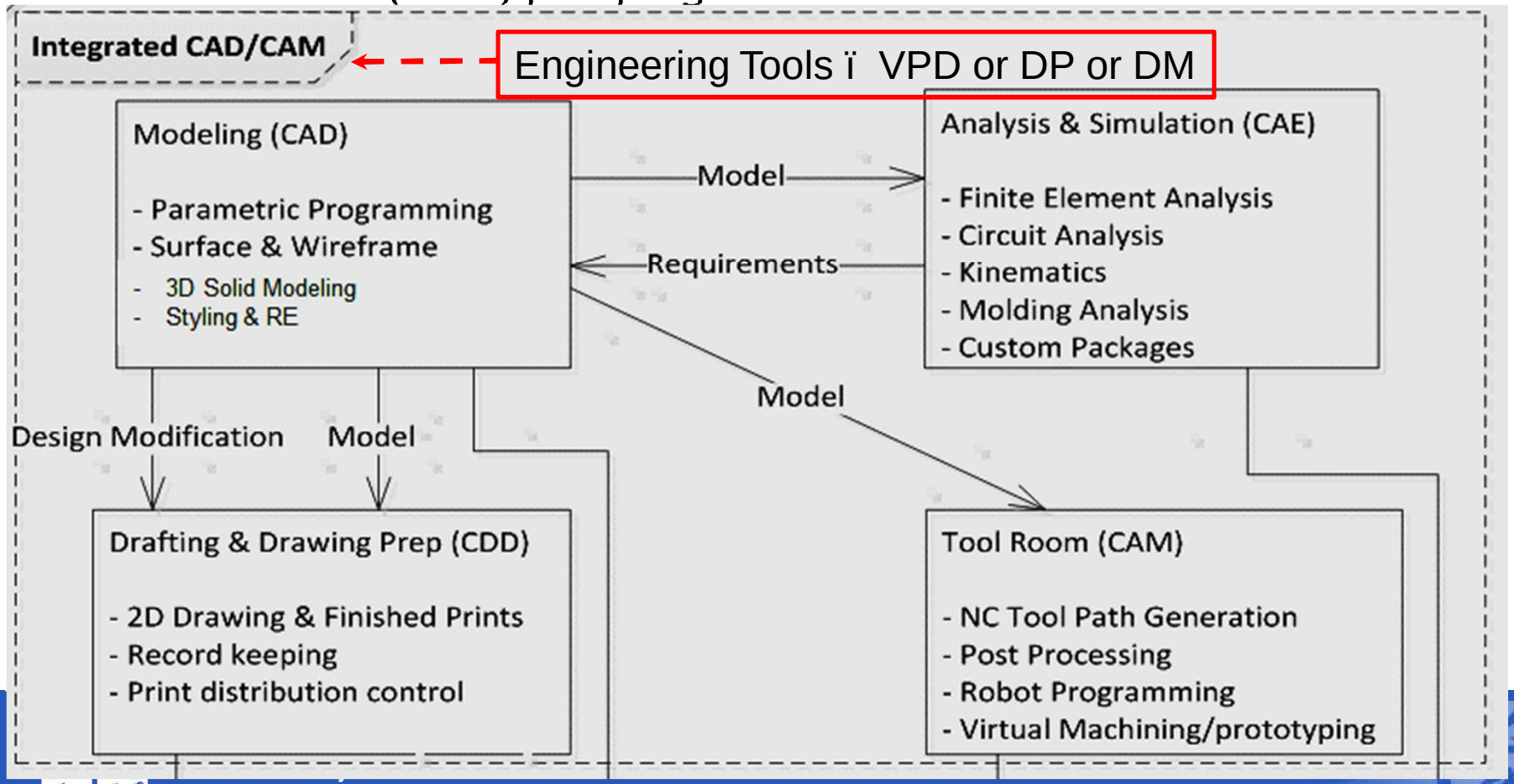
- **Group 1: CDD,** to produce engineering drawings and document designs.
- **Group 2: CAD,** to produce shaded images and animated displays.



