Management of the Digital Enterprise: A new, interdisciplinary master program in service-oriented manufacturing

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Agenda

1. The Context: 2020 Digital Enterprise
2. Business Analytics from Big Data
3. SOEA & vMES (Enterprise Integration and Virtualization)
4. A new Master Program: Management of the Digital Enterprise

The Context: Digital Enterprise – the next frontier for innovation and competitiveness

- "Factories of the Future" 2020:
  - Total enterprise integration: the Manufacturing Integration Framework (MIF) linking business processes with supply- and production processes
  - Advanced manufacturing processes (3D shape construction, …)
  - Adaptive and smart manufacturing processes
  - Digital, virtual and resource-efficient factories
  - Collaborative and mobile enterprises
  - Human-centred manufacturing
  - Customer-focused manufacturing

- Mission for Higher Education:

Teach the **overall enterprise architecture and core technologies to establish a comprehensive, Internet-scale platform for networked management & production** that encapsulates the right abstractions to link scalable the stake-holders (production factories, material and technology providers, service firms) to enable the emergence of sustainable Internet economy.

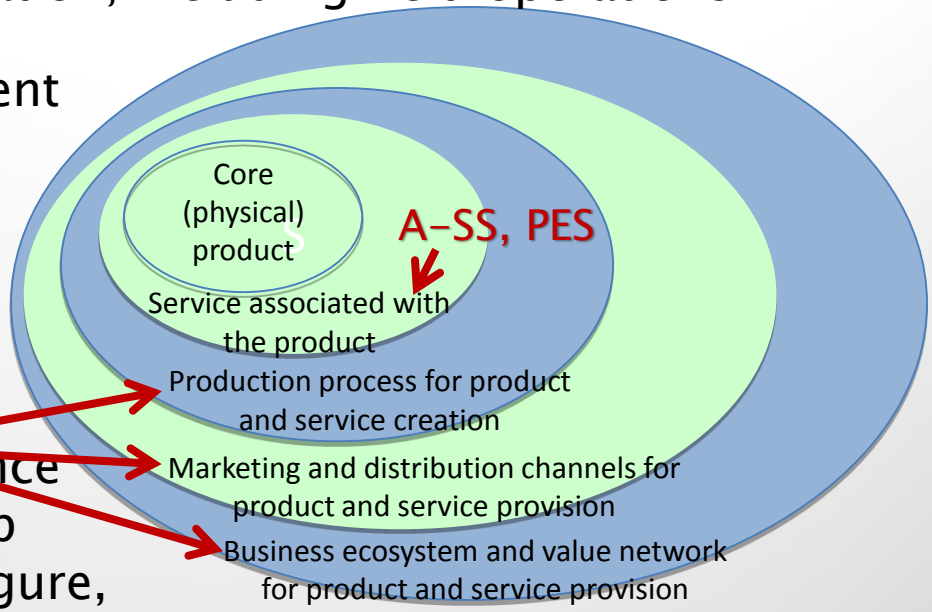
The Context: Digital Enterprise – the next frontier for innovation and competitiveness

Three viewpoints:

1. **Smart Enterprise**: Novel controls based on ICT convergence in mixed batch planning and product scheduling, automation, robotics, quality control, environment and resource instrumenting.

2. **Digital Enterprise**: Novel operations based on product and process modelling, management and simulation, including field operations.

3. **Virtual Enterprise**: Novel management of complex supply chains across production sites and including logistics and material flows across the product life cycle, including field operations



Trend: Shift from G-DL to S-DL: enhance the utility that the product's ownership delivers to the customer (install, configure, repair, maintain, upgrade, take-back, ...)

Opportunity of Industrial Business in the Digital Enterprise

Business analytics from Big Data: Optimizing the Decision

- Big Data can underpin a substantial wave of gains:
  - Improved efficiency in design and production
  - Improvements in product quality
  - Better meeting customer needs through: (a) more precisely targeted products; (b) effective promotion and distribution; (c) collaborative product development based on customer data.

