



***Euro-CASE Annual Conference 2010
Berlin, 2 December 2010***

Automation & Innovation

Value creation through innovation

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Introduction

- Innovation is a fashionable but poorly understood and often (politically) misused concept
- What is innovation?
 - The process that **renews something that exists** – it is **not invention!**
 - Renewal takes place only if **people do things differently** or when they **make choices outside their norms** (Schumpeter)
- Innovation can be seen as **a change in the thought process for doing something**, or the **useful application of new inventions or discoveries**
- Innovation involves **incremental or radical (revolutionary) changes in thinking, products, processes, or organizations** as an answer to emerging (societal or industrial) paradigm shifts

Introduction

- Successful innovation requires

A good idea
A recognised need (paradigm shifts!)
A supporting (academic) environment
A positive risk investment environment
A visionary government

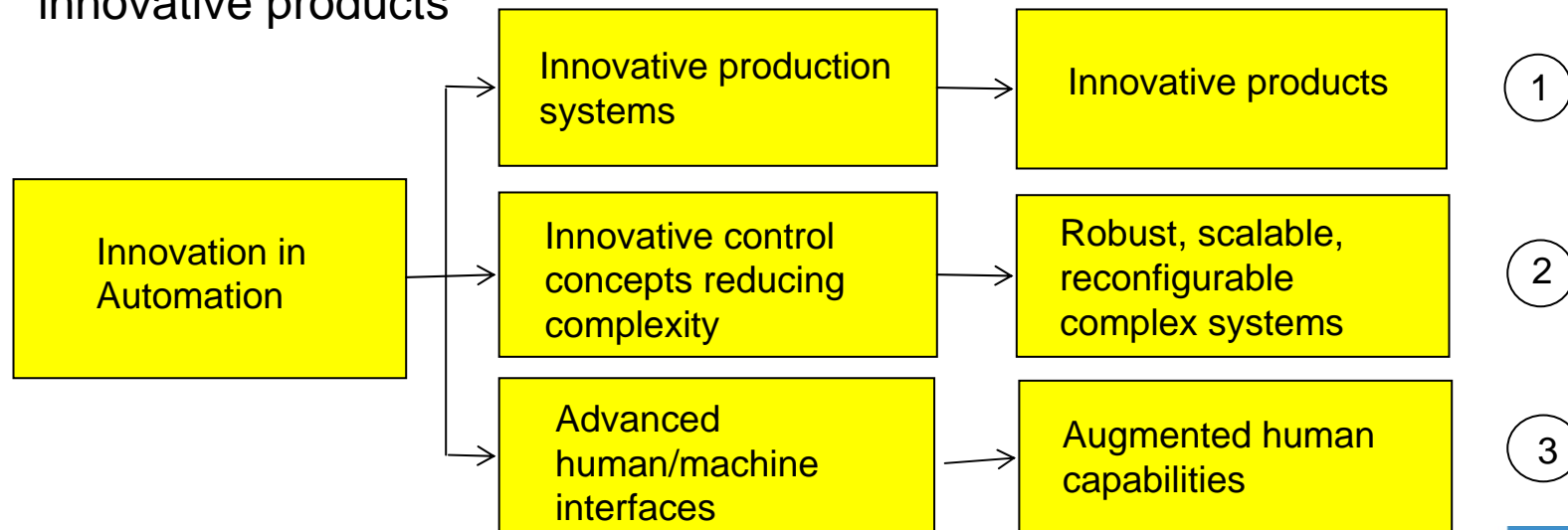
- Many successes in innovation are
 - driven by enthusiasm and belief
- rather than
 - by the ready availability of sufficient venture capital
- Innovation should be **facilitated rather than regulated**

Innovation in automation

- What is automation?