VPD/DP/DM or Integrated CAD/CAM

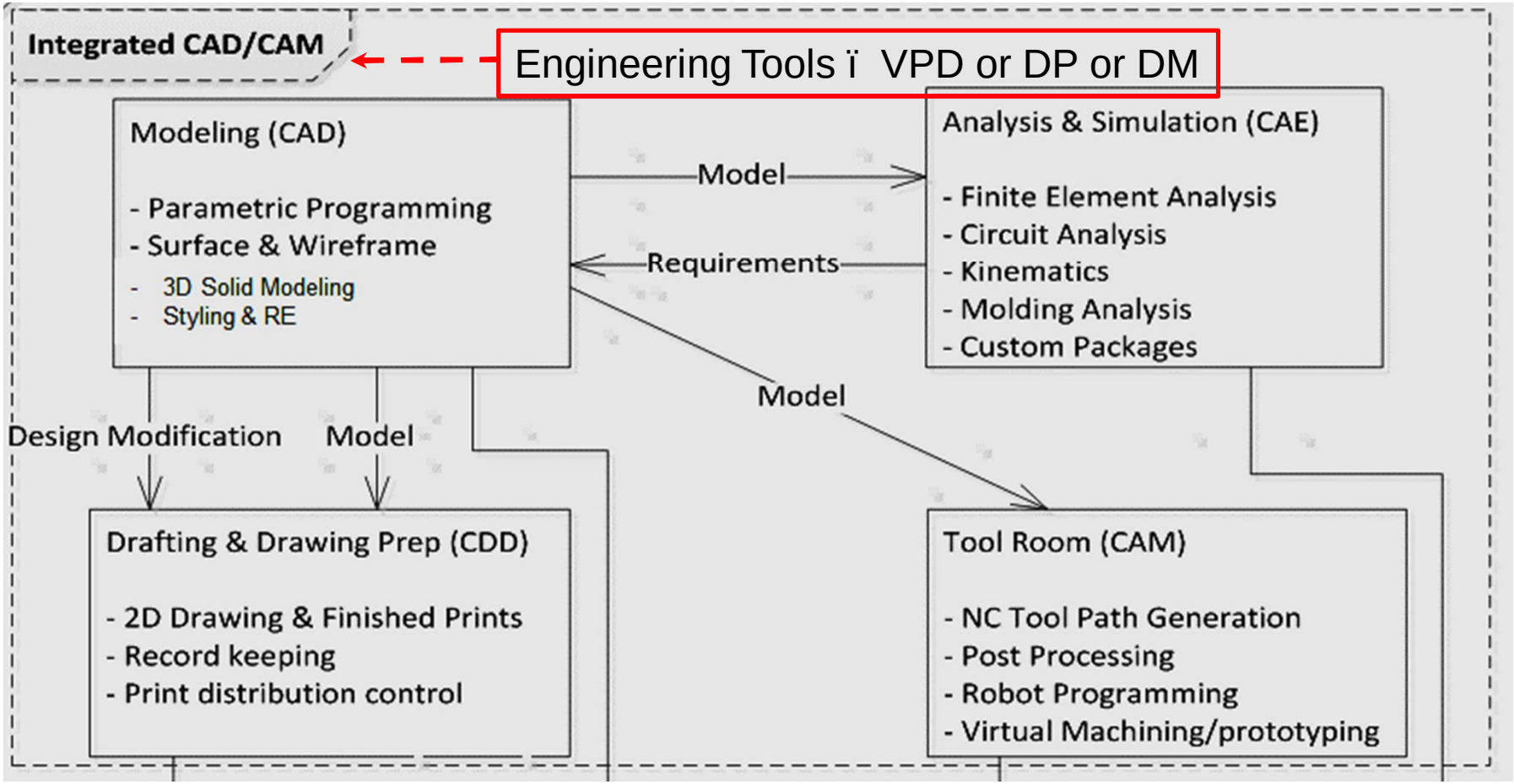
There are four user groups in VPD/DP/DM

- **Group 3: CAE,** to perform engineering analysis such as FEA (Finite Element Analysis).
- **Group 4 : CAM,** to perform process planning and generate Computer-Numerical Control (CNC) part programs.



VPD/DP/DM or Integrated CAD/CAM

The VPD/DP/DM or integrated CAD/CAM allows these four user groups to exchange their information more efficiently and simultaneously for accelerating product development.



VPD/VP/DP/DM

Benefits

- It bridges a longstanding gap between design and production technology that has acted as a drag on ñagile manufacturingò and competitive product development.
- **Agile manufacturing** is a term applied to an organization that has created the processes, tools, and training to enable it to respond quickly to customer needs and market changes while still controlling costs and quality

References

- P. Schmitt (2007), PLM in Aerospace: High-profile project helps extend PLM technology through the entire aerospace supply chain. Manufacturing Engineering, March Vol, 138, No. 3.
- http://en.wikipedia.org/wiki/Digital_prototyping
- http://www.plm.automation.siemens.com/en_us/products/velocity/solidedge/overview/digital_prototyping.shtml
- https://en.wikipedia.org/wiki/Agile_manufacturing

- The technology for using virtual prototypes was pioneered and adapted initially by large automotive and aerospace industries.

References

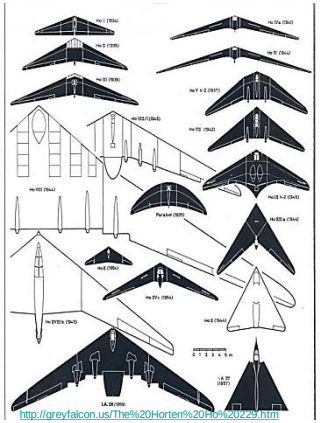
- M. Söderman, (2005), virtual reality in product evaluations with potential customers; an exploratory study comparing virtual reality with conventional product representations, Journal of Engineering Design 16 (3), 311-328.
- G.R. Bennett, (1997), The application of virtual prototyping in the development of complex aerospace products. Aircraft Engng Aerospace Technol 69 (1): 19-25.
- F. Dai, W. Feiger and T. Fruhauf, (1996), virtual prototyping examples for automotive industries, in Proceedings of Virtual Reality World, pp,. 1-13.

VPD/VP/DP/DM

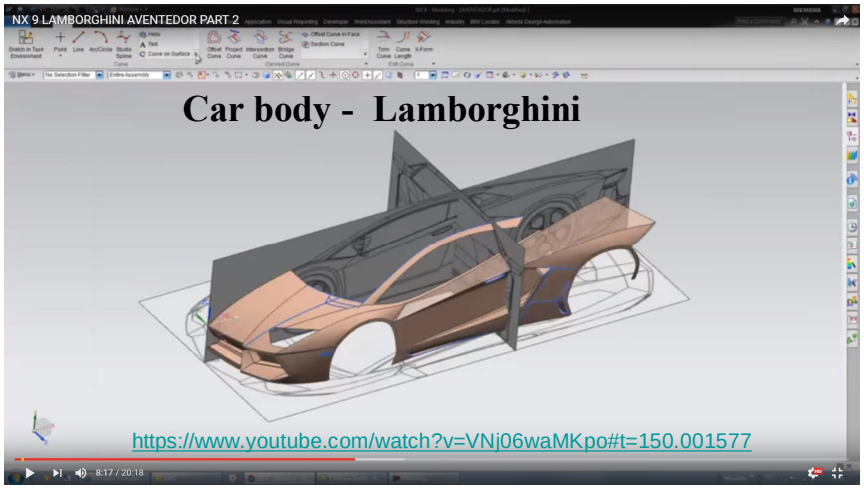
- VPD/VP/DP/DM has undergone rapid progress in recent years and has been widely accepted for commercial product development and research.
- It has become a very valued tool in the early phases of product design.