- Big Data can enable 7 performance levers for manufacturers, related to 5 components of the Manufacturing Value Chain:
  - R&D and product design
  - Supply Chain Management
  - Production
  - Marketing and sales
  - After-sales

Business analytics from Big Data: Optimizing the Decision

We have identified the following big data levers across the manufacturing value chain

	R&D and design	Supply-chain mgmt	Produc-tion	Market-ing and sales	After-sales service
1 Build consistent interoperable, cross-functional R&D and product design databases along supply chain to enable concurrent engineering, rapid experimentation and simulation, and co-creation	✓				
2 Aggregate customer data and make them widely available to improve service level, capture cross- and up-selling opportunities, and enable design-to-value	✓			✓	
3 Source and share data through virtual collaboration sites (idea marketplaces to enable crowd sourcing)	✓			✓	
4 Implement advanced demand forecasting and supply planning across suppliers and using external variables		✓	✓	✓	
5 Implement lean manufacturing and model production virtually (digital factory) to create process transparency, develop dashboards, and visualize bottlenecks			✓		
6 Implement sensor data-driven operations analytics to improve throughput and enable mass customization			✓		
7 Collect after-sales data from sensors and feed back in real time to trigger after-sales services and detect manufacturing or design flaws			✓	✓	✓

SOURCE: McKinsey Global Institute analysis

The 7 Big Data levers across the MVC

Business analytics from Big Data: Optimizing the Decision

1. R&D and product design

- (L1) Product lifecycle management (PLM): CAD, CAE/CARE, product development management tools, digital manufacturing and more recently digital marketing. Co-create designs with suppliers; Enable experimentations at design stage; Create simulations to test: designs, choice of parts, costs [collaborative use of data for modelling, simulation and controlled experimentation – the Digital Enterprise viewpoint]

- (L2) Design to value: extract crucial insights from the increasing volume of customer data to refine existing designs and help develop specifications for new models and variants [customer insights mined from sources: point of sales data, social media, customer feedback, sensor data on product usage]

- (L3) Open innovation: outside inputs for innovation through new channels [collaborate on product development via Web 2.0, Web-based platforms]

Business analytics from Big Data: Optimizing the Decision

2. Supply Chain

- (L4) Advanced demand forecasting and supply planning: use own data, integrate data from other sources, include data from retailers (promotion data, launch data, inventory data) [collaborative supply chain management and planning]

3. Production

- (L5) Digital factory: used to design and simulate the most efficient production system for a specific product [create a digital model of the entire manufacturing process; Internet of Things applied to the MVC (sensors and actuators within networks of physical objects)]

- (L6) Sensor-driven operations: IoT data allows process control and optimization to reduce waste and maximize throughput [embedding real-time, highly granular data from networked sensors in the supply chain and production processes]

