



# INNOVATIVE SMART ENTERPRISE

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Drvengrad, Mećavnik, October 7, 2017

## Agenda

1. Introduction
2. Project Innovative Smart Enterprise – INSENT
3. Learning Factory FESB Split



## Agenda

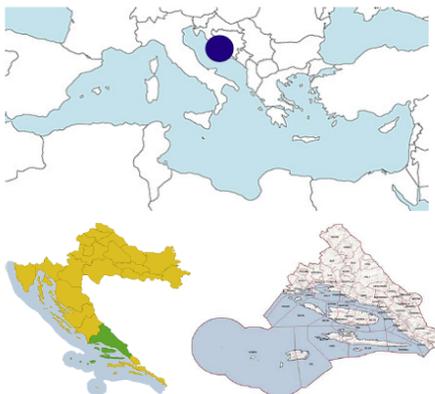
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### 1. GENERAL PROFILE OF SPLIT-DALMATIA COUNTY



#### OUR ROLE IN CROATIA



- Largest Croatian county with surface area of 14,045 km<sup>2</sup> (mainland 4,572 km<sup>2</sup>)
- Highest number of inhabitants among Croatian counties (464 thousand)
- Total 55 local self-government units, out of that 16 cities and 39 municipalities
- Natural diversity (hinterland, coastland, islands) and attractions (Natural Park Biokovo, Cetina River, Zlatni Rat beach, Blue Cave...)
- Rich cultural heritage: UNESCO (Old Town Split with Diocletian's Palace, Old Town Trogir), archaeological findings (Salona, Pharos, Issa), events (Split Summer Festival, Harmony-Singing Festival Sinjska Alka chivalrous tournament)...
- BDP in 2006 approximately EUR 6.000 per capita (approx. 80% Croatian average)
- Approx. 142 thousand of employees total



## ECONOMY DEVELOPMENT - ACTIVITIES OF COUNTY ECONOMIC DEVELOPMENT DEPARTMENT



*•The successfully society does not miss development chances; it undertakes steps in order to they would create it.*

	<b>ECONOMIC RESTRUCTURING PROGRAM</b>		<b>CLUSTER DEVELOPMENT</b>
	<b>SMALL AND MEDIUM SIZE ENTERPRISE INCENTIVE PROGRAM</b>		<b>DEVELOPMENT FUNDS</b>
	<b>ENTREPRENEURSHIP ZONE ESTABLISHING PROGRAM</b>		<b>MASTER PLAN OF TOURISM</b>
	<b>AGRICULTURE AND AGROTOURISM DEVELOPMENT PROGRAM</b>		<b>SCIENCE-TECHNOLOGY PARK</b>
	<b>ENERGY DEVELOPMENT PROGRAM</b>		



Split is the cultural and economic hub of Central Dalmatia.

**Split**  
**Diocletian's palace 305-2005**

It grew out of the Palace of the Roman Emperor Diocletian, built around AD 300 and now a place where ancient times live on along side the urban rhythm of the twentieth century. Its 1700 years of living history is protected by the UNESCO and will always fire the interest of visitors and travellers.



## CITY PROFILE

### SPLIT – GENERAL PROFILE

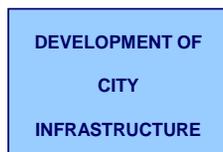
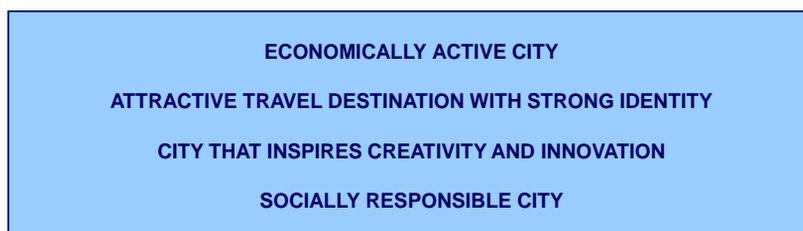


- The second largest town in Croatia and the largest town on the Croatian coast of Adriatic (200 thousand inhabitants)
- Center of the most dynamic administrative, economic, and transportation activities in the region of Dalmatia, with growing entrepreneurship and traffic connections
- The cultural and historical center of Croatia with rich, diverse, and globally attractive cultural and historical heritage
- The sports center of Croatia with global reputation in the world of sports
- The city with the largest potentials for tourism development in Croatia



## DEVELOPMENT PROJECTS

### SPLIT – VISION OF DEVELOPMENT



## CITY PROFILE

### SPLIT – CITY OF KNOWLEDGE



#### UNIVERSITY OF SPLIT

- The largest university in Dalmatia
- 11 faculties
- 3 university centers for studies
- University library
- Approximately one thousand professors and assistants
- Approximately 25 thousand students



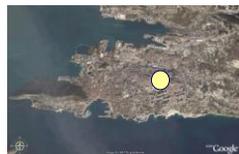
#### OTHER INSTITUTIONS OF EDUCATION AND KNOWLEDGE

- 28 elementary schools
- 26 high schools
- Mediterranean Institute for Life Sciences

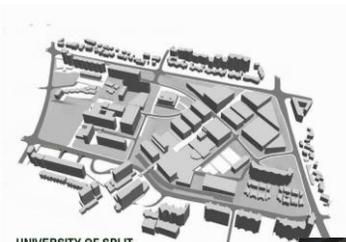


## DEVELOPMENT PROJECTS

### UNIVERSITY CAMPUS



- SURFACE** ■ 20,16 hectares
- CONCEPT** ■ Development of university campus with the following facilities:
- New buildings of several faculties
  - Scientific center, technology center, and multimedia center
  - University library
  - Sports hall and sports courts
  - Student center, student housing, and hostel
  - Administrative and supporting facilities
- INVEST.** ■ Approximately 200 million euros
- TERMS** ■ From 2006 to 2014



UNIVERSITY OF SPLIT  
CAMPUS PLAN - 3D SIMULATION



## FESB 1960 – 2009

- Founded 1960



- 1980 – New building



FESB



## FESB - PRESENT

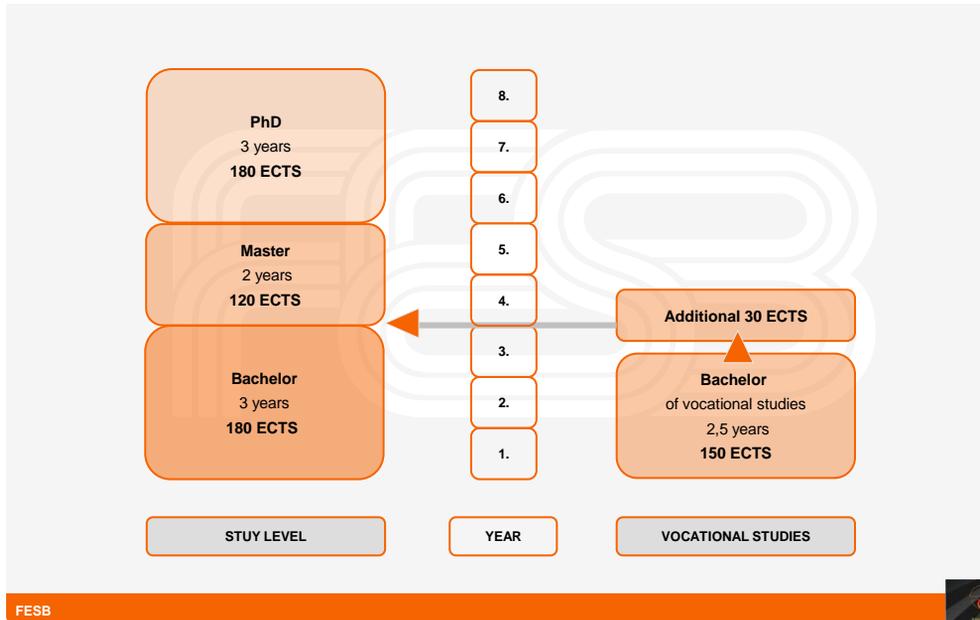


FESB





## Bologna process @ FESB



## Electrical Engineering and Information Technology

• Freshmen per year: 200 (40 paying fees)

### ▪ Bachelor of

#### ▪ ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY



### ▪ Master of

- AUTOMATICS AND SYSTEMS
- ELECTRONICS AND COMPUTING ENGINEERING
- ELECTRICAL ENGINEERING
- COMMUNICATION AND INFORMATION TECHNOLOGY

## Computing

- **Bachelor of**
  - **COMPUTING**
    - First year: general knowledge and basic programming
    - Second year: databases, algorithms, OOP, discrete systems ...
    - Third year: networks, software engineering, distributed systems, business systems



- **Master of**
  - **COMPUTING**
    - Advanced programming
    - Advanced distributed systems
      - e.g. research in GRID
    - Advanced architectures
    - Multimedia systems ...
    - Diploma thesis – whole semester



FESB



## Mechanical Engineering

- **Bachelor of**
  - **MECHANICAL ENGINEERING**
    - Freshmen per year: 90



- **Master of**
  - **MECHANICAL ENGINEERING**
  - Specialisations in:
    - **ENGINEERING DESIGN**
    - **PRODUCTION ENGINEERING**
    - **COMPUTER AIDED DESIGN AND ENGINEERING**

FESB

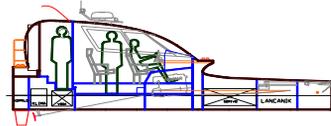


## Naval Architecture

- Bachelor of
  - **NAVAL ARCHITECTURE**
    - Freshmen per year 40



- Master studies
  - **NAVAL ARCHITECTURE**



FESB



## Industrial Engineering

- Bachelor of
  - **INDUSTRIAL ENGINEERING**
    - Freshmen per year 80 (30 paying fees)



- Master of
  - **INDUSTRIAL ENGINEERING**

- Joint study with Faculty of Economics in Split



FESB



## Doctoral studies

### ▪ ELECTRICAL ENGINEERING AND INFORMATION TECHNOLOGY



### ▪ MECHANICAL ENGINEERING



FESB



## Vocational studies

- **ELECTRICAL ENGINEERING**
  - Students per year: **80** (50 paying fees)
- **COMPUTING**
  - Students per year: **60** (50 paying fees)
- **MECHANICAL ENGINEERING**
  - Students per year: **40** (20 paying fees)
- **NAVAL ARCHITECTURE**
  - Students per year: **40** (20 paying fees)



FESB



## Computing equipment

- One medium size computer classroom (30 PCs)
- Two small size computer classroom (20 PCs)
- Few more small computer labs (~ 10 PCs)
- Public terminals
- WiFi
- GRID cluster
- Teleconferencing room
- 100 MB/s internal network with a 1 GB/s backbone
- Missing space for computer classroom
- FESB E-campus



FESB



## Number of students graduating per year

University studies (diploma engineers = master)	
Electrical engineering	110
Mechanical engineering	30
Computing	30
Industrial engineering	30
Vocational studies (engineers)	
Electrical engineering	40
Mechanical engineering	10
Naval architecture	15
Computing	20

FESB



## Research

### Our researchers are

- Leaders of more than 40 scientific/technological/information technology projects sponsored by Ministry of science, education and sports
- **Participating in international projects:**
  - Croatian-Slovenian cooperation program
  - COST (Electromagnetic Compatibility in Distributed and Complex Systems)
  - ALIS CROATIA - The British Council
  - CEEPUS
  - ERASMUS
  - CERN (ALICE - A Large Ion Collider Experiment, CMS - Compact Muon Solenoid)
  - CROATEA (Croatian Observatory At The Eastern Adriatic)
  - FP 7 and HORIZON 2020 projects
- **Guest professors and guest scientists** at many universities and labs
  - University of Berkeley, Universität Stuttgart, Technische Universität Berlin, Fraunhofer Institut für Betriebsfestigkeit, Columbia University, Imperial College of Science, University of Texas, Stanford University, Max Planck Institute, Université Libre de Bruxelles, King's College London, University of Vienna, University of Wales, Emory University Atlanta, Paul Scherrer Institute, Ecole Polytechnique, UNIDU ...