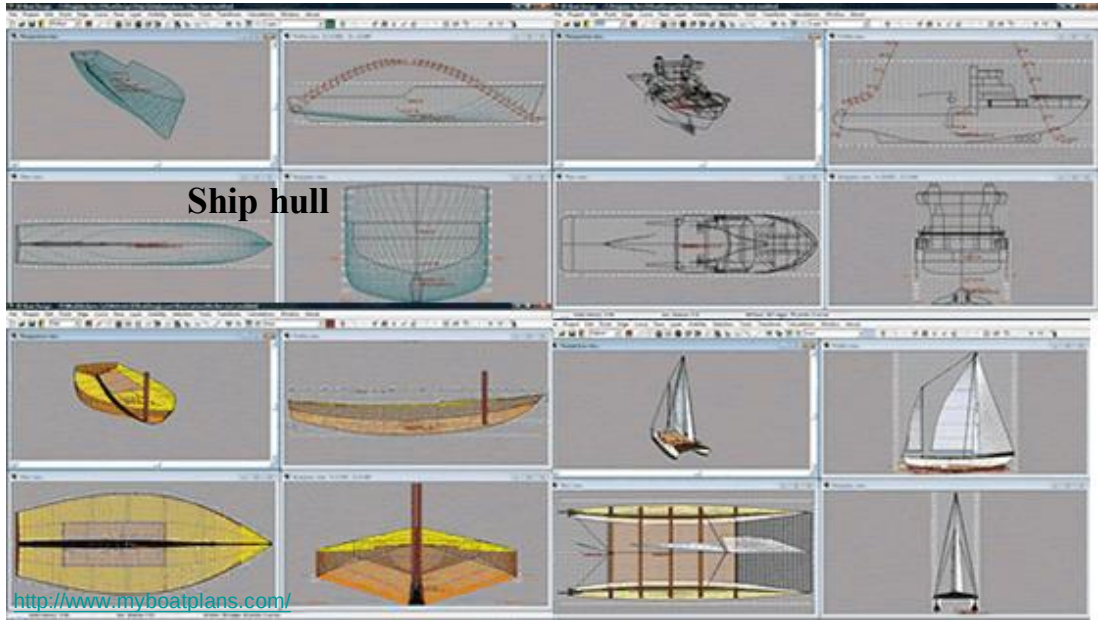
Here are a few examples;

Complex Engineering Products – Shape Design



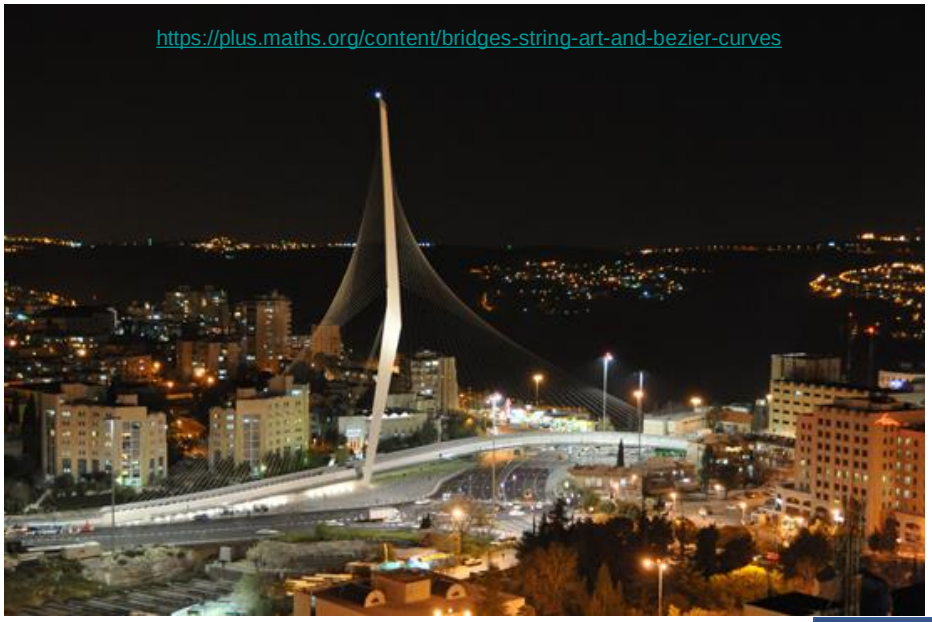
Airplane fuselage & Wings





Complex turbomachinery & propeller blades

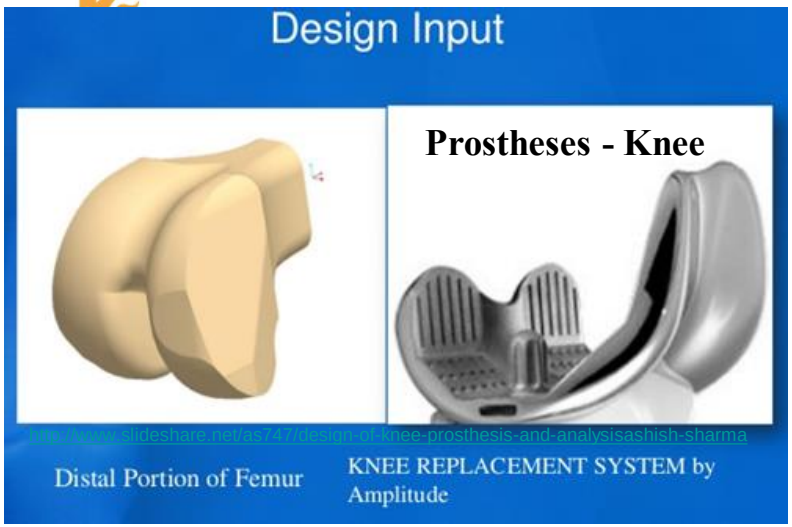
Complex Engineering Products – Shape Design