Business analytics from Big Data: Optimizing the Decision

4. Marketing and sales

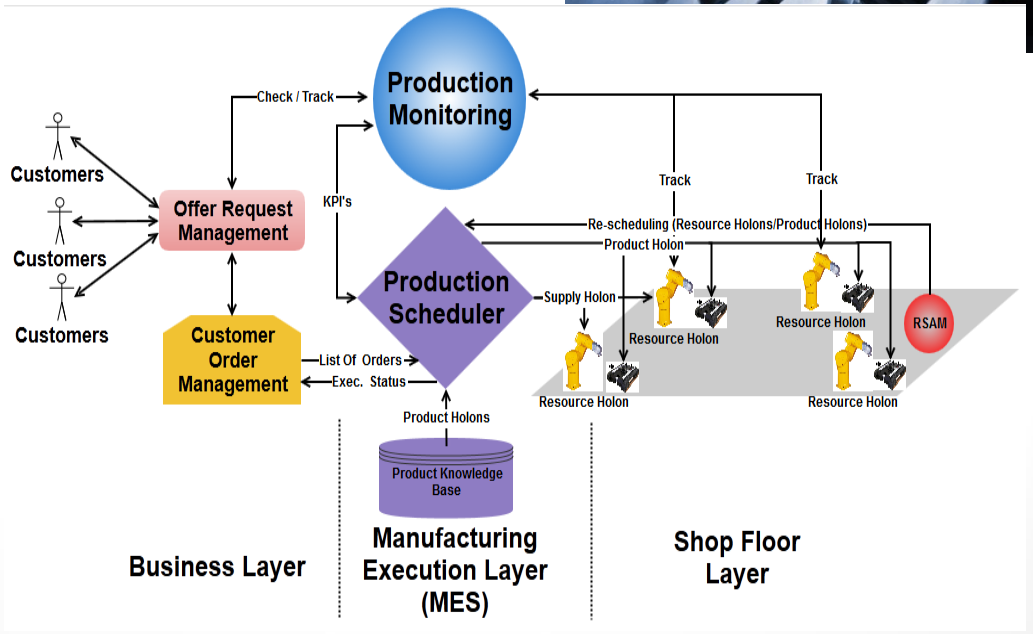
Use data from customer interactions to: (a) improve marketing and sales; (b) influence product development decisions. Embed sensors in products that can generate data about actual product usage and performance [obtain real-time input on emerging defects and adjust the production process immediately]

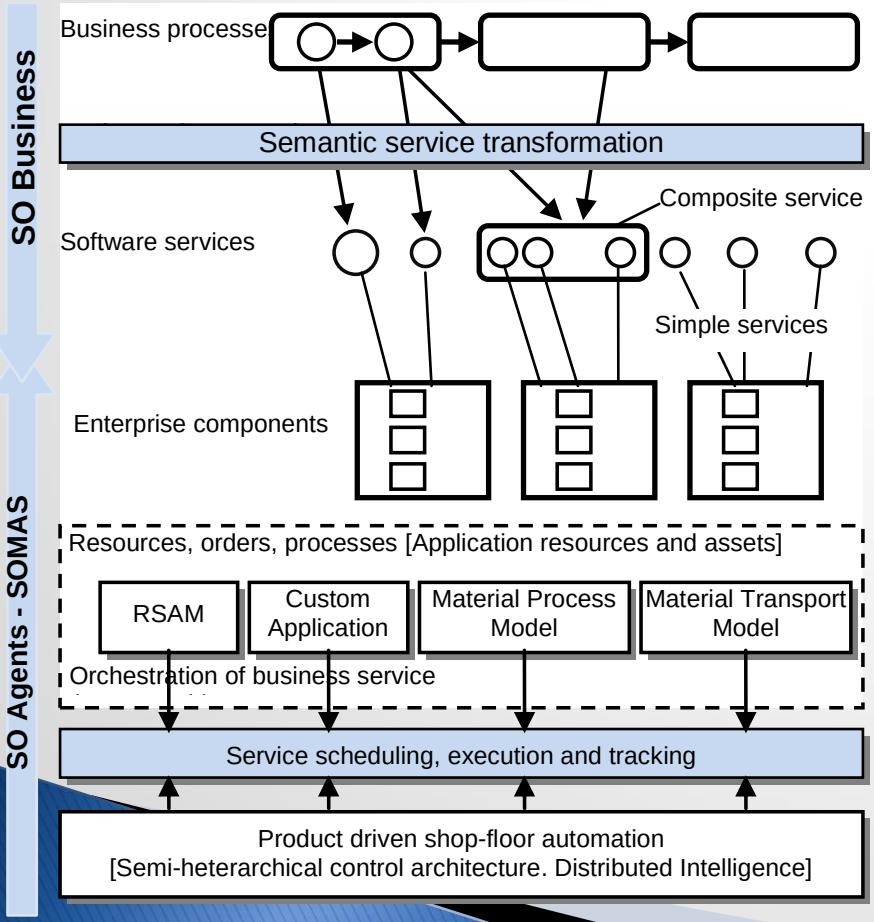
5. After-sales services

❑ (L7) Shift from GDL to SDL; Collect after-sales data from sensors and feed back in real time:

- ✓ Transform the commercial relationship with customers from one in which they sell a product to one in which they sell a service [Product-Service Extensions].
- ✓ Use sensor data from products once they are in use to: (a) improve service offerings, (b) create proactive smart preventive maintenance service packages, (c) detect manufacturing and design flaws [Intelligent Products]

SOEA and vMES: Enterprise Integration and virtualization





HMES – the SOA perspective

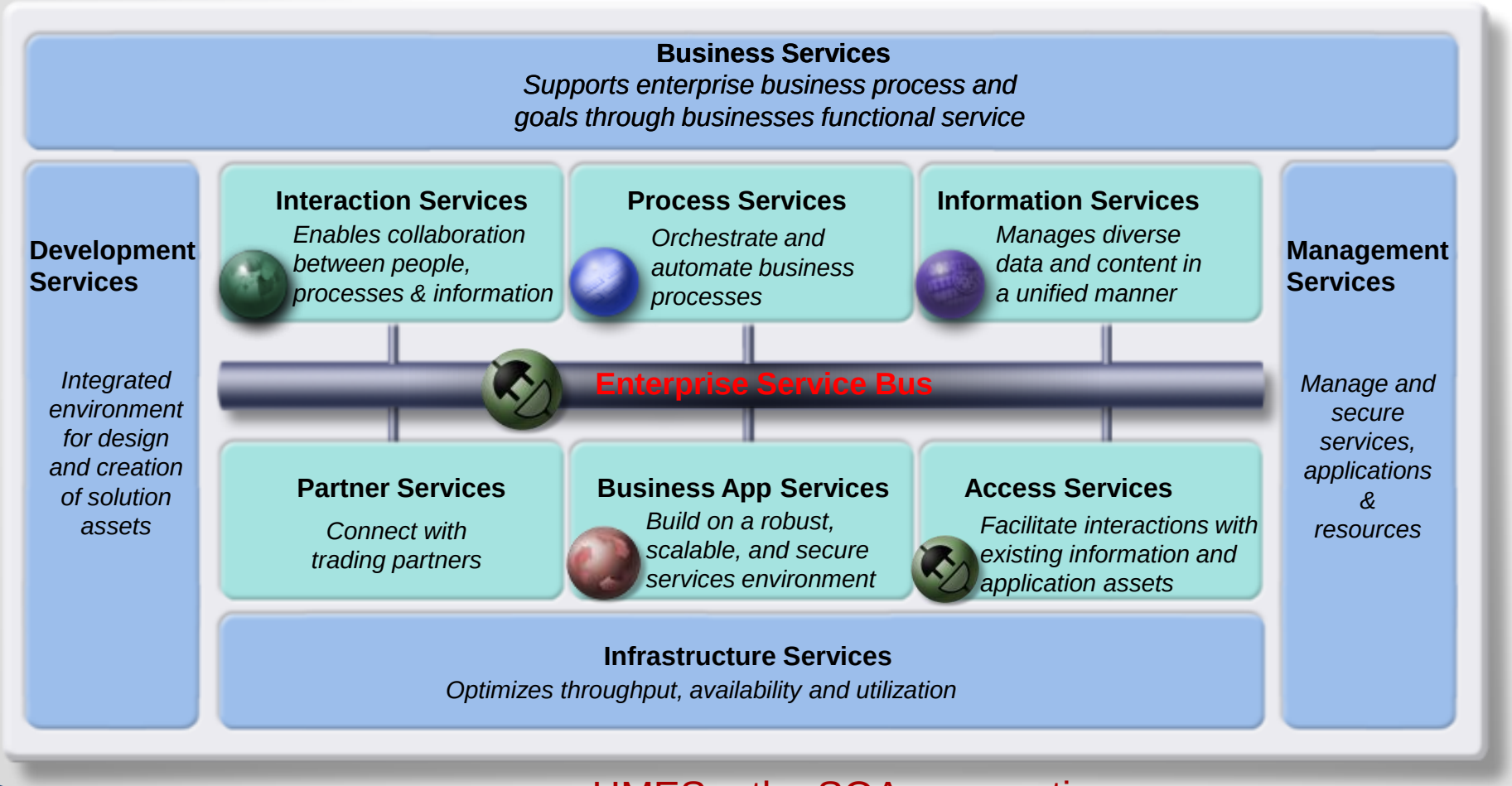
Componentization of BP lead to IT-supported services, interconnected through Enterprise Service Bus (ESB)