FESB



## Ivica Veza: Curriculum vitae

- Professor in fields of Production Management, Production Systems, Plant Layout and Logistic,
- Specialization at Fraunhofer Institutes - IPA Stuttgart, IPK Berlin, RTWH Aachen – three years
- Published 8 books, 30 papers in journal and over 150 articles on domestic and foreign symposiums,
- Worked 3 years in Shipyard Split and development director in Jugoplastika Footwear Split
- Secretary of Mechanical Engineering and Naval Architecture department of Croatian Academy of Engineering
- Counselor of the president of Split-Dalmatian County for economy
- Management member of the Technology center Split
- Head of the Technology Platform of Croatia [www.manufuture.org](http://www.manufuture.org)
- Head of the Shipbuilding cluster of the Split-Dalmatian County...



# Fraunhofer-Gesellschaft

The leading organisation for applied research in Europe



66 institutes, 80 research facilities  
 22 000 employees  
 € 1.9 bn EUR research budget  
 2/3 of Project Turnover from Industry-Projects  
 1/3 of Project Turnover from Public Research-Projects

Subsidiary  
 Center  
 Project Center  
 ICON / Strategic Cooperation  
 Representative / Marketing Office  
 Senior Advisor



Kyoto



Nagoya

Tokyo

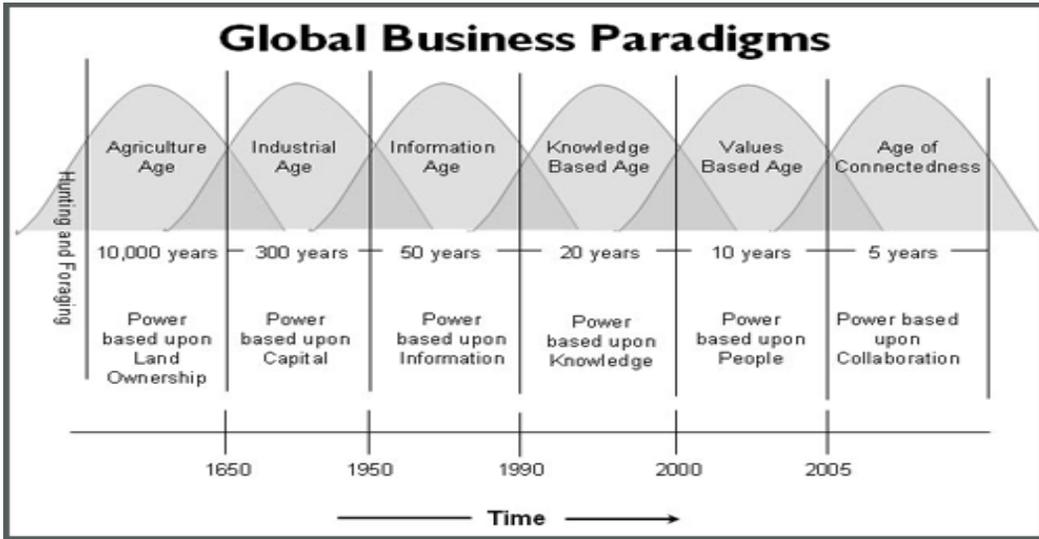




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2. **Project Innovative Smart Enterprise – INSENT**
3. Learning Factory FESB Split





Source: Guillory W. A, Harding C, Guillory D: "The FuturePerfect Organization - Driven by Quantum Leadership", 2004



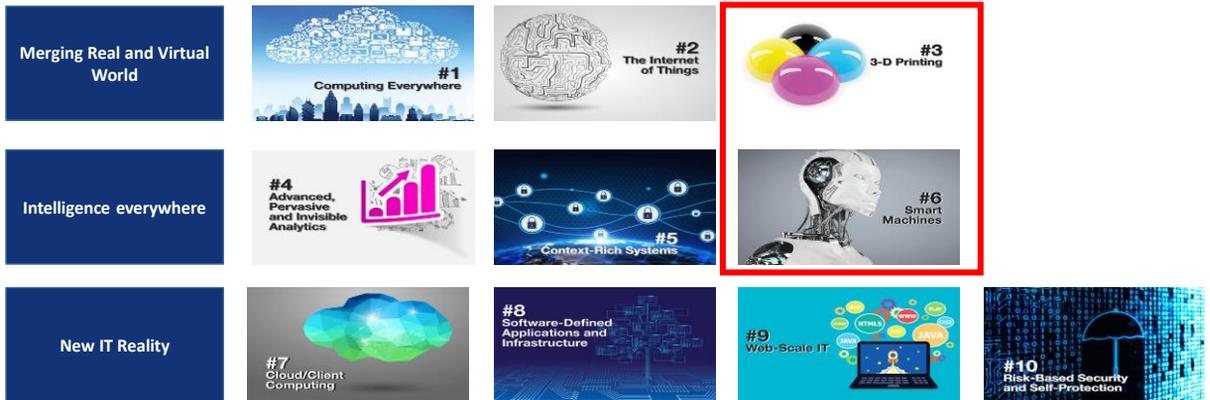
### Megatrends - overview



Source: Abele & Reinhart, 2011; Credit Suisse, 2009; Credit Suisse, 2010; Geisberger & Broy, 2012; Z\_punkt & BDI, 2011



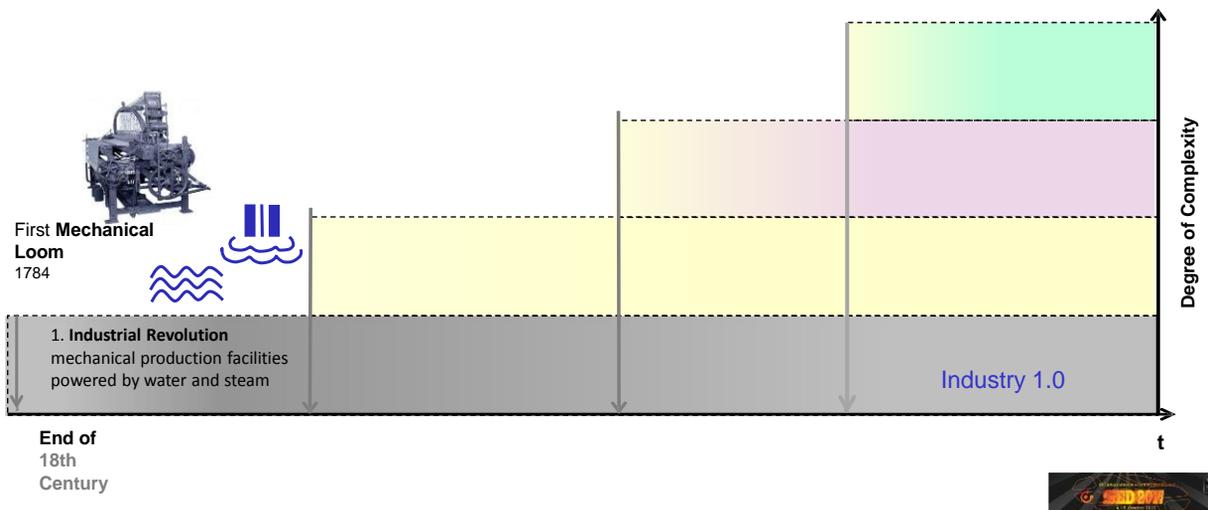
## Technology trends



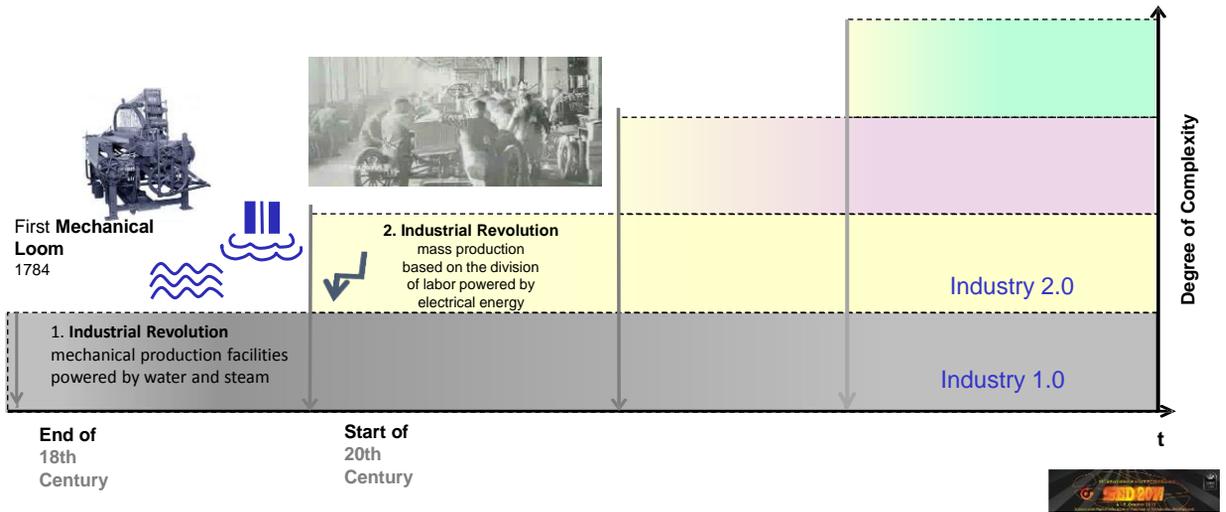
Source: Gartner | information-management.com



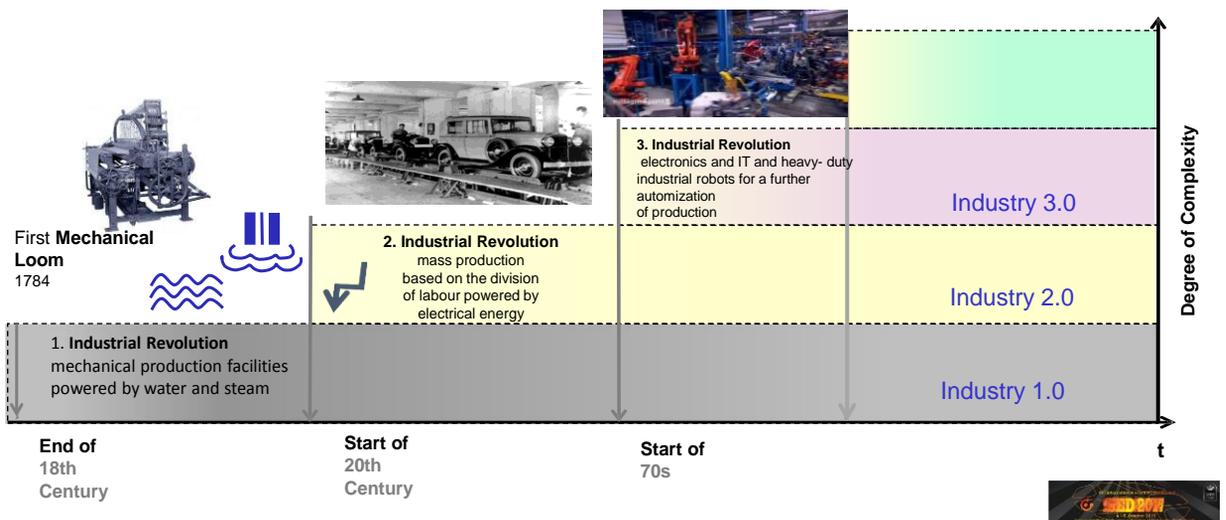
## From Industry 1.0 to Industry 4.0: Towards the 4th Industrial Revolution



