STRATEGIC GUIDANCE FOR THE FORMULATION OF A NATIONAL PROGRAM ON FOSTERING MANUFACTURING INNOVATION HUBS' SYSTEM IN SERBIA

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United Nations
Industrial Development Organization

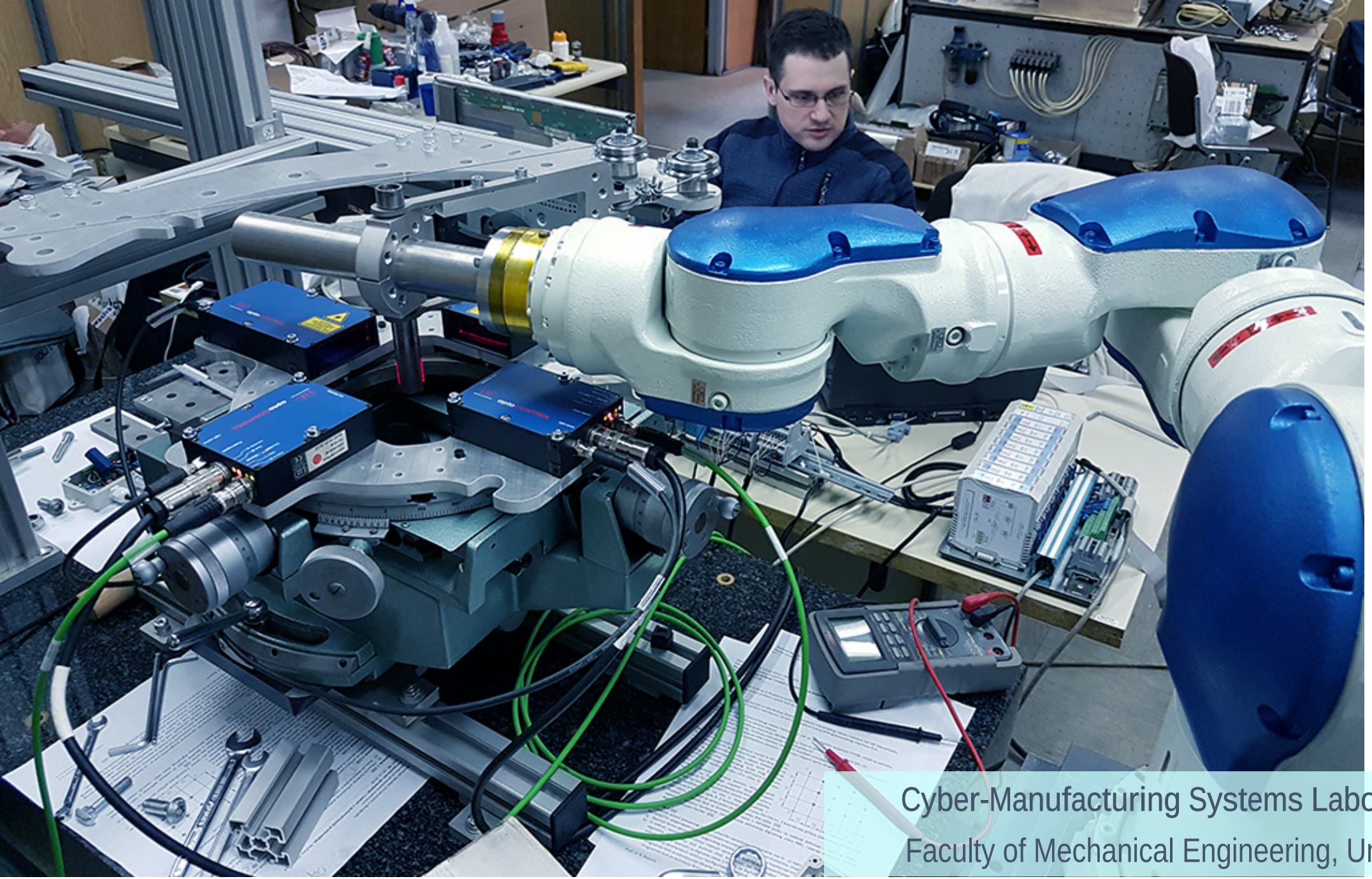
Chamber of Commerce and
Industry of Serbia

Ministry of Science, Technological
Development and Innovation
The Government of the Republic of Serbia

Partnership with Serbia for PROSPERITY
Project number: 200037
Project title: Promoting smart manufacturing through innovation system building in Serbia

Thematic area code: HC2 (Advancing Economic Competitiveness)
HC21 (Investment, Technology, and SME development)