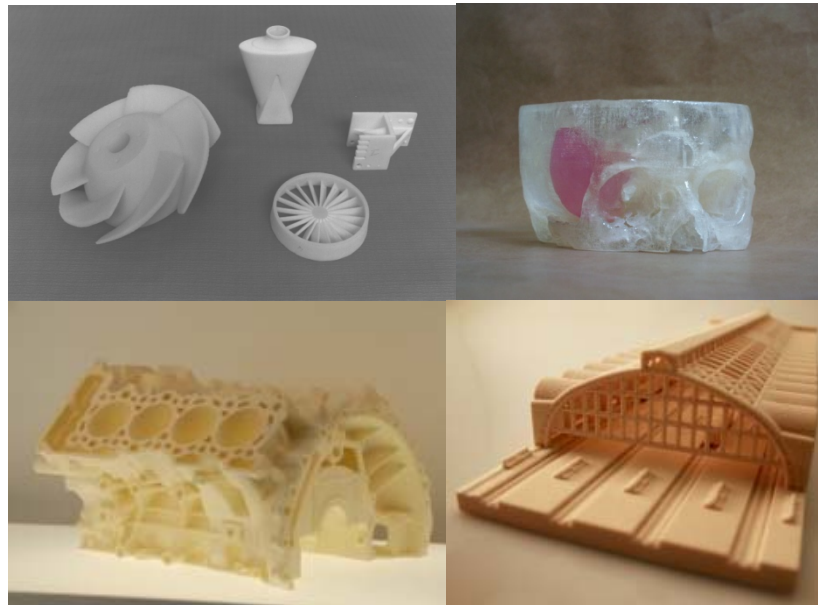
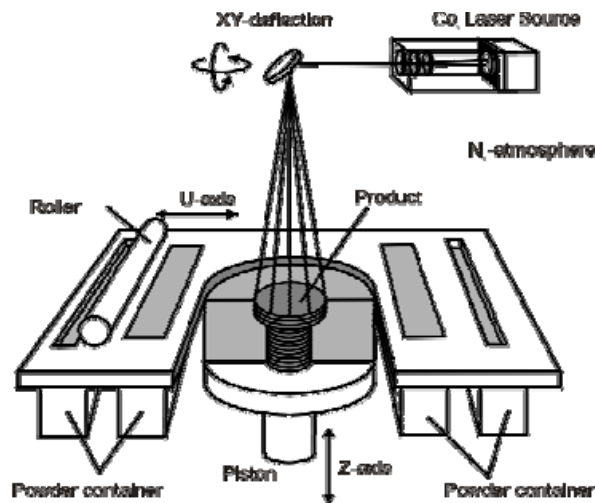
Where mechanisation replaces the human for the doing the mechanical work in a machine by using motors, **automation is the use of control systems and information technology to assist or replace the human in controlling the state of the machine**

- There are several ways in which innovation in automation can lead to innovative products



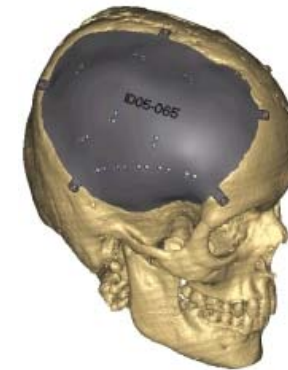
Innovation in Automation – Case 1

- Example: Company MATERIALISE in Leuven, Belgium
 - Spinoff of PMA/K.U.Leuven
 - Started in 1990, they employ now 800 people worldwide
 - Activity: Rapid prototyping and manufacturing, using stereolithography, selective laser sintering, 3D printing, ...
 - Principle: layerwise buildup through solidifying a liquid or powder layer with a laser



Innovation in Automation – Case 1

- Example MATERIALISE (cont'd)
 - Advantages of rapid prototyping
 - Fast manufacturing of prototypes or small batches (NextDay service)
 - Complex shapes in difficult-to-machine materials (e.g. tungsten carbide)
 - ICT based (e.g. CAT-scan data)
 - Innovative applications
 - **Surgical models and guides**



- **Design lamp shades**



Innovation in Automation – Case 2

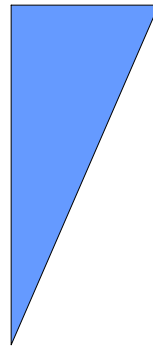
- Control of complex systems (shop floors, traffic, smart grids, fleets of harvesters, road making equipment, warehouses, logistic systems,...) requires decentralised control methods to ascertain robustness, scalability, reconfigurability, ..., rather than traditional hierarchical control schemes

Hierarchical control
(Fixed rules)



Holonic control

Fixed Rules

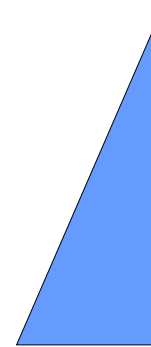


Hierarchical

Holonic

Heterarchical

Flexible Strategies



Heterarchical control
(Flexible strategies)