1. Top-layer services: *Business Services*, support enterprise business processes and goals.
2. Core Services:

- *Process Services*: orchestrate and automate BP;
- *Interaction Services*: enable collaboration;
- *Information Services*: manage data and content;
- *Business Application Services*: build services environ.;
- *Access Services*: facilitate interactions;
- *Partner Services*: connect with SC partners.

3. Bottom-layer services: *Infrastructure Services*, optimize throughput, availability and utilization

SOEA and vMES: Enterprise Integration and virtualization



HMES – the SOA perspective

Process (IT-services) connectivity through the ESB

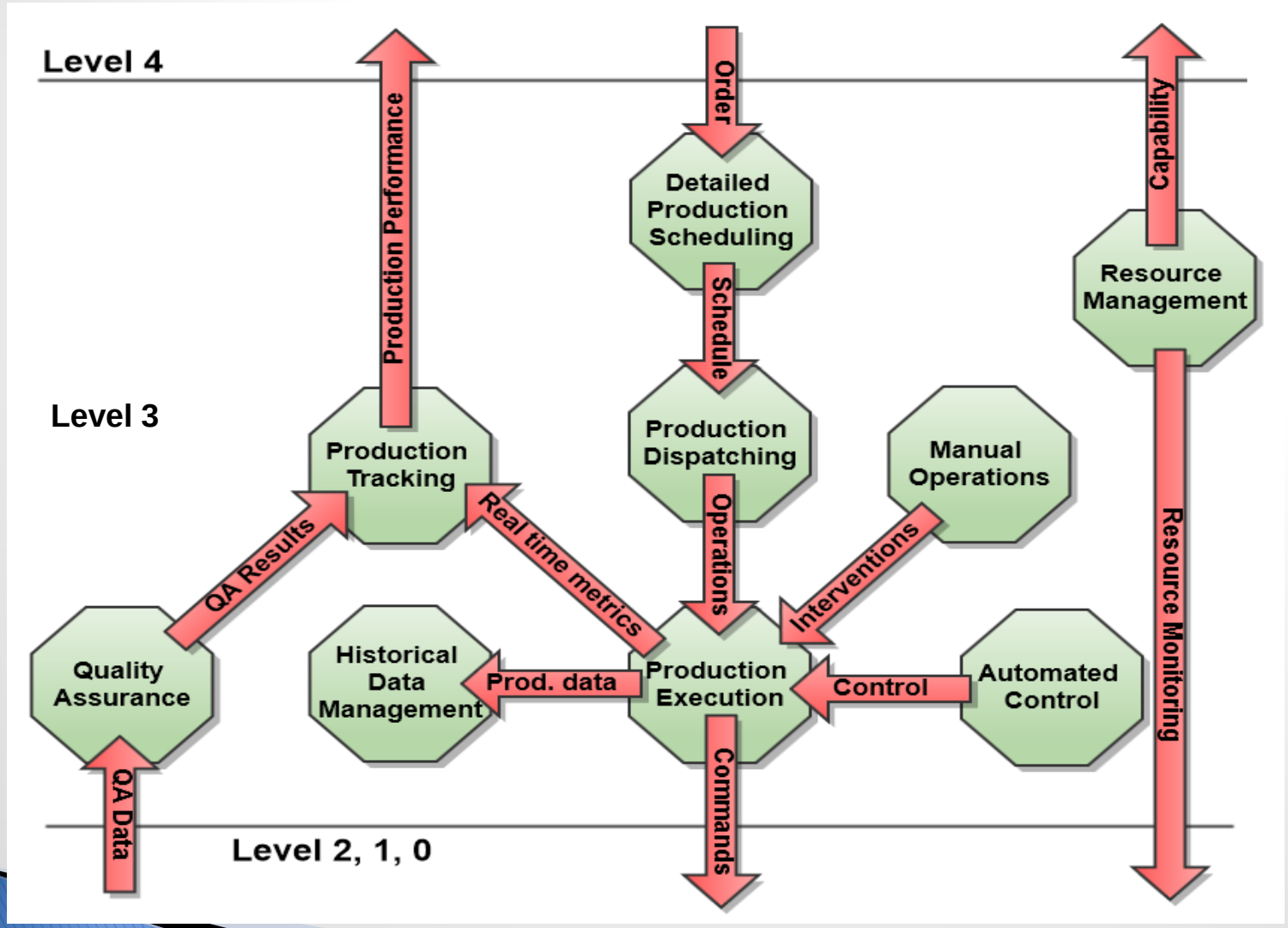
SOEA and vMES: ISA-95 Layers in manufacturing enterprises