Duration: 18 months
Project site: Serbia
Government Co-ordinating agency: Ministry of Science, Technological Development and Innovation
Counterpart: University of Novi Sad, Faculty of Technical Sciences

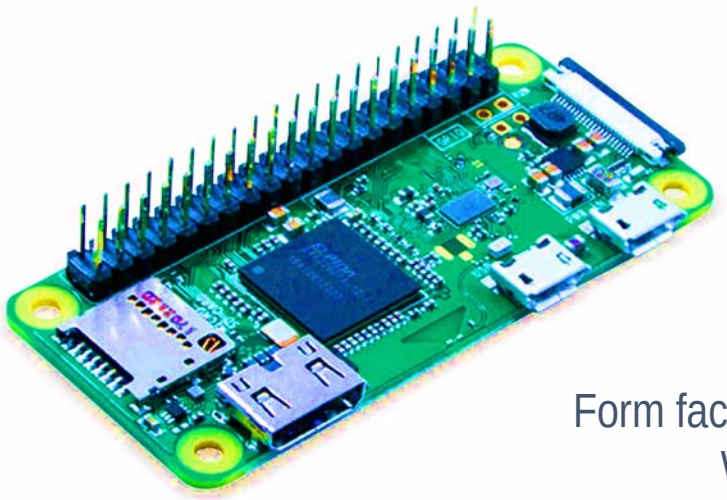


Cyber-Manufacturing Systems Laboratory (CMSysLab)

Faculty of Mechanical Engineering, University of Belgrade

Raspberry Pi

Raspberry Pi Zero: the $5 computer!



Form factor: 65 x 30 x 5mm
Weight 9 grams

- 1GHz single-core CPU Broadcom BCM2835
- 512MB RAM
- Mini HDMI port
- Micro USB OTG port
- Micro USB power
- HAT-compatible 40 GPIO pin header
- Composite video and reset headers
- CSI camera connector (v1.3 only)

Albert Einstein once said that **black holes** are where **God divided by zero**, and that created some **strange physics**.

While the **marginal costs of digital goods** do not quite approach zero, they are close enough to **create some pretty strange economics**.

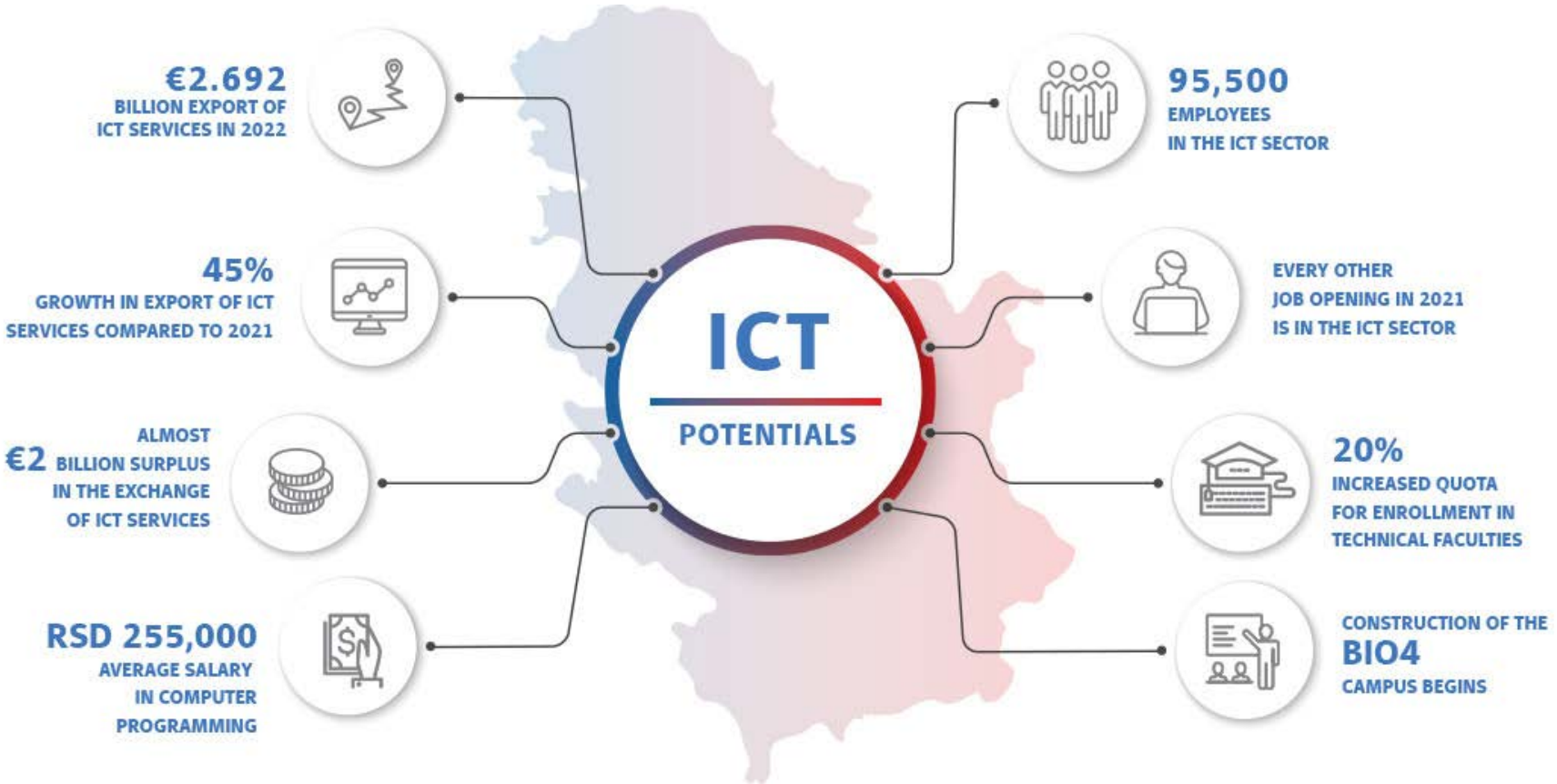
Cluster of 4 Raspberry Pi Zero Computers