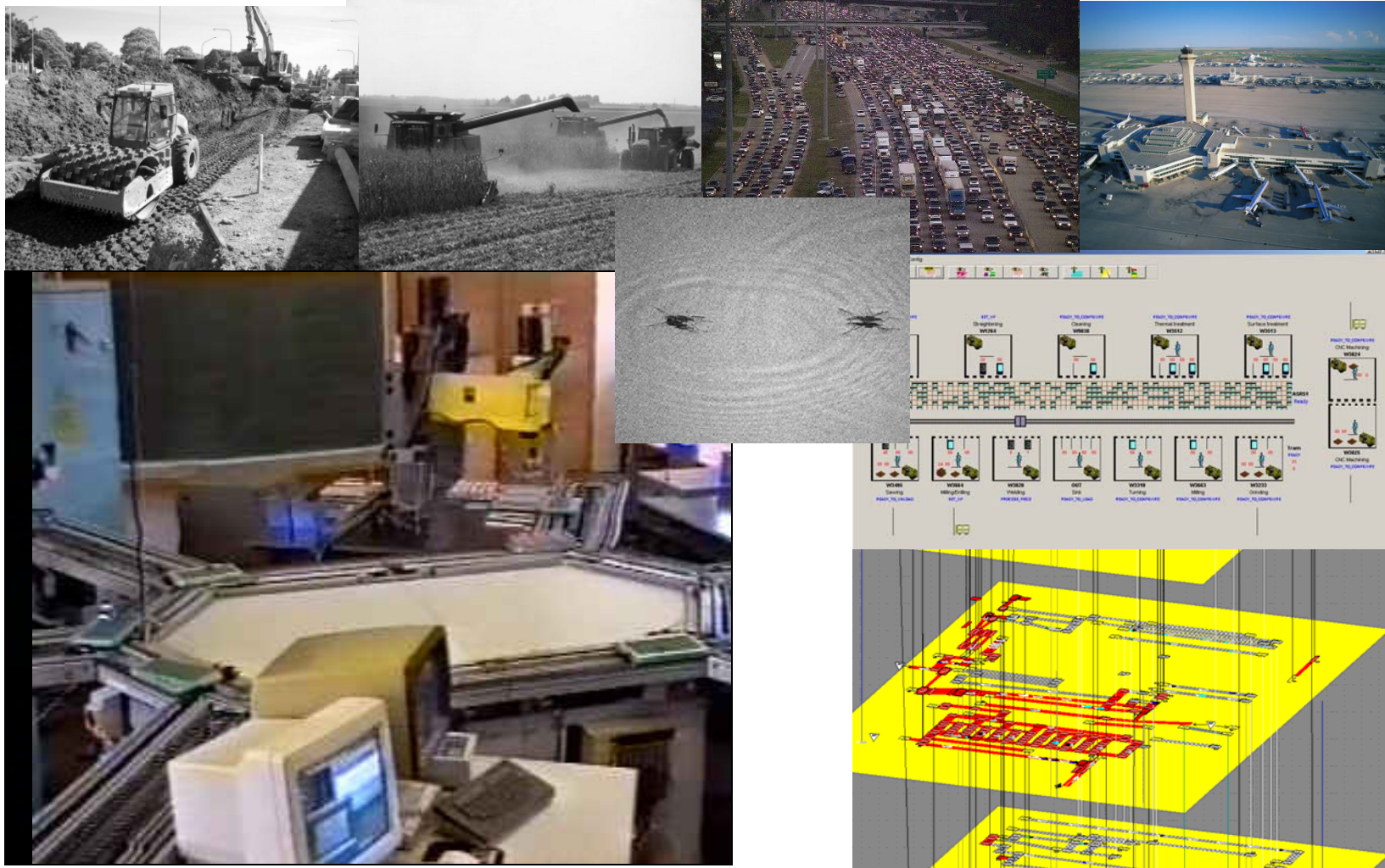


- A holonic system is a set of holons (agents), which are autonomous entities, interacting with each other in order to achieve a global system

Innovation in Automation – Case 2

- The interaction mechanisms are local and are increasingly biologically inspired (e.g. ant colony behaviour)
- The holonic (multi-agent) control paradigm leads to robust, scalable, easily reconfigurable systems
- **The Mechatronics Society:** intelligent complex machine (infrastructure) systems ('**system of systems**')
 - Intelligent traffic
 - Smart (power) grids
 - Networked production (virtual factories)
 - Intelligent manufacturing
 - Smart multi-modal transport and logistics
 - Supply networks
 - Hospital logistics and operations management
 - Fleets of harvesters