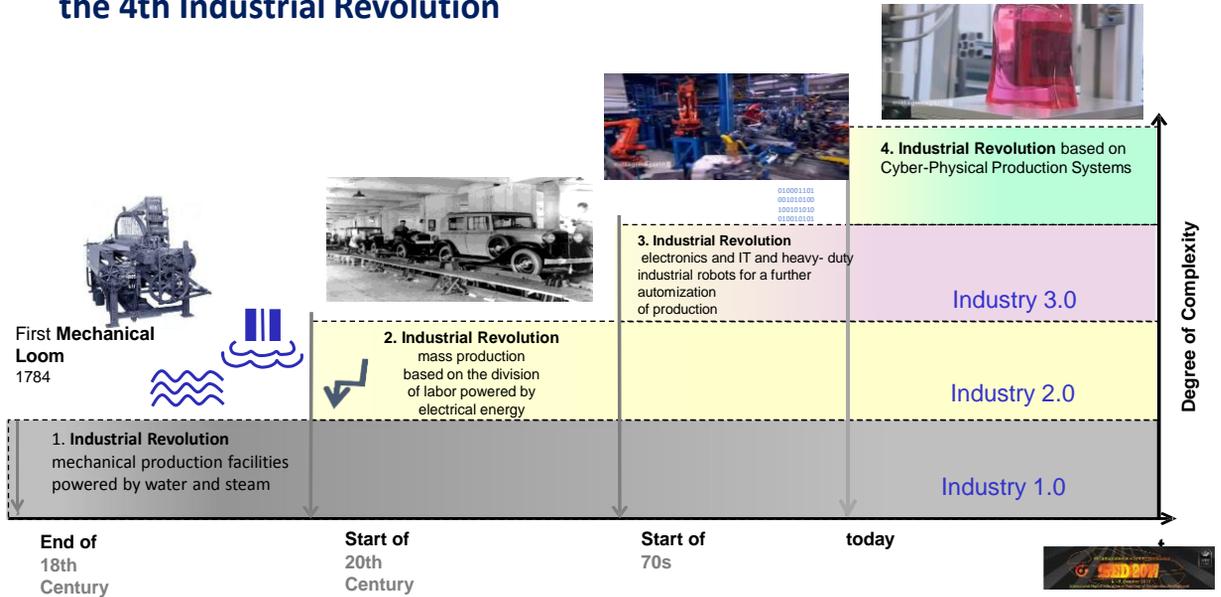
## From Industry 1.0 to Industry 4.0: Towards the 4th Industrial Revolution



## From Industry 1.0 to Industry 4.0: Towards the 4th Industrial Revolution



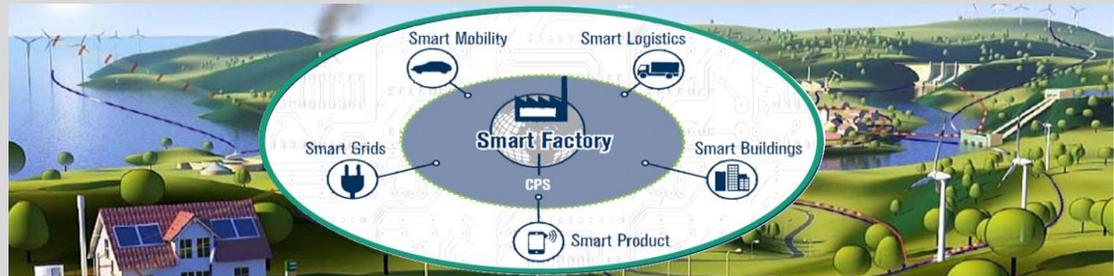
# From Industry 1.0 to Industry 4.0: Towards the 4th Industrial Revolution



## Industry 4.0 – What is it about?

Definition Industry 4.0

- “Industry 4.0” encompasses the **integration of state-of-the-art information- and communication technology (ICT) with conventional physical production and processes**, which enables the **development of new markets and business models**.
- “Industry 4.0” thereby targets the question of **how this integration can generate a customer-individual benefit**, for which the client is willing to pay.



# What is the Basic Idea of Industrie 4.0?

The Internet of Services – The Internet of the Things – Smart Everything



### Characteristics:

- Several autonomous Systems
- M-2-M Communication
- Complexity
- Heterogeneous Networks

Source: Acatech, BMW, TUWIn 4.0

### Challenges:

- Controlling and Monitoring
- Actuality, Integrity and Propriety of Data
- Integration of the physical Environment and IKT



# How does Industrie 4.0 work?

As a Cyber-Physical Production System, connecting the material and virtual world

### Technologies:

- Sensors & Actuators
- Cloud Services
- Wireless & Mobile Com.
- Self X
- (Standards)

### Cyber Space



### Functions:

- Communicating & Negotiating
- Interpreting & Deciding
- Configuration & Adjusting
- Analyzing & Optimizing



virtual/abstract



Visualization



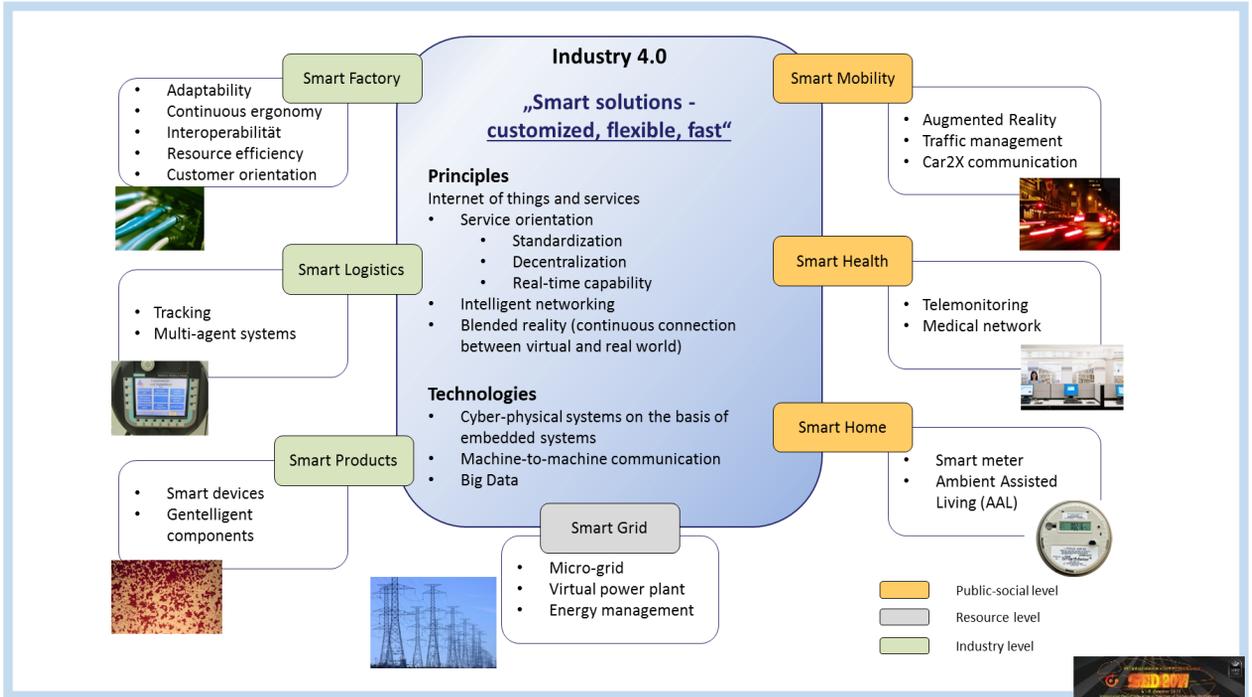
Control



real/concrete

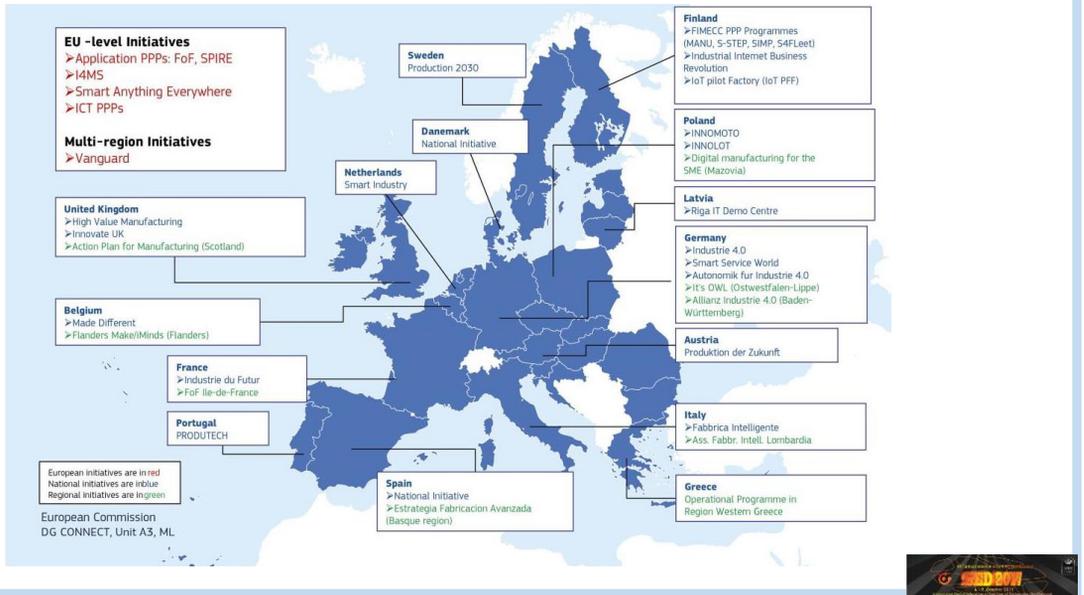
Source: TU Wien, Gerhard, 2014, TUWIn 4.0



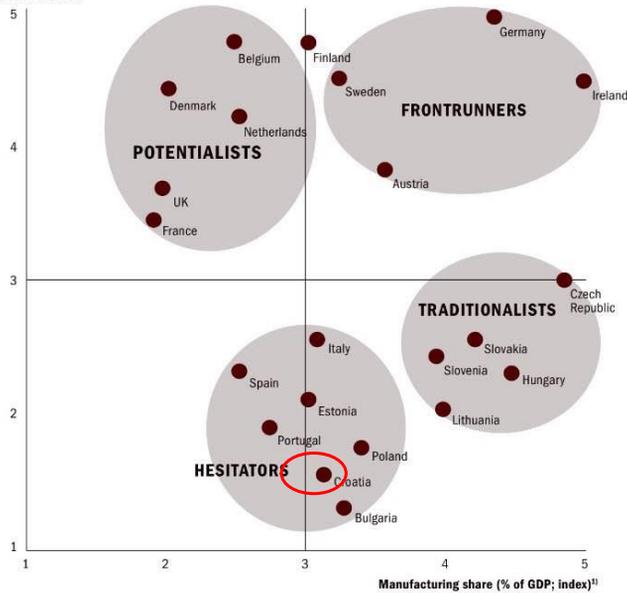


# Industry 4.0

## Overview of digital manufacturing initiatives in Europe



RB Industry 4.0 Readiness Index<sup>(1)</sup>



1) 1 = low, 5 = high 2) Adjusted for outliers Cyprus, Latvia, Luxembourg, Romania, Greece



## Project information

- Name: **Innovative Smart Enterprise**
- Acronym: **INSENT**
- Budget: ~ **100.000 €**
- Funding: **Croatian Science Foundation**
- Leader: **prof. dr.sc. Ivica Veža**
- Partners: **FESB Split, EFST Split, FSR Mostar**
- Start-date: **1<sup>st</sup> September 2014**
- Finish-date: **31<sup>st</sup> October 2018**



## Project INSENT

The main aim of this project is to develop the Croatian Model of Innovative Smart Enterprise (HR-ISE model).