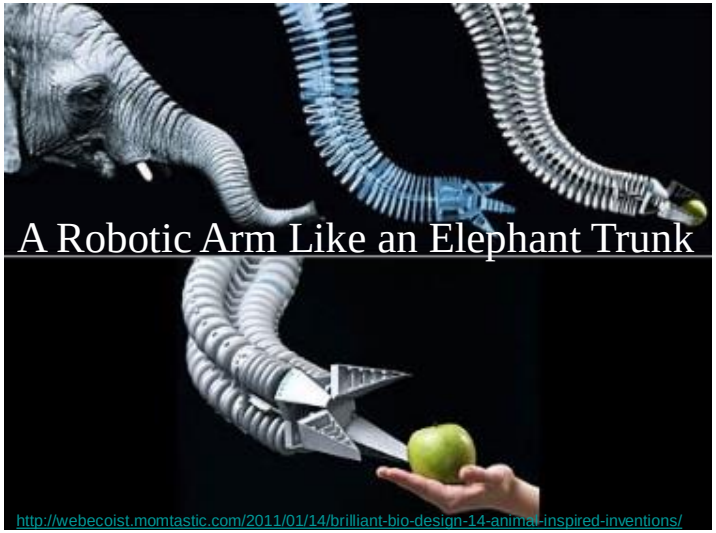


Suspension Bridge Design

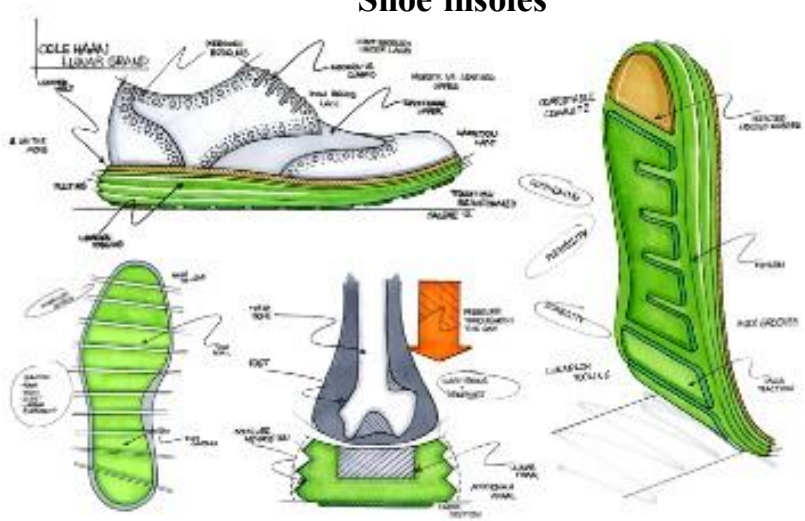
University of BRISTOL

Bio-inspired Products - Shape Design





Shoe insoles



http://solecollector.com/news/2012/10/cole-haan-lunargrand-wingtip-design-sketches1

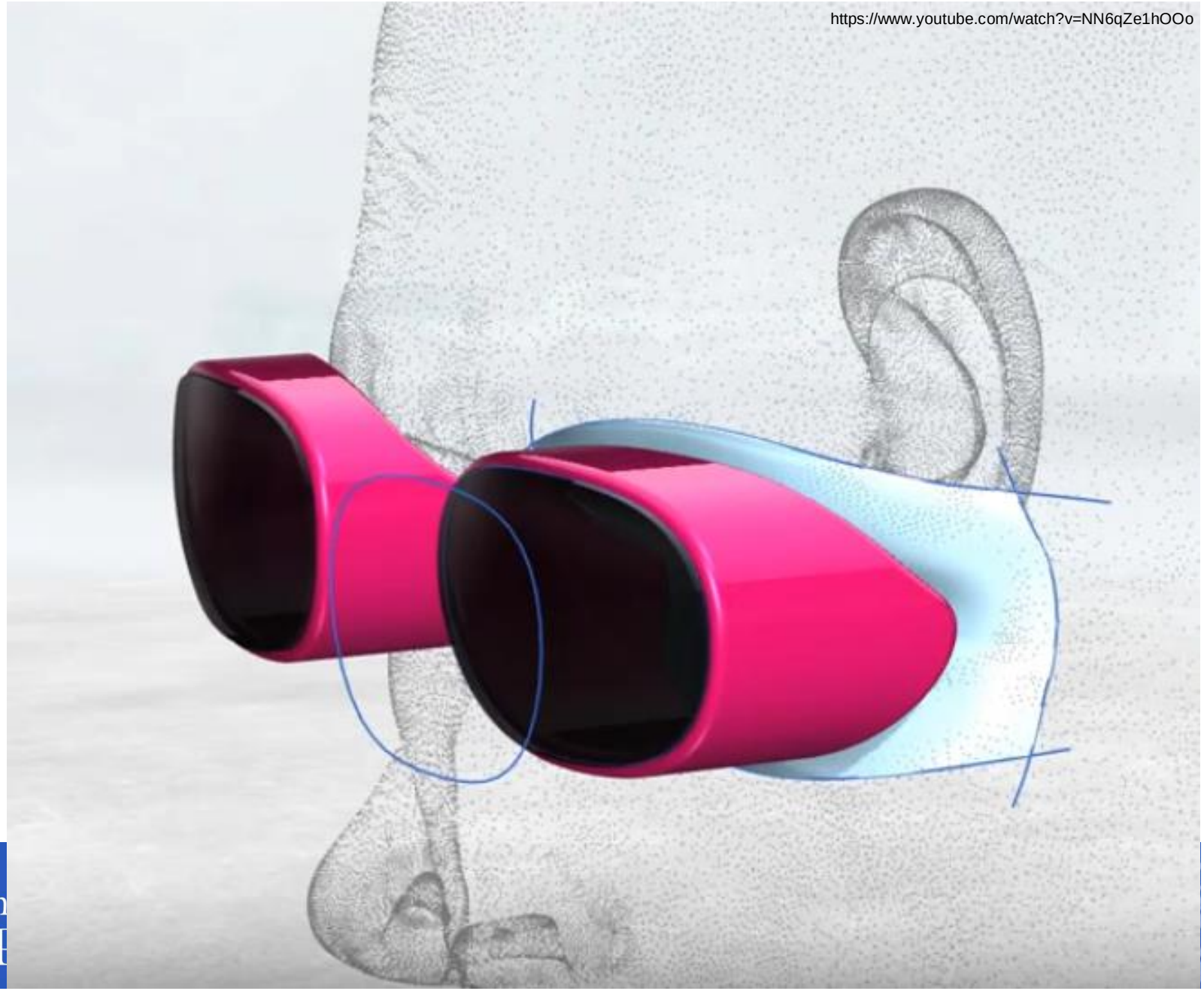
EARNING FROM THE KINGFISHER HOW TO REDUCE TURBULENCE