- **Levels 0, 1** and **2** represent the process control levels and their objective is to directly control the physical shop floor equipment in order to execute the actual production operations that result in one or more finished products;

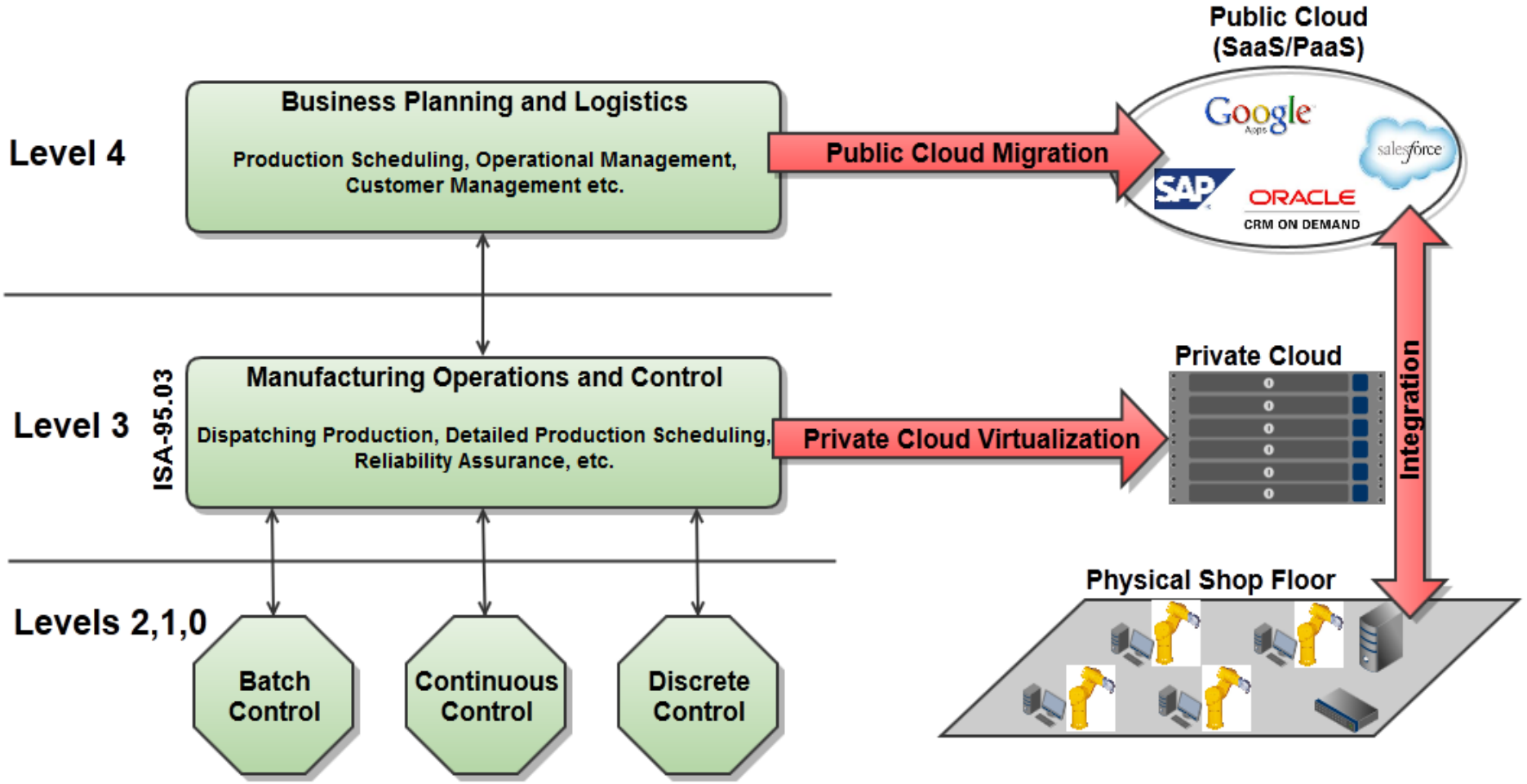
- **Level 3** is the MES (Manufacturing Execution System) level and consists of several activities that have to be executed in order to prepare, monitor and complete the production process executed at level 0, 1 and 2;