- The aim is to make a regional adaptation of the model with a specific regional:
  - way of thinking,
  - production,
  - organizational tradition,
  - education.

The HR-ISE model can help Croatian enterprises to bridge the gap between their competences and the competences and opportunities of EU enterprises.



<http://insent.fesb.hr>



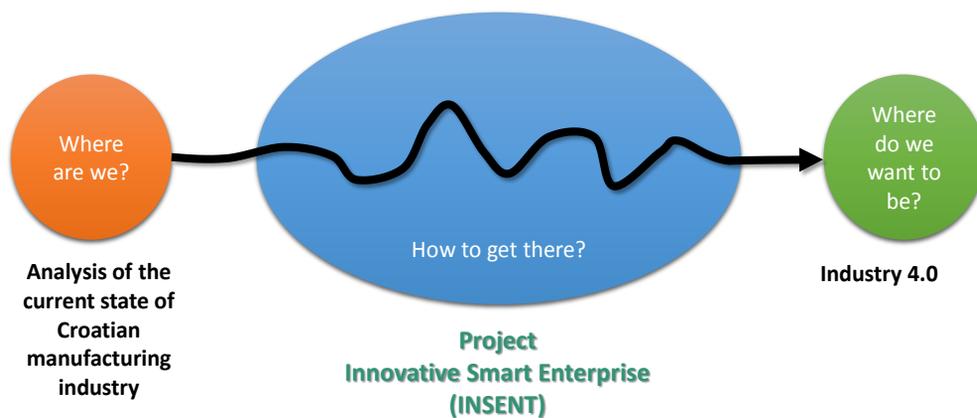
## Vision

**Vision of Innovative Smart Enterprise** for next generation manufacturing can be summarized into following features:

- Lean
- Flexible
- Agile
- Efficient
- Responsive
- Information Enabled
- Predictive
- Safe



## Project INSENT - Main aim



## Objective 1

- Objective is to answer the question: **“Where are we?”**
- It is important to perform profound research to **describe current state of Croatian manufacturing enterprise**
- It will be done by **questionnaires and interviews** with CEOs and/or technical directors of manufacturing enterprises in Croatia



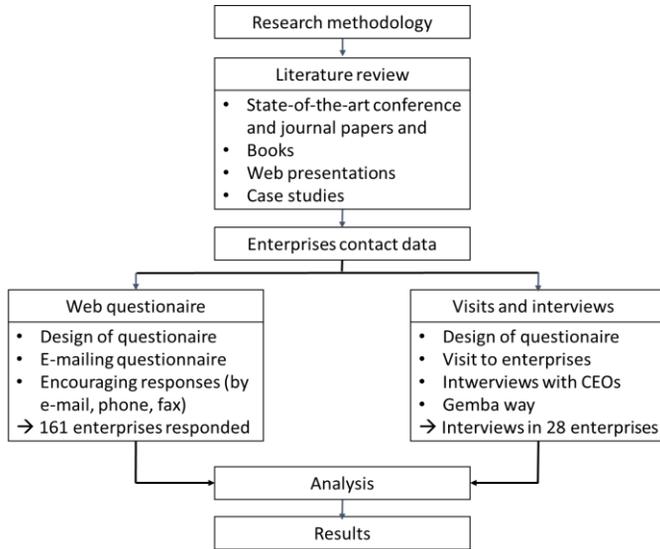
## Objective 2

- Objective is to answer the question: **“Where do we want to be?”**
- A synthesis of analysis of Croatian manufacturing enterprises will be done through **development of Croatian model of Innovative Smart Enterprise (HR-ISE model)**
- A special efforts will be made **to bridge the cultural and mentality gaps** between State-of-the-art models and current Croatian model

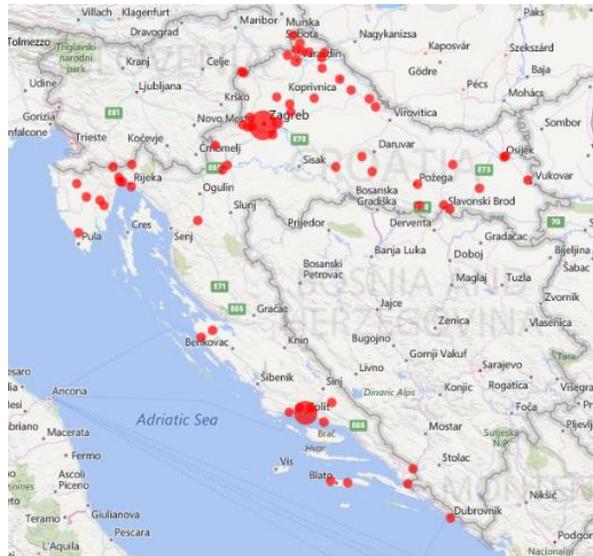
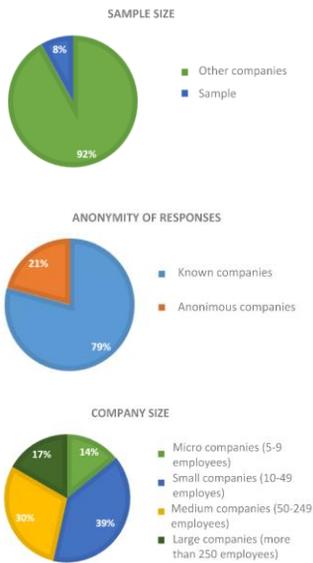




## Methodology for obtaining maturity level of Croatian industrial enterprises



## Where are we?



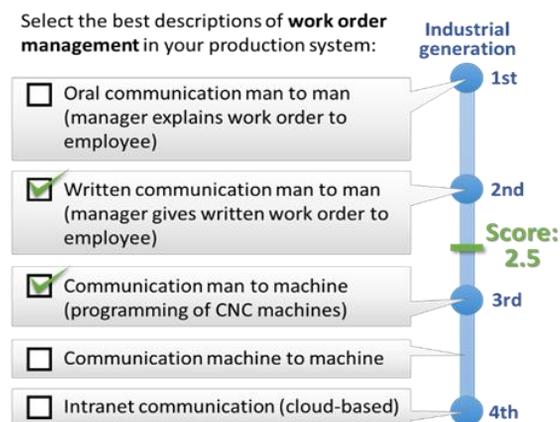
## Set of nine questions for factories

1. Product development,
2. Technology,
3. Work orders management in your production system,
4. Monitoring of production traceability,
5. Materials inventory management,
6. Finished products stocks management,
7. Quality Assurance,
8. Product Lifecycle Management,
9. Application of Toyota Production System TPS and Green and Lean Production GALP concept.

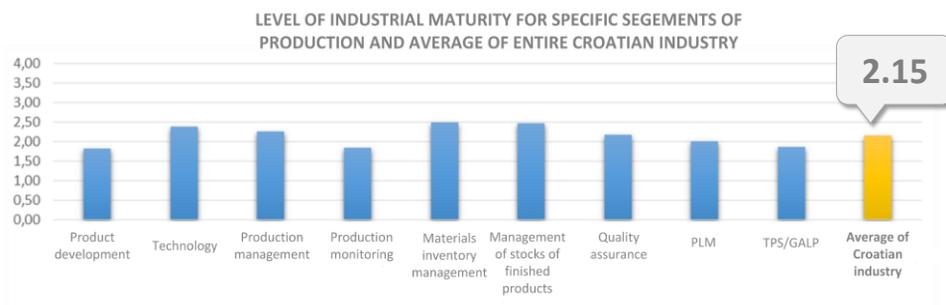


## The example of scoring model for one question

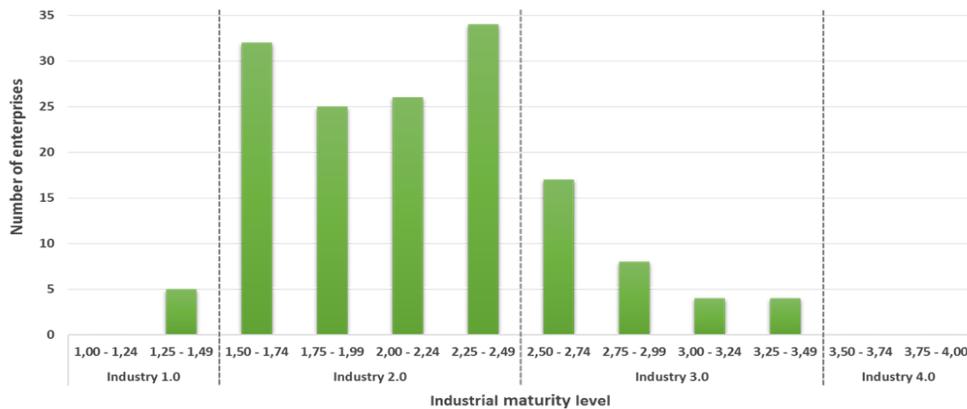
Select the best descriptions of **work order management** in your production system:



## Results: Average level of Industrial maturity



## Enterprises positioned according to their industrial maturity



## Range of Industrial Maturity Index in Croatia

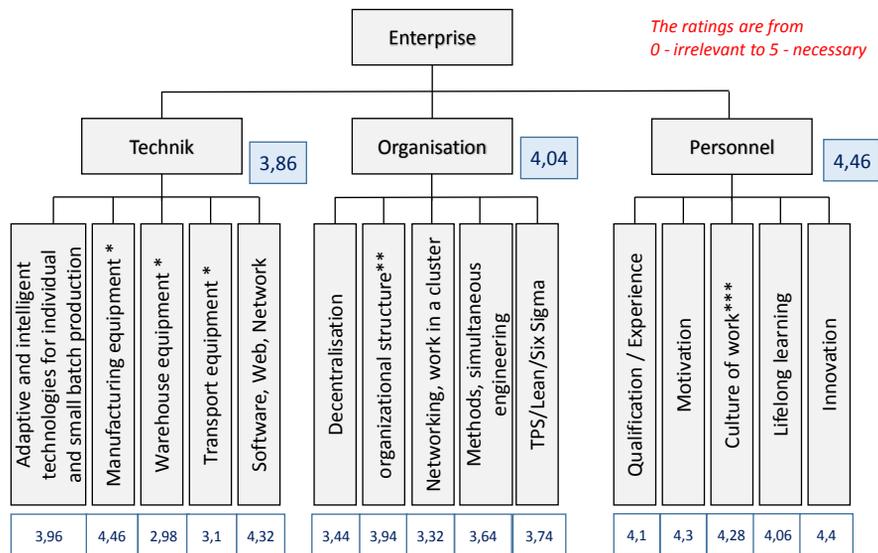
From Industrial maturity index **1,7**



To Industrial maturity index **3,4**



## Evaluation results of techniques, organization and personnel



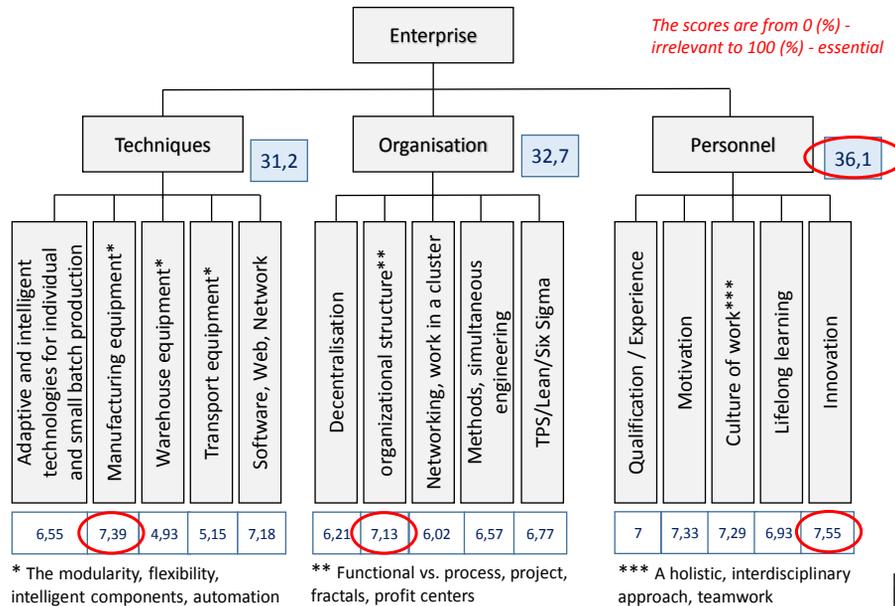
\* The modularity, flexibility, intelligent components, automation

\*\* Functional vs. process, project, fractals, profit centers

\*\*\* A holistic, interdisciplinary approach, teamwork



## Evaluation results of techniques, organization and personnel



## Analysis of personnel

### 1. The age structure

- Domination of older workers with experience and knowledge (from 50 to 60 years)

### 2. Level of the qualification

- From 5-10% of workers employed in the company has university degree, master's degree or a doctorate degree (in companies with more than 100 employees). A large percentage of companies do not have research and development department.

- Enterprises also complain about the lack of specific knowledge and competencies at all levels: **industrial practice finished students, knowledge of a foreign language, computer application in product development and manufacturing, numerical control machine tools, basic knowledge in the field of mechanical engineering, naval architecture and mechatronics** etc.

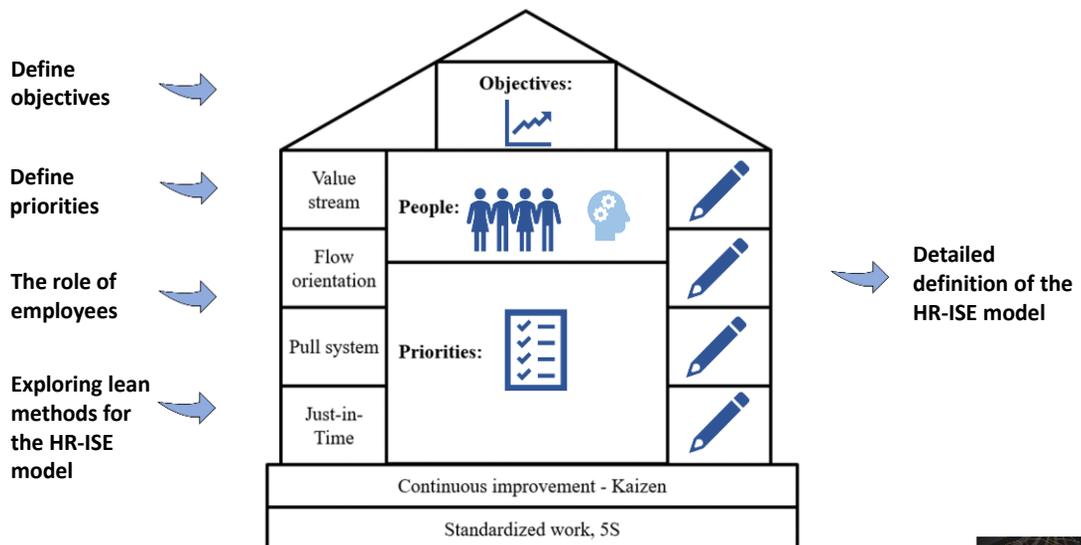
- Only rare enterprises give scholarships to students during high school and university.

## Analysis of personnel

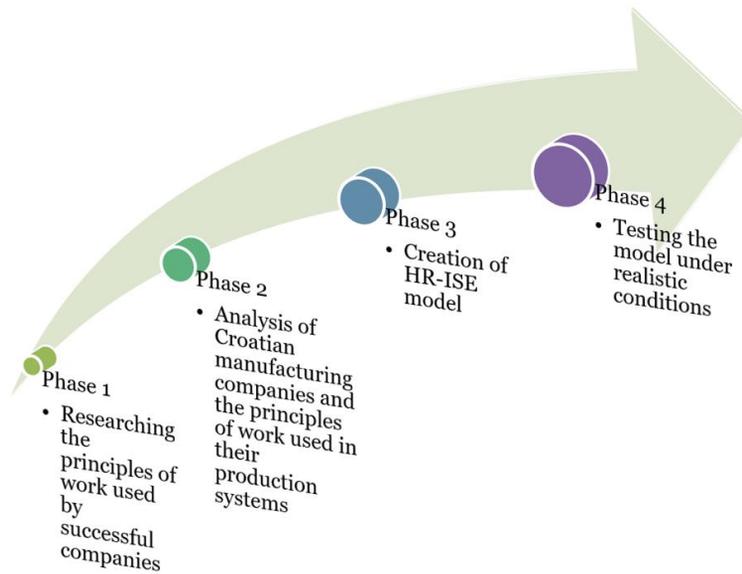
3. **Motivation** - Enterprises often do not offer any type of motivation to its employees. In practice, the most common form of employee motivation is financial incentives to reward.
4. **Innovation** - Enterprises generally do not have system for evaluation of employee innovation. Exceptions are those companies that have a service that tracks innovation and suggestions for improvements from employees.
5. **Life-Long Learning** - Other important factors include the following areas: **foreign language skills, knowledge of legislation, management skills, knowledge of ISO norms and standards of quality assurance products, computer aided design and manufacturing, design, knowledge of specific computer programs and tools, knowledge of new technologies, handling equipment and machinery, etc.** There are rare enterprises whose employees spend more than 5 days per year on training.



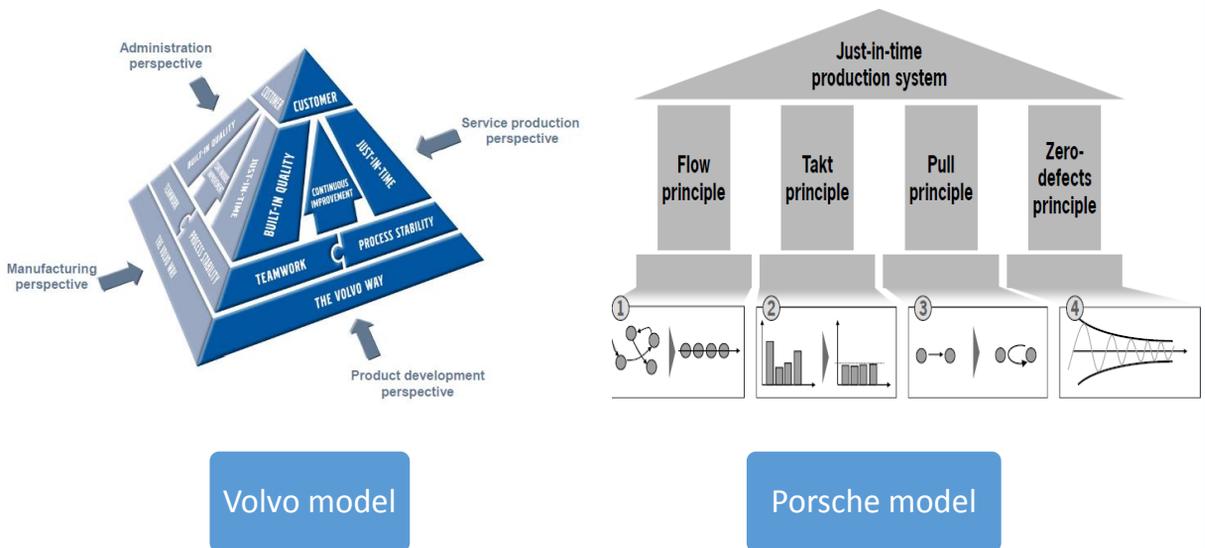
## Generic HR-ISE model with basic lean tools



## How to move toward Industry 4.0?

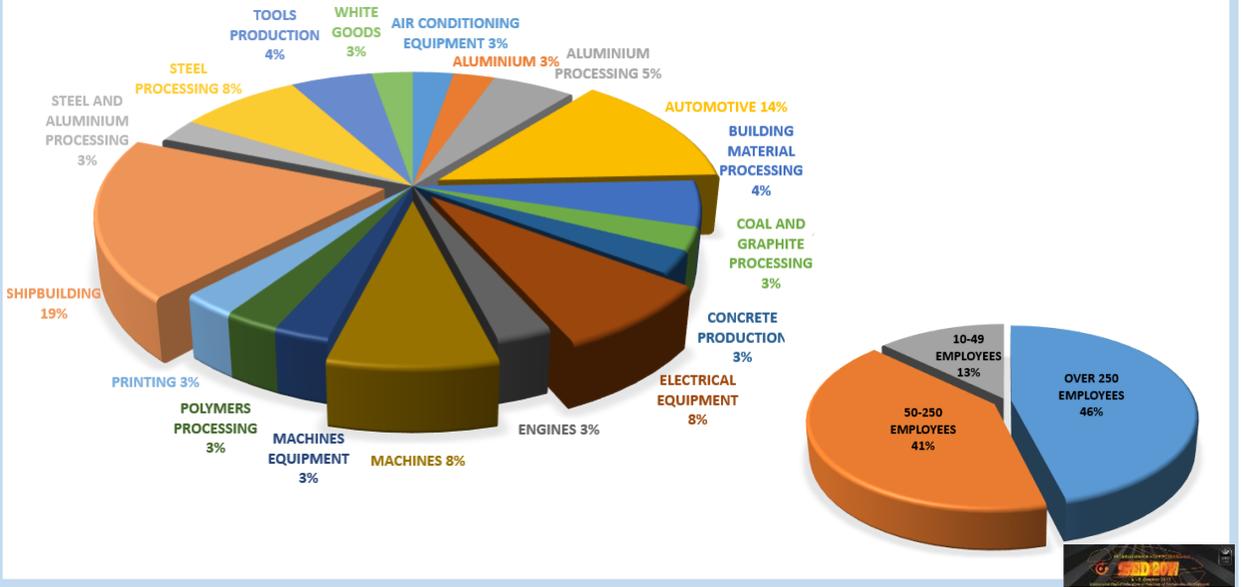


## Overview of models of foreign enterprises





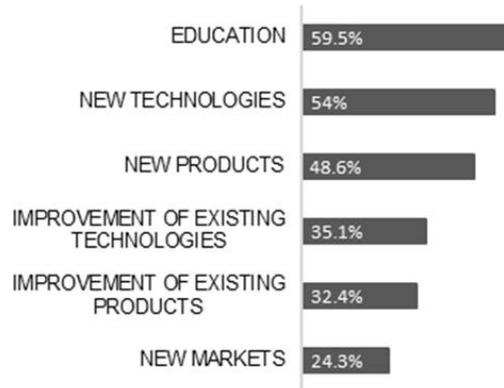
### The surveyed enterprises belong to different industries



What are the basic objectives of your enterprise?