Japan - High speed bullet train

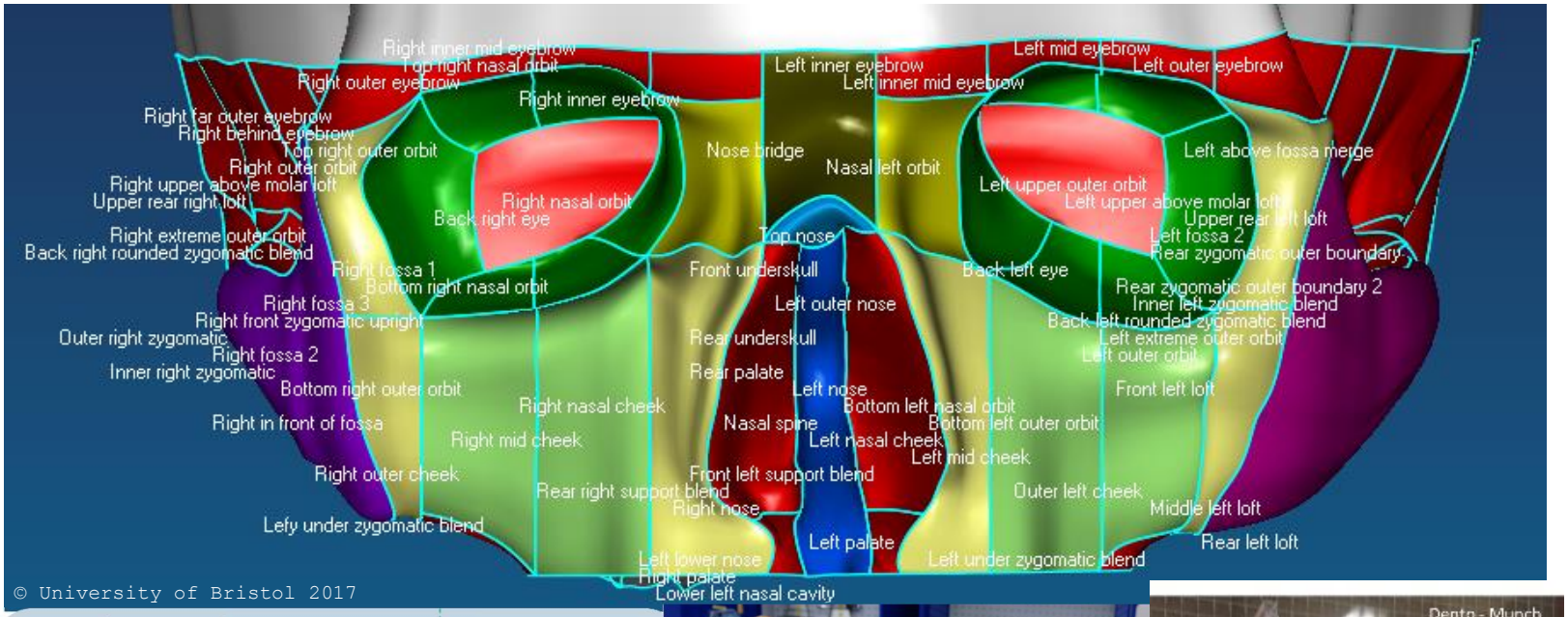
- https://www.theguardian.com/world/2015/feb/10/kenji-ekuan-industrial-designer-of-bullet-trains-and-soy-bottles-dies
- https://www.youtube.com/watch?v=2zQ90LRnpbw
- https://www.youtube.com/watch?v=ZhAcUEeGyuA