Innovation in Automation – Case 2

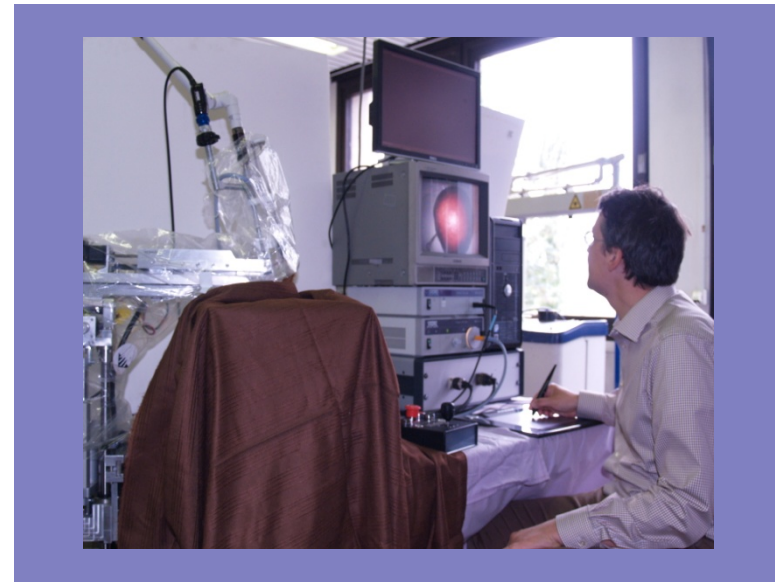
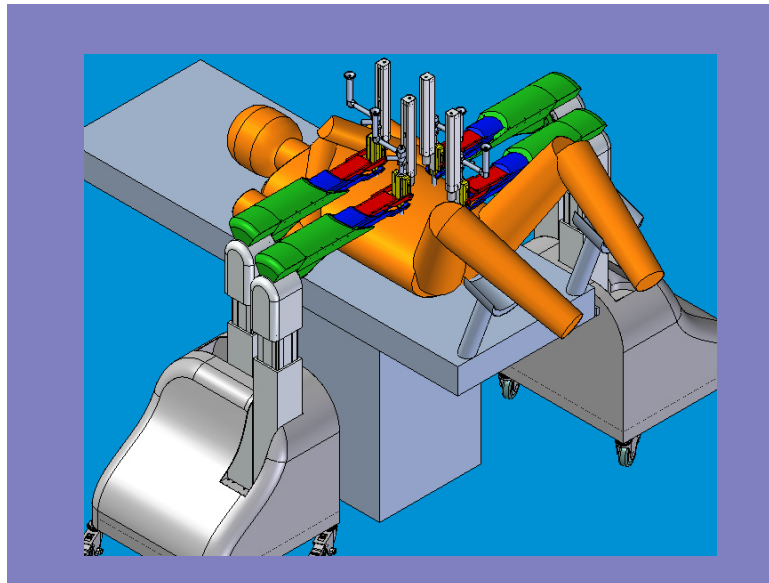
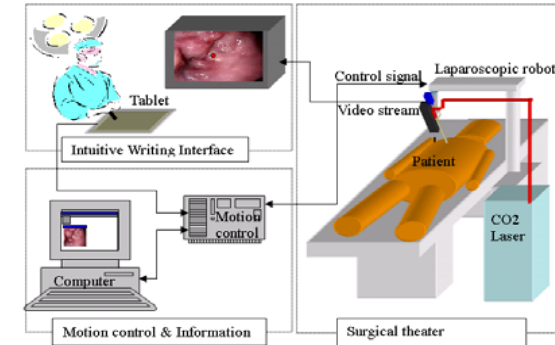
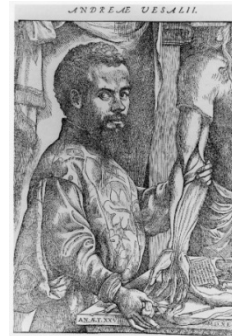


Innovation in Automation – Case 3

- Robotised laparoscopic laser surgery
 - Advantages of laparoscopic surgery
 - Reduced lesion for the patient
 - Reduced hospitalisation time
 - Drawbacks of laparoscopic surgery
 - Reduced mobility for the tools
 - Reduced visibility
 - Long learning curve
 - Advantages of robotised laparoscopic surgery
 - High accuracy
 - Reduced learning curve
 - Less fatigue for the surgeon
 - Drawbacks of robotised laparoscopic surgery
 - No haptic feedback (not needed for laser surgery)

Innovation in Automation – Case 3

- **The Vesalius project**
 - Mechanically fixed remote centre of rotation
 - Natural writing interface
 - Inherent safety by robot positioned above the patient



Innovation in Automation – Case 3

- **Intelligent wheelchairs**

- Wheelchair intelligence can be enhanced by introducing shared control
 - The driver's intention is inferred from the (corrupted) joystick signals
 - A path planning and obstacle avoidance programme helps the driver to execute the task correctly (after a training phase in which an ANN is trained)

Safe docking at table



Collision-free navigation



Concluding remarks

- Innovation is doing things in a different way, incrementally or radically, thereby making use of existing inventions
- Automation is the use of control systems and information technology to assist or replace the human in controlling the state of a system
- Innovation in automation can be beneficial in several ways
 - By developing innovative production systems that in their turn give rise to innovative products
 - By developing innovative control algorithms that enable to control complexity, resulting in robust, scalable and reconfigurable systems
 - By introducing innovative human/machine interfaces enabling to augment human capabilities in controlling machines