- **Level 4** is the ERP (Enterprise Resource Planning) level that executes the financial and logistic activities.

SOEA and vMES: Level 3 ISA-95modules and information flow



SOEA and vMES: resource virtualization for ISA-95 Levels 4 and 3 enterprise processes



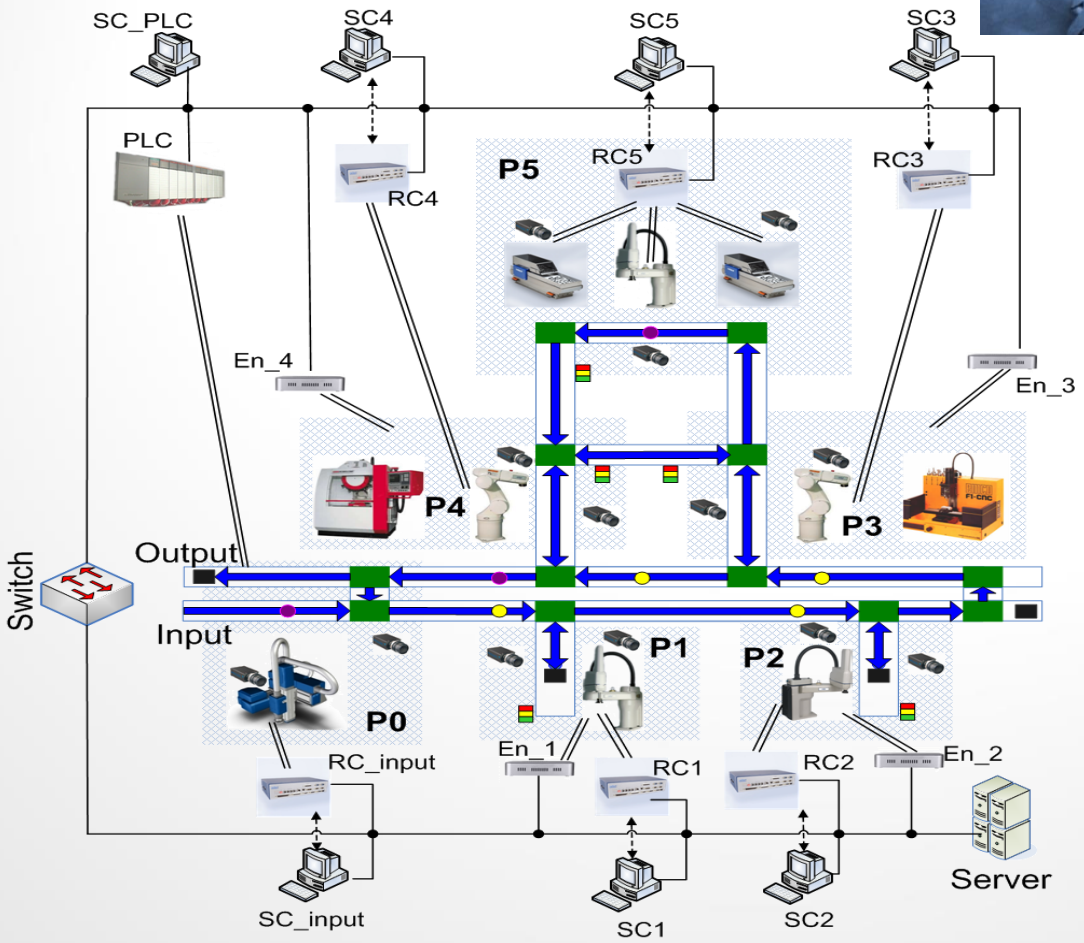
A new master program: Management of the Digital Enterprise (MDE)