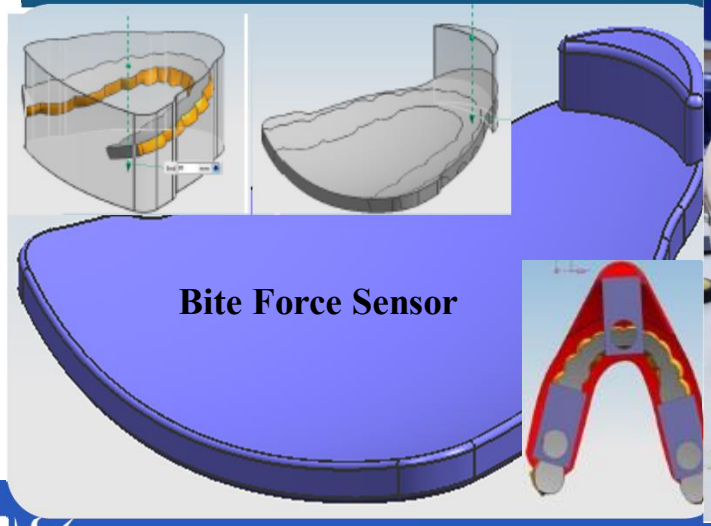
Swimming Goggle Design

https://www.youtube.com/watch?v=NN6qZe1hOOo



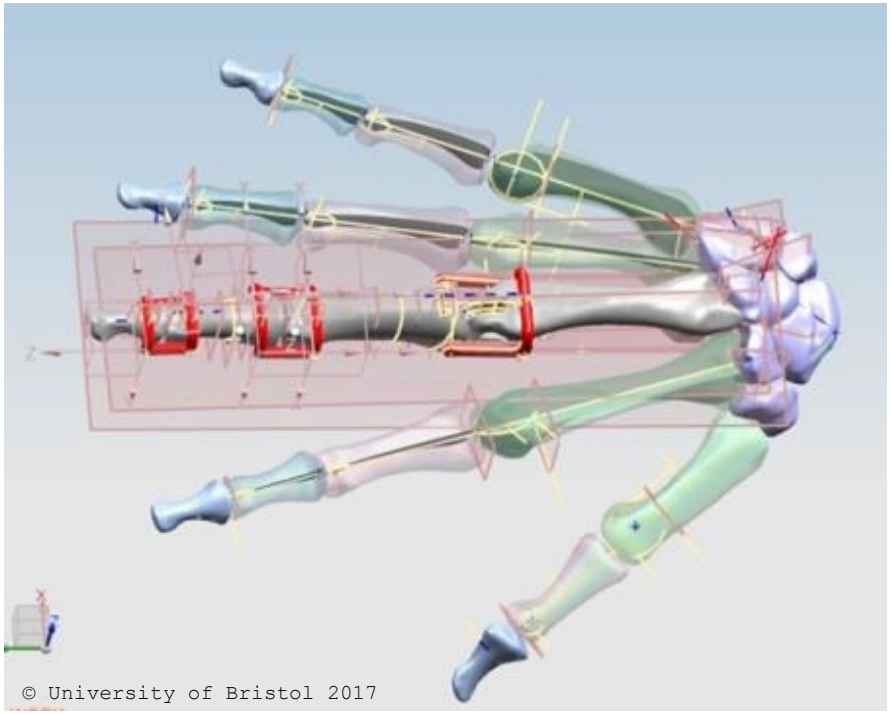
Bio-inspired Products – Humanoid Robotic Chewing Simulator

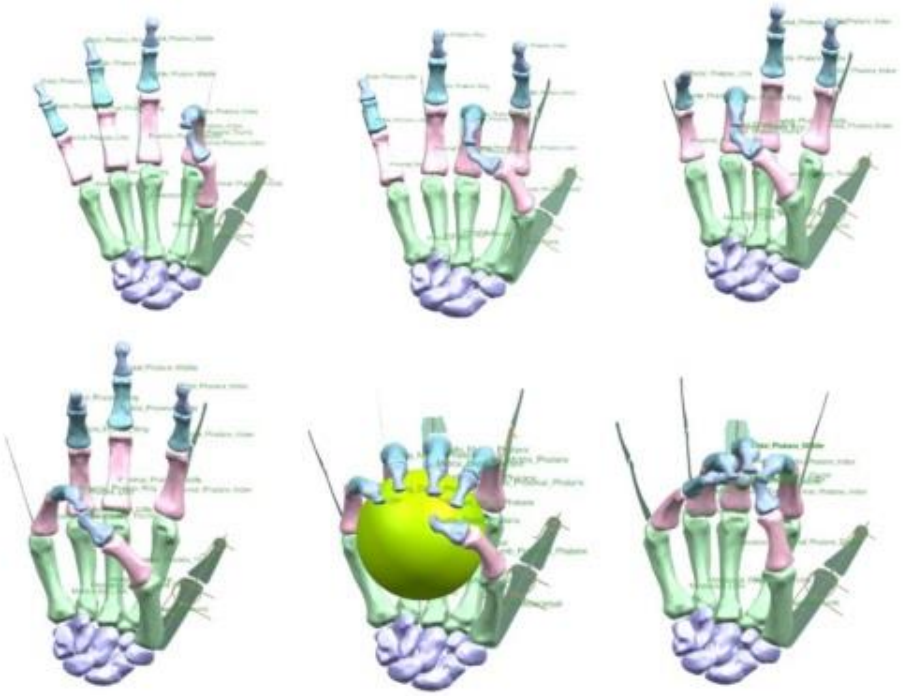




University of BRISTOL

Bio-inspired Products -Robotic Hand





VPD/VP/DP/DM – Industrial Example

- VP/DP of complex products require the realistic CAD representation of components, which possess accurate geometry, topology and appearance ï this reflects characteristics of the target parts to perform robust analyses and simulates engineering characteristics, including behaviour with real-time responses.