**What are the main priorities of your enterprise?**



Set  
PRIORITIES



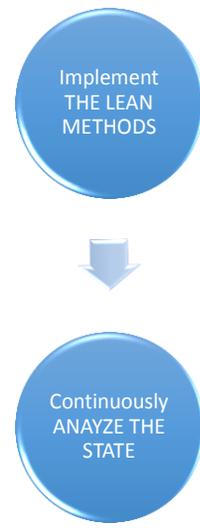
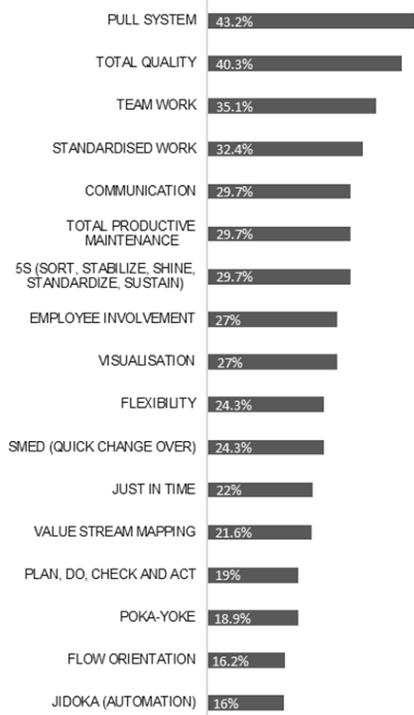
**What are the requirements of an enterprise for employees (qualification, motivation, innovation, lifelong learning, etc.)?**



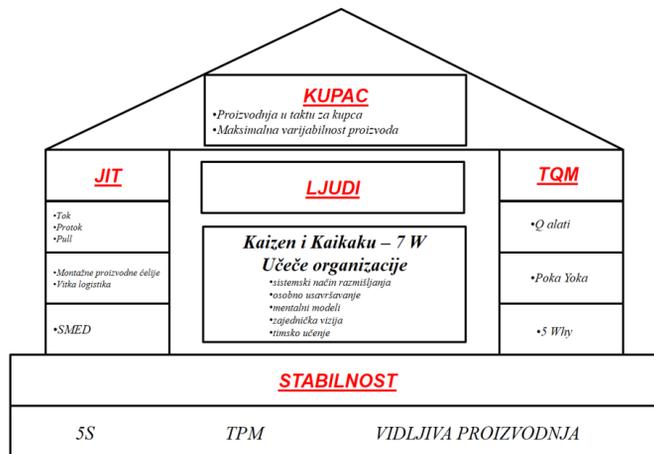
Include  
EMPLOYEES



Which tools and lean methods should be set in the HR-ISE model?

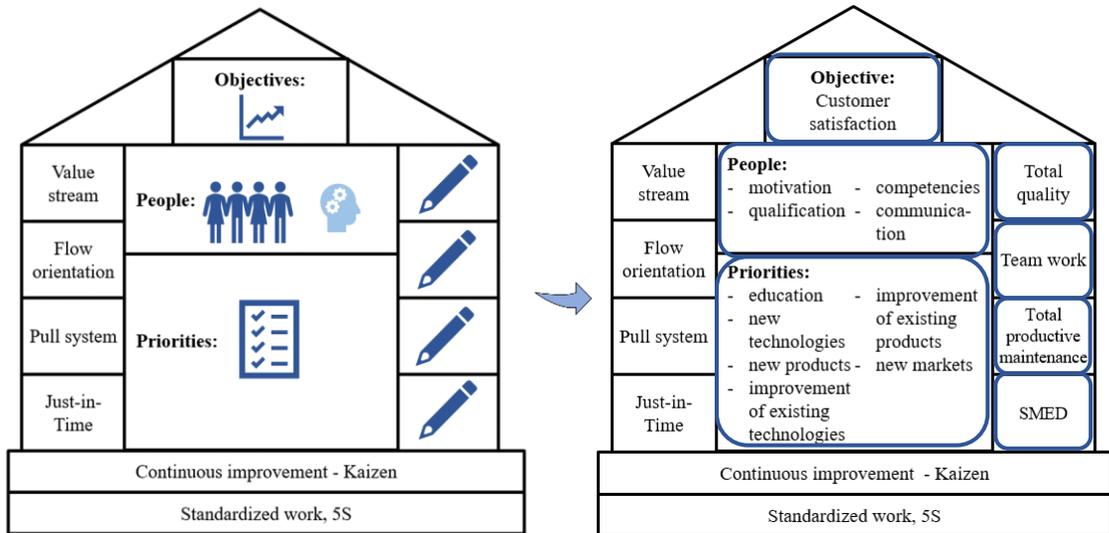


### The example of model in Croatian enterprise

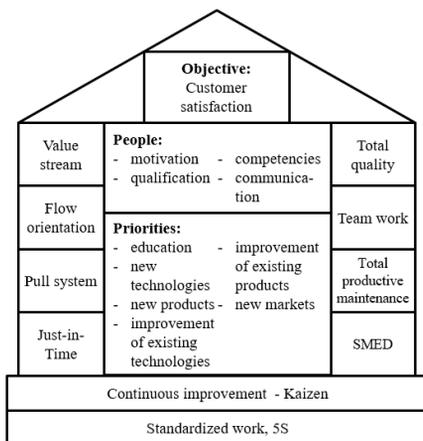


One of 37 surveyed enterprises has model similar as HR-ISE model

## Definition of the HR-ISE model



## Future research



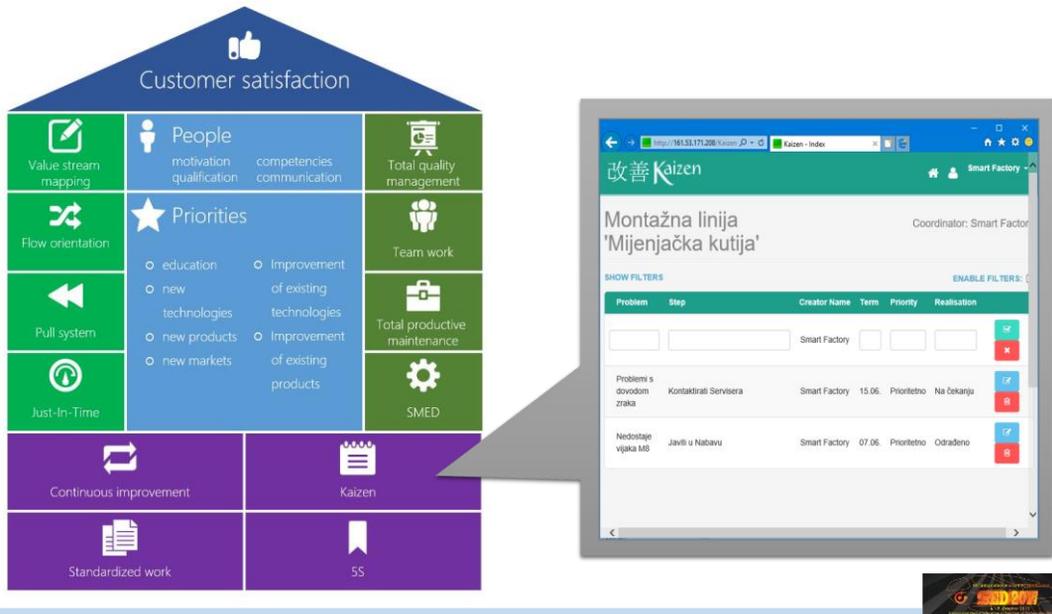
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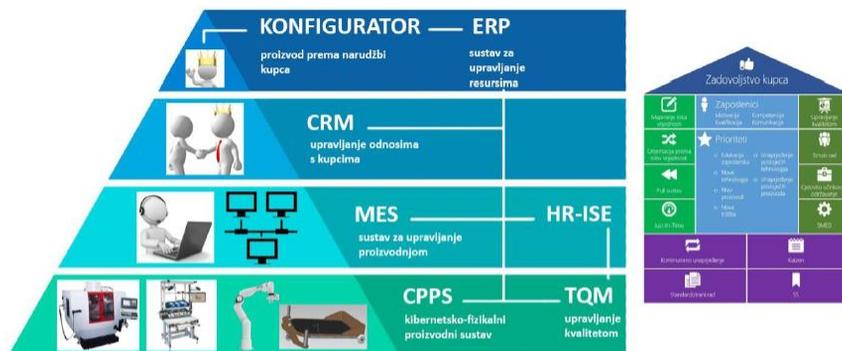
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## Applications to support the introduction of the HR-ISE model



## Shematski prikaz razvijenog Inovativnog pametnog poduzeća modela



Skraćenice:

CPPS – Cyber-physical Production System (Kibernetičko-fizikalni proizvodni sustav)