Goal: Qualifying graduates with the necessary skills to reengineer and manage sustainable enterprises

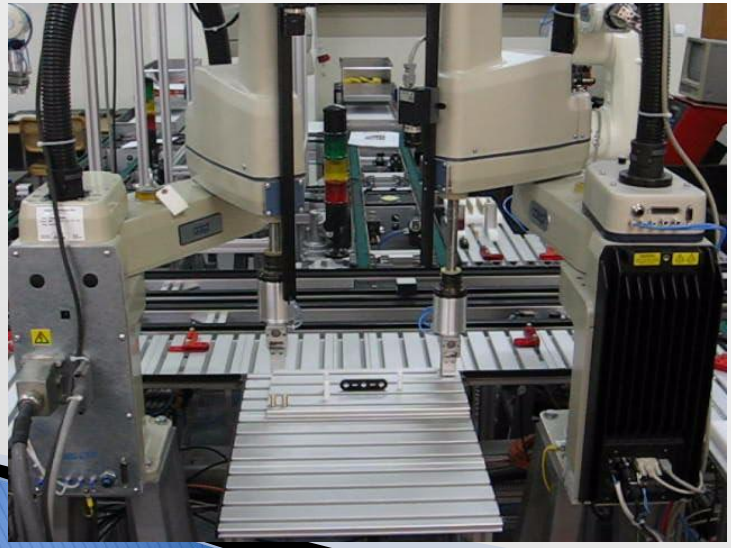
Course	Sem	Course	Sem	Course	Sem
Production Systems & Group Technology	I	Integrated Supply Chains and Logistics	II	Digital Marketing	III
Batch Planning and Resources Allocation	I	Enterprise Warehousing and Information Systems	II	Entrepreneurship	III
Organizational Management	I	Financial Management	II	Service Management	III
Scientific Research	I	Business Process Modelling	II	Business Communication	III
*Managing Human Capital**	I	Scientific Research	II	Business Process Management	III
*Economics for Managers**	I	*Project Management**	II	Scientific Research	III
*Business Intelligence and Risk Management**	I	*Team Management**	II	*Customer Relationship Management**	III
*Quality Management**	I	*Power Management for Sustainability**	II	*Asset Management**	III
		*Sustainability Product Design**	II	Scientific Research & Dissertation	IV

* Optional courses

A new master program: MDE
Manufacturing structure for Lab/Projects



A new master program: MDE
Manufacturing structure for Lab/Projects



Thank you!