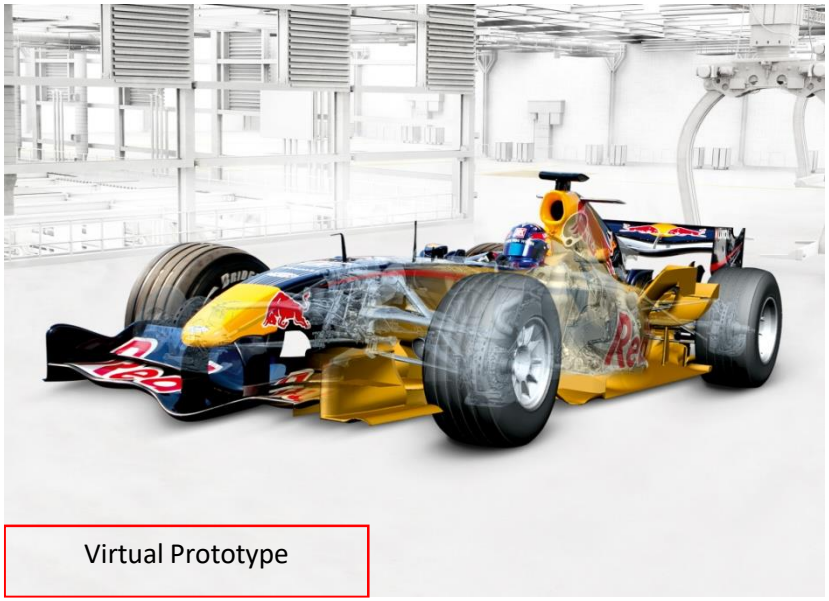
Ford Engine video

- http://www.youtube.com/watch?v=kkIvmW_qSuI [accessed Jan. 6, 2011]

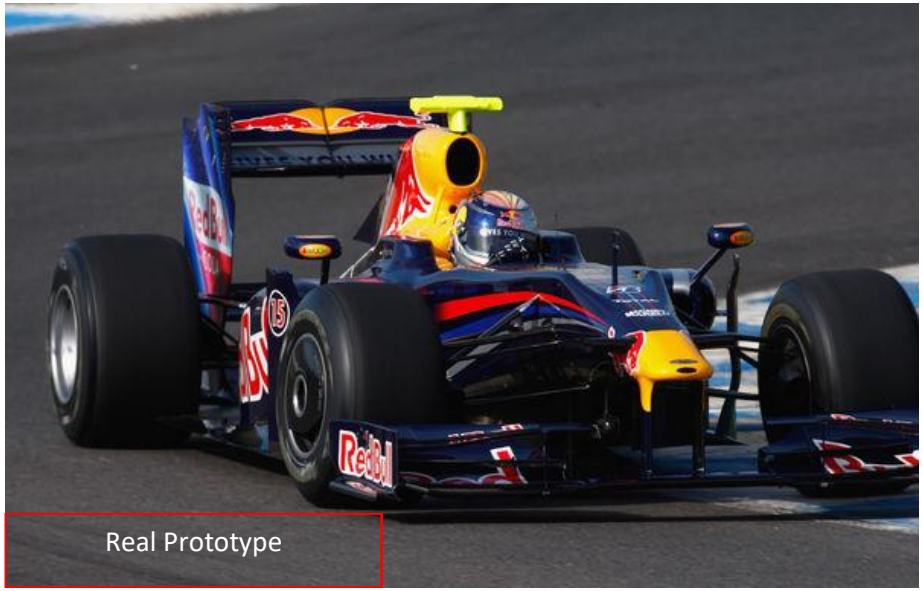
Formula one –Red Bull & PLM & VP

- Red Bull has won the World Champions 6 times.
- PLM & VP help make racing cars faster and Formula One factories more energy-efficient.

https://www.youtube.com/watch?v=prQnj8z6oPo (8.0 min.)