CRM – Customer Relationship Management

ERP – Enterprise Production System

HR-ISE – Hrvatski model – Innovative Smart Enterprise

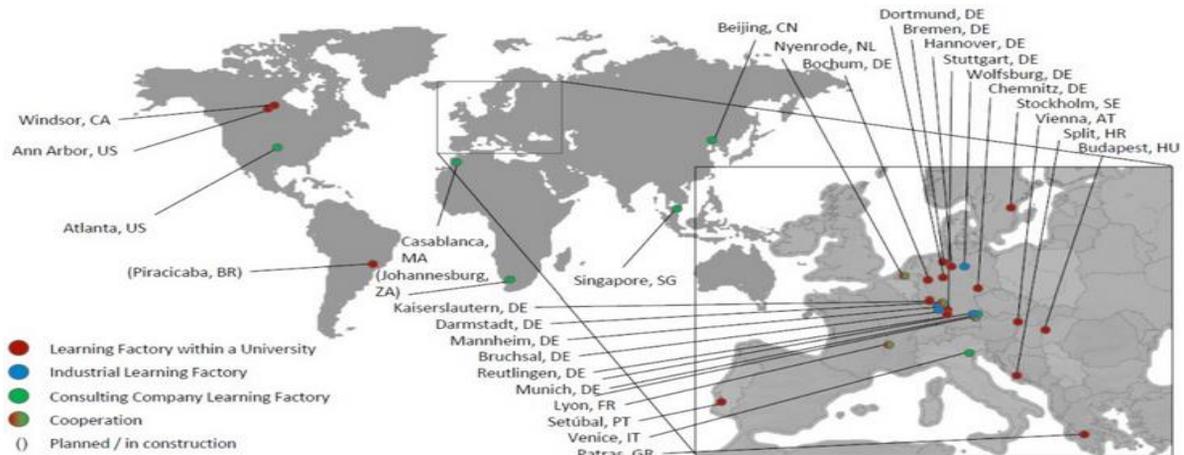
MES - Manufacturing Execution System

TQM – Total Quality Management





## Worldwide Learning factory

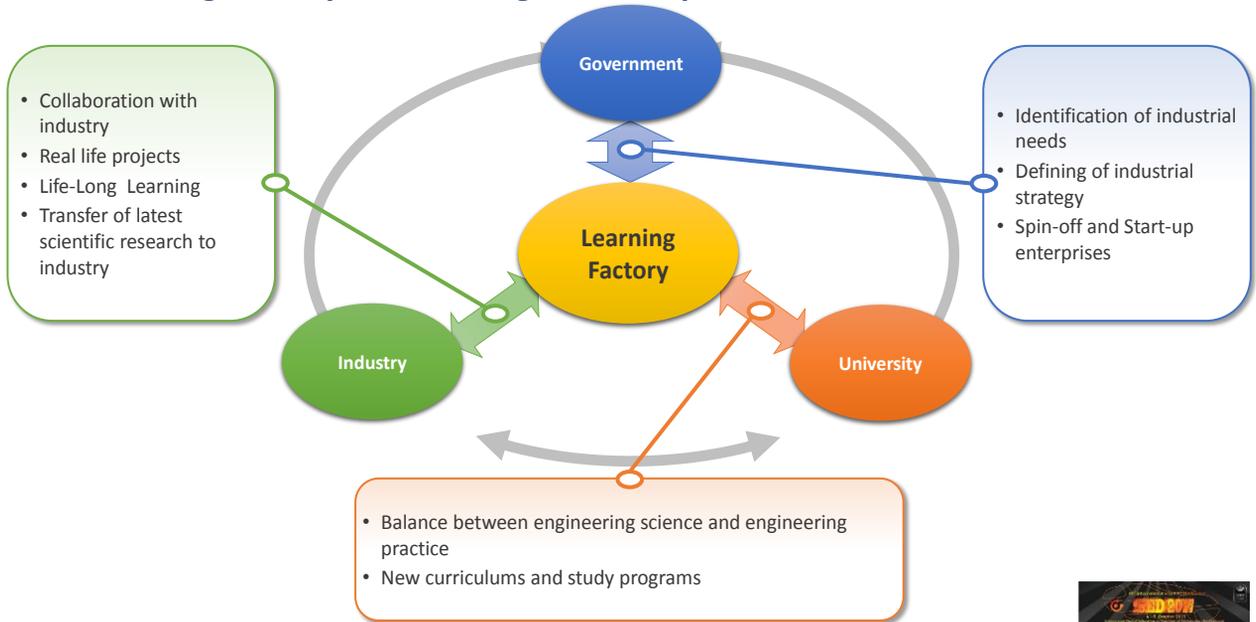


## Vision and Mission of Lean Learning Factory at FESB

- Vision of Lean Learning Factory at FESB is to be a place where University, Industry and Government meet each other share needs and expectations, and work on collaborative projects.
- Mission of Lean Learning Factory at FESB is to help bring the real-world into the classroom by providing practical experience for engineering students, to help transfer latest scientific research to industry through collaborative projects and LLL, and to help government identify needs of industrial enterprises.
- “Living lab” will be based on Learning Factory concept, and aims will be achieved through projects: **NIL (DAAD project)** and **INSENT (CSF project)**.



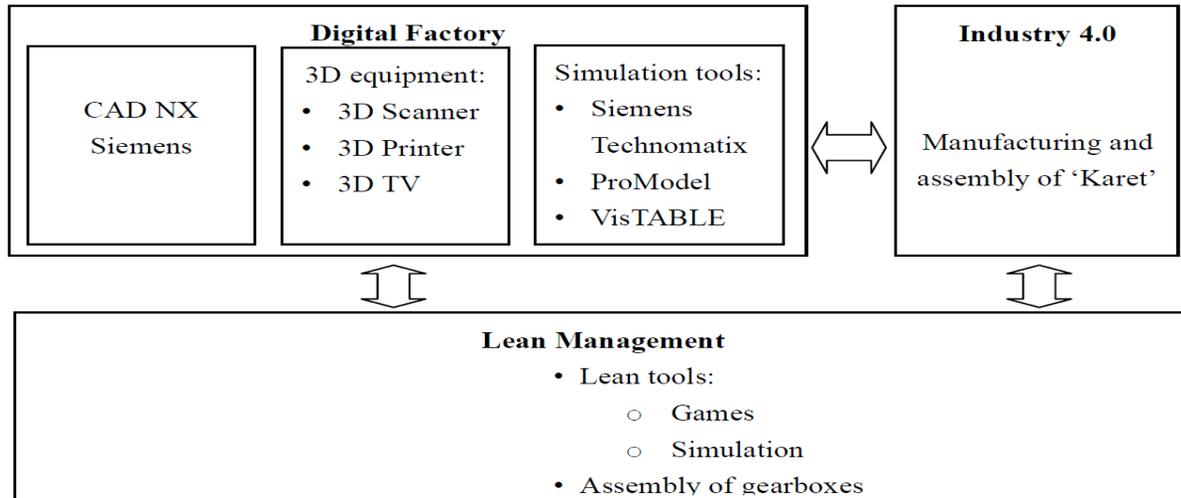
## Learning Factory as a missing link in Triple helix model



## Definition of Lean Learning Factory at FESB profile from a typology

Characteristic	Features				
	Operating organization	industry	consulting	university	technical college
Type of use	education / training		research	further industrial use	
Industrial target groups	operational staff		engineer	manager	
Academic target groups	students			research stuff / post graduated	
Other target groups	lean experts / lean specialist			other consultants	
Selected industries	machine building	automotive industry	chemical industry	electrical industry	insurance, banks, etc.
Product	real products			imaginary (didactic) product	
Production process	machining	assembly	logistic	IT	indirect / production
Module content	process improvement		diagnosis	system design	quality control
	quality		material flow	technology optimization	lean transfer
Integrated departments	production	distribution	purchasing	ideas mgmt.	design / develop. / prod. plan. and control
Integrated teaching methods	presentation	demonstration	tutorial	web-based training	simulation game
	discussion	case study	role play	experimental game	...
Learning factory size	< 300 sqm	300 – 2000 sqm	2000 – 10000 sqm	> 10000 sqm	
Number of course participants	< 5	5 – 10	10 – 20	20 – 30	> 30
Duration of module	< 2 h	2 – 5 h	5 – 10 h	10 – 20 h	> 20 h

## The content of Laboratory for Learning factory at FESB



## Education

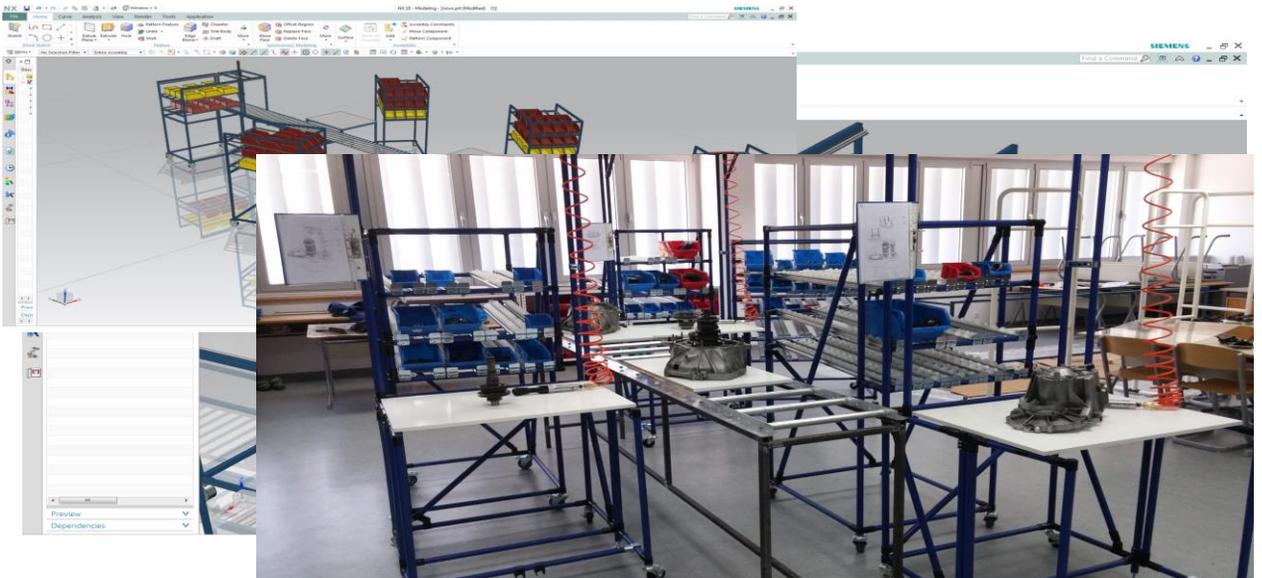
- Undergraduate lectures: study of work and time, organization of production systems
- Bachelor thesis
- Graduate lectures: manufacturing technologies planning and optimization, plant layout
- Master thesis
- Postgraduate study lectures: Modeling and simulation, CIM, Logistics optimization
- Doctoral thesis
- Professional study lectures: production planning and control
- Professional study thesis



## Implementing and improving didactic games for learning purpose



## Reconfigurable assembly line in Learning Factory



## BeeWaTec AG assembly workplaces

- Hands-on education in the LLF
  - Assembly process of toy trucks and toy formula cars
  - Modified “Lego flowcar®” simulation game
- Complete used car gearboxes, from models Zastava 101 and Yugo 45
  - 2 versions of gearbox cases and different parts
  - gearbox consists of 118 parts
  - more than 20 different final products

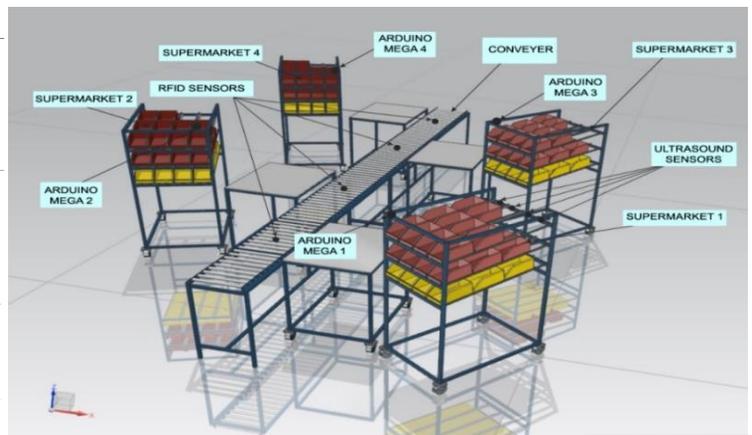


## Assembly line with sensors

I4.0 element	Element installed in LF@FESB	Cost range (in general)
RFID antenna	TURCK BL R/W Antenna 13.56 MHz (2 - 4 antennas)	1.000 - 5.000 EUR
RFID I/O module	Lucas-Nuelle Evaluation unit (TURCK BL I/O modular system) with up to 4 antennas	1.000 - 5.000 EUR
CPU	Siemens PLC 314	5.000 - 10.000 EUR
User interface	Tablet Lenovo MIX 300	100 - 500 EUR
Total		7.100 - 20.500 EUR

### MES elements implemented in assembly line 'gearbox'

I4.0 element	Element installed in LF@FESB	Market price
4 x RFID antenna	RFID RC522	2 - 8 EUR (x 4)
30 x Ultrasonic sensor	Ultrasonic 11C-S4504	3 - 10 EUR (x 30)
5 x CPU	Arduino Mega microcontroller	3 - 10 EUR (x 5)
1 x User interface	Custom-made box with led display	10 - 30 EUR (x 1)
Total		178 - 652 EUR



### 3D model of laboratories in VisTable



## The development of new products, specific to the City of Split

Karet - vehicle without drive, braking and safety elements; generations favorite street toy on downhill of Split.