Virtual Prototype



Real Prototype

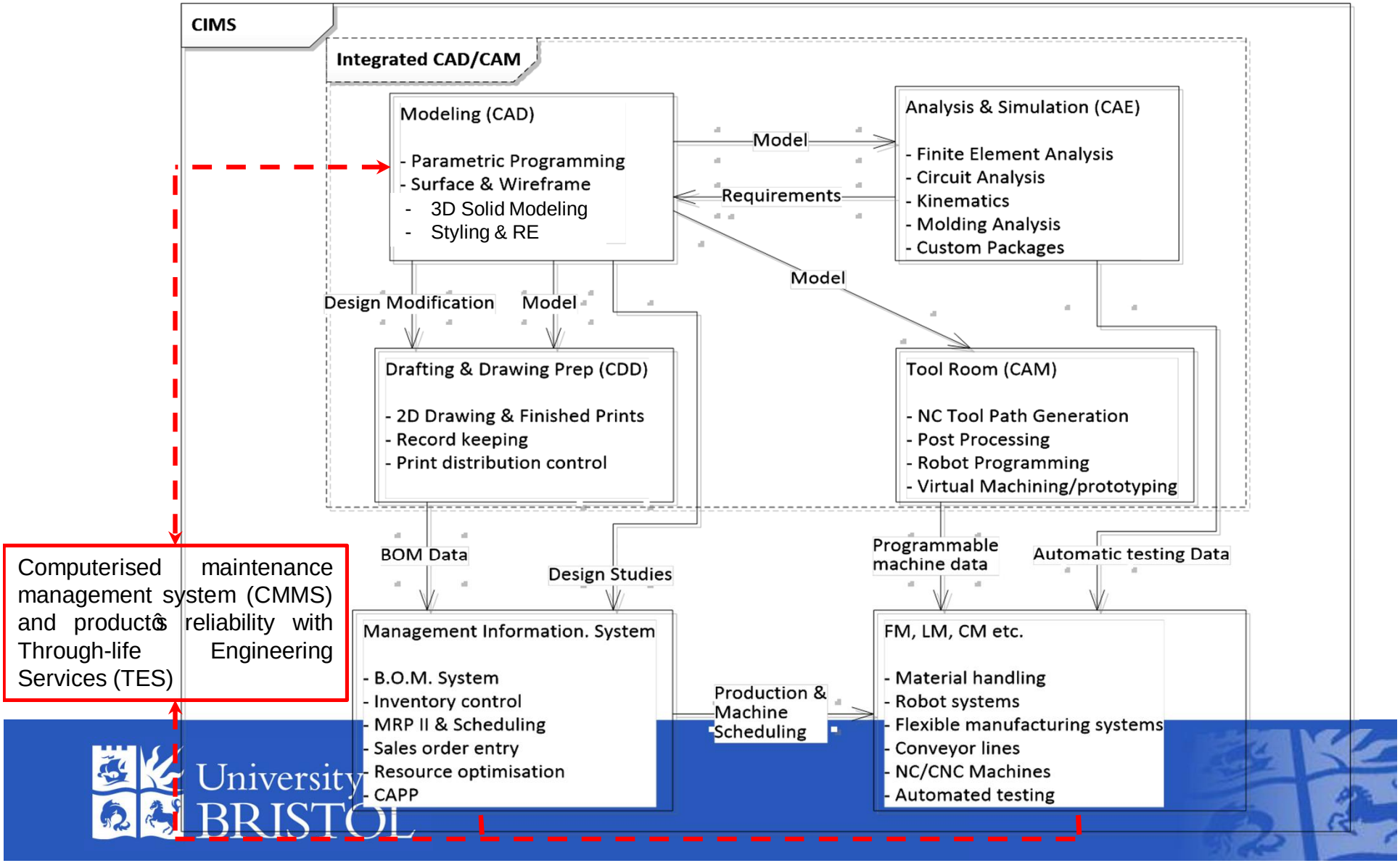
PLM, CMMS & TES

Final Comments

- The use of virtual (VDP/VP/DP/DM) technologies is of special interest in the **development and maintenance** of the products, mainly due to the large costs, sizes and complexity of physical prototypes (e.g. military, aerospace, wind turbine manufactures and high capital cost equipment).
- Integration of CIMS and computerised maintenance management system (CMMS), productûs reliability and Through-life Engineering Services (TES) will create real PLM.
- (TES) provide product support throughout each stage of the product-life cycle: from conception, through design, manufacture and operational life, to its disposal.

PLM, CMMS & TES

- Real PLM environment integrated with CIMS:



Through-life Engineering Services (TES)

- Through-life Engineering Services (TES) provide product support throughout each stage of the product-lifecycle: from conception, through design, manufacture and operational life, to its disposal.

file:///C:/Users/meka/Chrome%20Local%20Downloads/9783319121109-c2%20(1).pdf

Product Lifecycle Management (PLM)

For further information about TES & PLM and its applications in renewable energy ï for wind turbines see my latest publications.

Igba, J., Alemzadeh, K., Durugbo, C. & Eiriksson, E. T. **Through-life engineering services of wind turbines,** 2017, CIRP Journal of Manufacturing Science and Technology, 17, 60-70..

Igba, JE, Alemzadeh, K & Durugbo, C, 2016, ó**Analysing RMS and peak values of vibration signals for condition monitoring of wind turbine gearboxes**ô *Renewable Energy*, vol 91., pp. 90-106

Igba, J, Alemzadeh, K, Gibbons, PM & Henningsen, K, 2015, **'A framework for optimising product performance through feedback and reuse of in-service experience**ô *Robotics and Computer-Integrated Manufacturing*, vol 36., pp. 2-12

Igba, J., Alemzadeh, K., Henningsen, K. & Durugbo, C. **Effect of preventive maintenance intervals on reliability and maintenance costs of wind turbine gearboxes,** 2015, Wind Energy. 18, 11, p. 2013-2024 12 p.

Igba, J., Alemzadeh, K., Durugbo, C. & Henningsen, K. **Performance assessment of wind turbine gearboxes using in-service data: Current approaches and future trends,** 2015, Renewable & Sustainable Energy Reviews. 50, p. 144-159 16 p.

Igba, J., Alemzadeh, K., Durugbo, C. & Henningsen, K. **Through-life engineering services: A wind turbine perspective,** 2014 *Procedia CIRP.* 1 ed. Elsevier Science, Vol. 22, p. 213-218 6 p. (Procedia CIRP)

Ford, G., Igba, J., McMahon, C., Alemzadeh, K., Rowley, C. & Henningsen, K., **Knowledge management: A cross sectorial comparison of wind generation and naval engineering,** 2014, IFIP Advances in Information and Communication Technology. 442, p. 129-138 10 p.

Igba, J., Alemzadeh, K., Anyanwu-Ebo, I., Gibbons, P. & Friis, J. **A systems a Reliability-Centred Maintenance (RCM) of wind turbines** 2013 *Procedia Computer Science.* Vol. 16, p. 814-823 10 p.

Igba, J. E., Gibbons, P. M. & Alemzadeh, K. **Combining Systems Thinking and PAS 55: Developing a Value Improvement Model for Asset Management (a-VIM) with a Wind Turbine Case Study,** Nov 2012 p. 1-6 6 p.

VPD & PLM Presentation

Any questions?