Version of the original karet

Improved karet by the FESB



## Integrated elements Smart Factory within Learning Factory

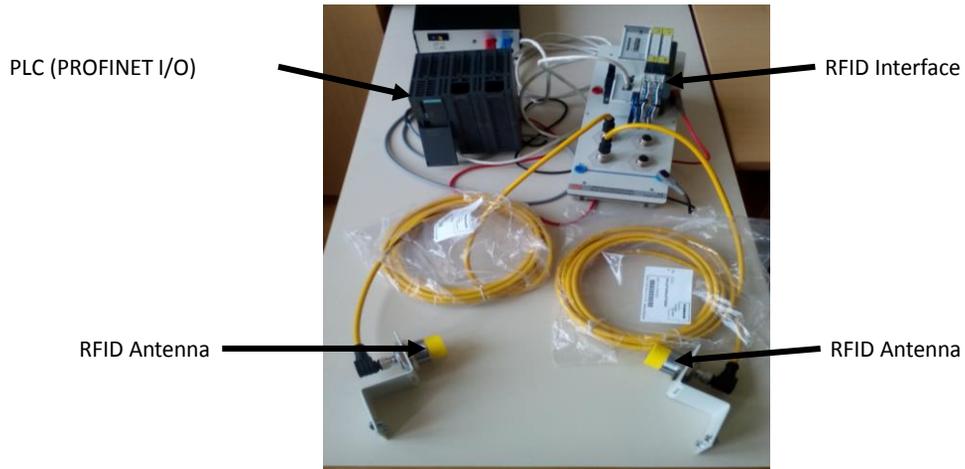
Windows tablets will be installed at four assembly stations.

For now is developed a web application for Kaizen.

Problem	Step	Creator Name	Term	Priority	Realization
Problemi s dovodom zraka	Kontaktirati Servisera	Smart Factory	15.06.	Prijeteljno	Na čekanju
Nedostajni vijaka M8	Javiti u Nabavu	Smart Factory	07.06.	Prijeteljno	Odradeno



## RFID oprema (Lucas-Nuelle)



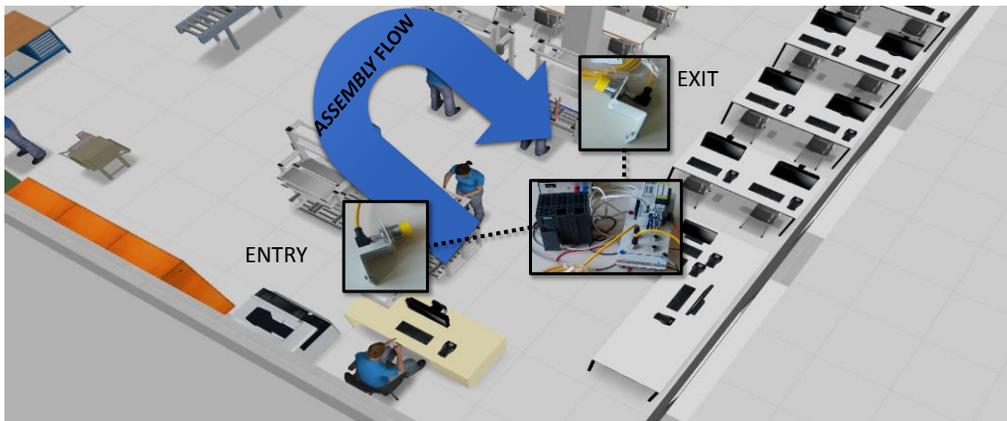
## Demonstration I4.0 assembly lines



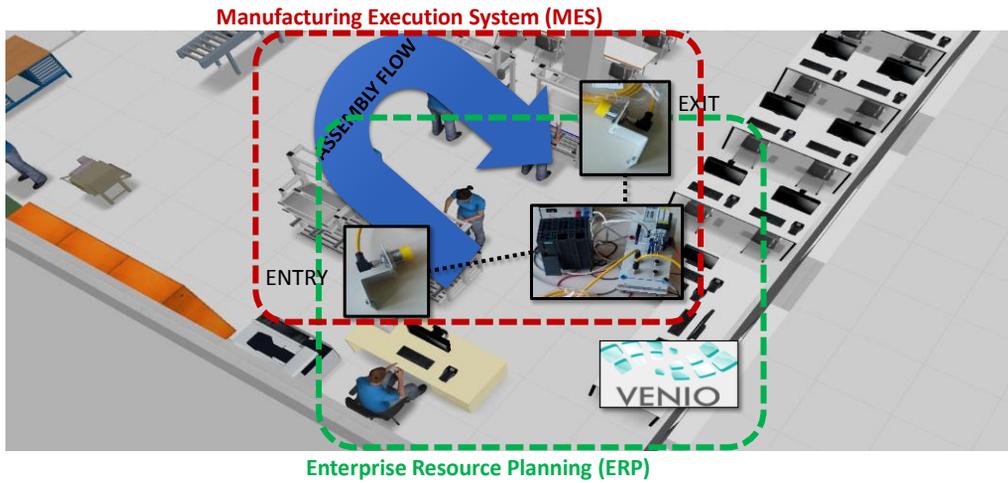
### Demonstration I4.0 assembly lines



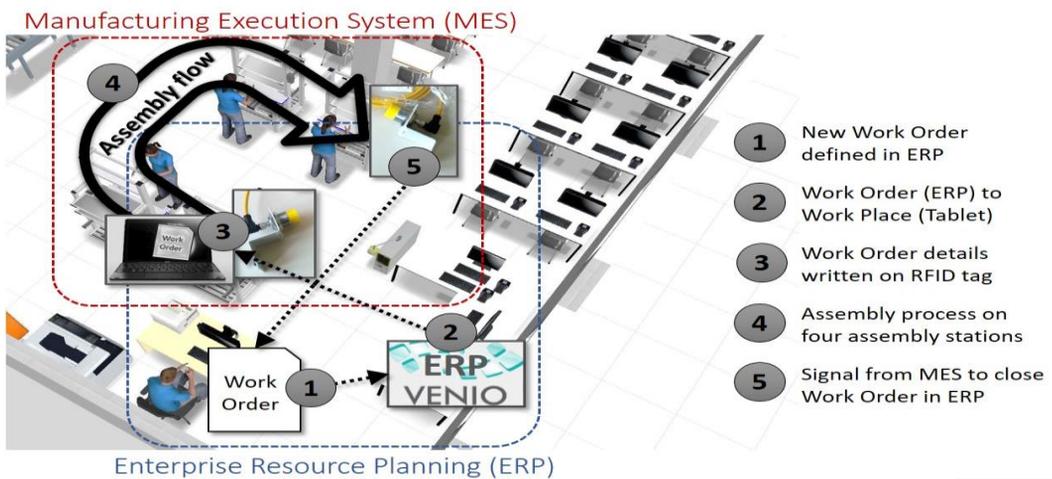
### Demonstration I4.0 assembly lines



## Demonstration I4.0 assembly lines



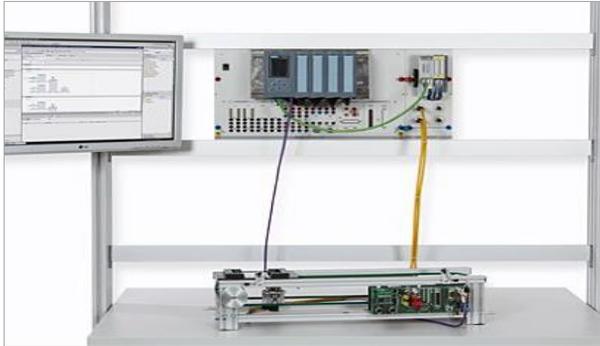
## Assembly line 'Karet' with Industry 4.0 elements



## Integrated elements Smart Factory within Learning Factory

Will be installed Lucas-Nuel RFID system with two antennas.

In addition, it will develop customized solutions for assembly lines and manipulator (based on PLC and Arduino micro-controller).



## NIL Network innovative Learning Factories

<http://www.esb-business-school.de/en/forschung/forschungsprojekte/nil-network-innovative-learning-factories.html>



## Logistics Personal Excellence by continuous Self-Assessment (LOPEC)

- Programme: **Leonardo da Vinci**
- Name: **Logistics Personal Excellence by continuous Self-Assessment**
- Acronym: **LOPEC**
- Budget: ~ **400.000 €**
- Funding: **75% EU**
- Leader: **Prof. Dr.-Ing. Vera Hummel**
- Partners: **ESB Business School Reutlingen, University of Dortmund, Fraunhofer Austria Research GmbH, University of Split, Eurofortis SA, IBK - Management Solutions GmbH**
- Start-date: **1<sup>st</sup> October 2012**
- Finish-date: **30<sup>th</sup> September 2014**



## Logistics Personal Excellence by continuous Self-Assessment (LOPEC)

### ILIAS

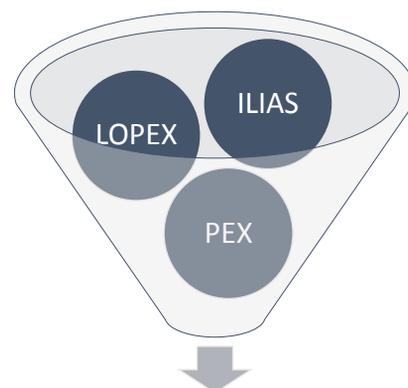
- Internet-based learning platform with rich learning content
- 5 maturity levels
- Multiple choices tests for users

### LOPEX

- Logistics Personal Excellence Assessment as part of Ilias platform
- Maturity grade based questionnaire

### PEX

- Personal Excellence Assessment based on EFQM Excellence Model
- Self-assessment tool – scoring, evidences, urgency for improvement
- Reporting (Strenghts & Area for Improvement)



LOPEC methodologic toolbox



## Implementation of Lean and Green concept in economy

### Scheme of team for implementation of Lean and Green concept



### Three steps of education of employees for successful implementation of Lean concept

Step 1: Basics of Lean	Step 2: Elements of Lean	Step 3: Lean thinking
<ul style="list-style-type: none"> <li>• Toyota Production System</li> <li>• Lean principles</li> <li>• Standardization of work</li> <li>• 7+1 types of waste</li> <li>• Quality techniques</li> <li>• Didactic games (car production, beer game etc.)</li> </ul>	<ul style="list-style-type: none"> <li>• Just-in-Time</li> <li>• Heijunka (line balancing)</li> <li>• Push-Pull production</li> <li>• One piece flow</li> <li>• Quick change-over (SMED)</li> <li>• Tact time</li> <li>• Supermarket</li> <li>• Kanban</li> <li>• Kaizen</li> <li>• Value Stream Mapping</li> </ul>	<ul style="list-style-type: none"> <li>• Leadership for lean</li> <li>• Lean in other areas (administration, hospital, education, government etc.)</li> <li>• Kata for improvement</li> <li>• Visual management (Obeya)</li> </ul>



**“It is madness to repeat again  
and again the same thing and  
except different results.”**



**Albert Einstein, Physicist  
(1879 - 1955)**

**Thank you for your attention!**

**Contact:**

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