The Government of the Republic of Serbia:

Serbia the country of opportunities

The Information-Communication Technologies Sector has recorded a huge increase in the previous year and represents one of the biggest potentials of Serbia

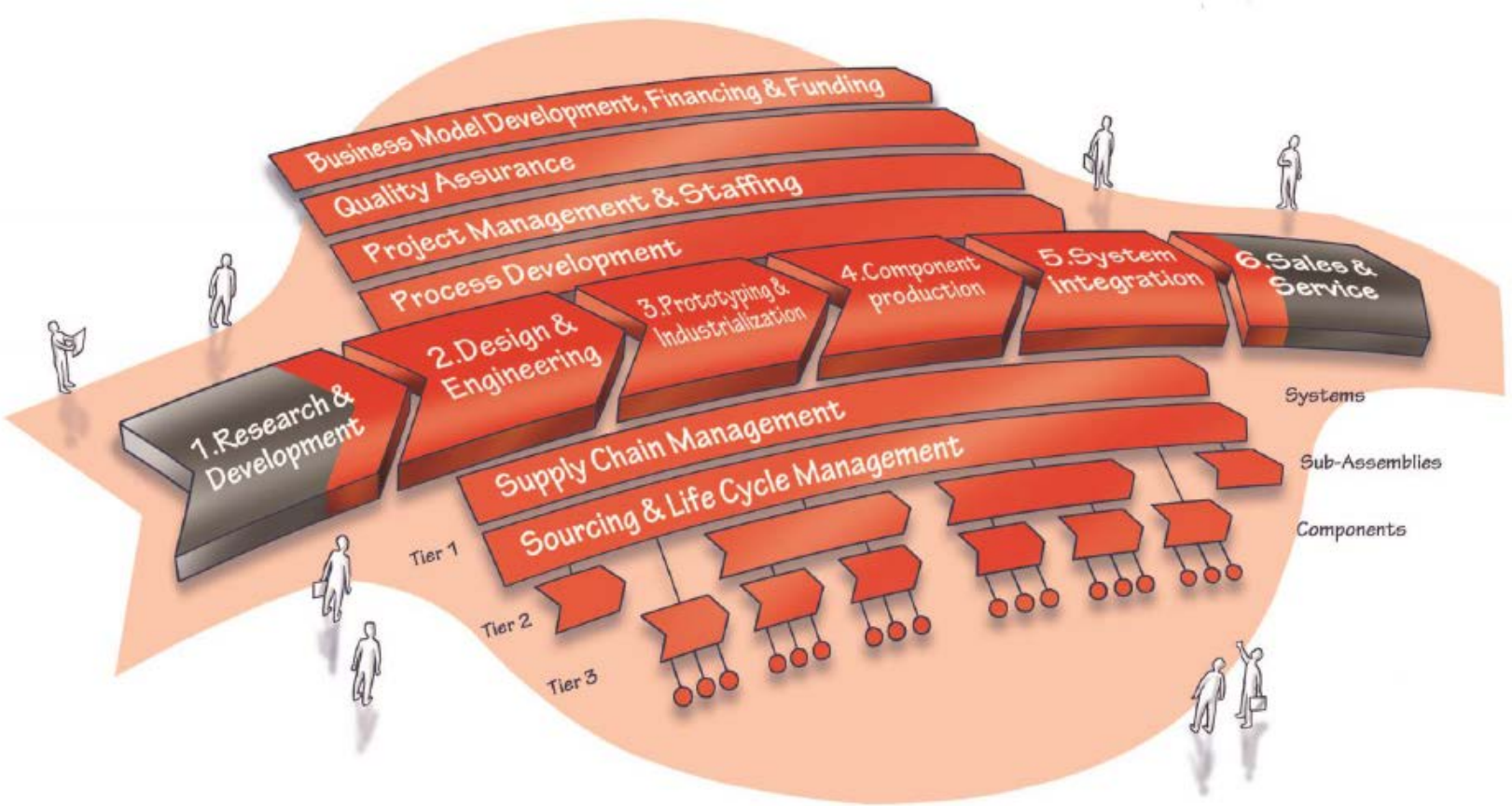
Official website front page, June 2023



SMART MANUFACTURING Innovation!!!

Everything is DIGITALIZED and NETWORKED!

Cybernatization of INDUSTRY (vertical and horizontal), Cybernatization of the WORLD



WHY SMART MANUFACTURING Innovation is so IMPORTANT

HOW to APPROACH SMART MANUFACTURING Innovation

WHAT could be done CONCRETELY with SMART MANUFACTURING Innovation in Serbia – possible options and scenarios

UNIDO Expert / strategic guidance / advice for the formulation of a National Program on fostering Manufacturing Innovation Hubs' System in Serbia

THE WORLD BANK

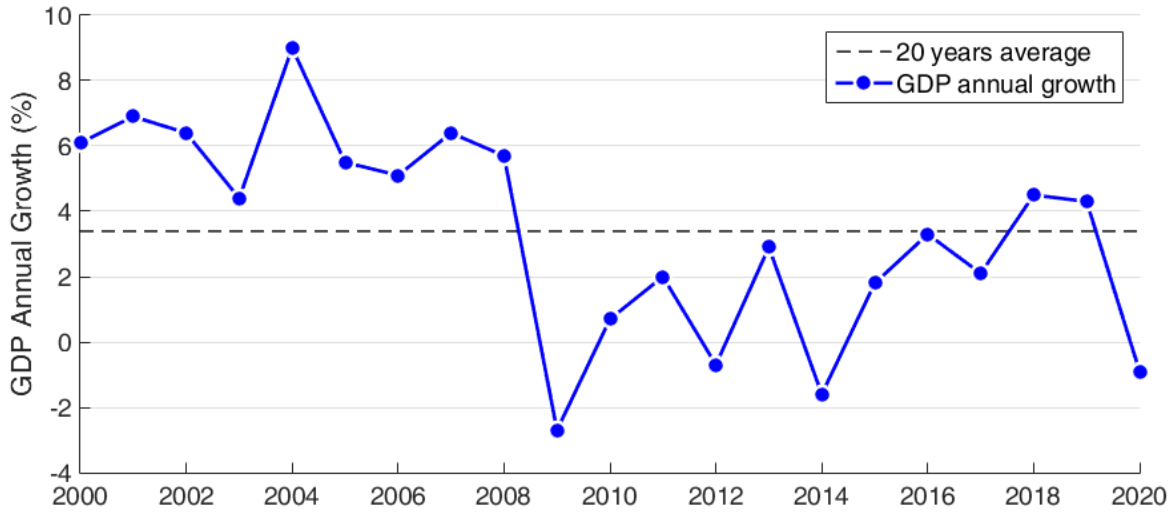
The urgency for a New Growth Strategy

Serbia is at a crossroads. Although current growth rates are improving incomes in Serbia, **they are not bringing the country closer to average living standards in the European Union fast enough.** Now is the time for Serbia to write the **next chapter** in its economic history for the **benefit of current and future generations.**

After a period of **retrenchment**, Serbia has arrived at the point at which, as in other small transition economies in Europe, a **critical mass of reforms** powered a **higher rate of growth**, marked by **sustained investment, productivity gains, and rising incomes**

To enter that phase, Serbia needs a clear, and **evidence-driven strategy for a new wave of structural change**, while **maintaining macroeconomic stability.**

With what we call the **New Growth Agenda**, Serbia has a shot at growing at **7% a year**, well beyond the current 3 or 4%. This higher rate would **double per capita income in 10 years**, benefiting Serbia citizens soon, not in the distant future.



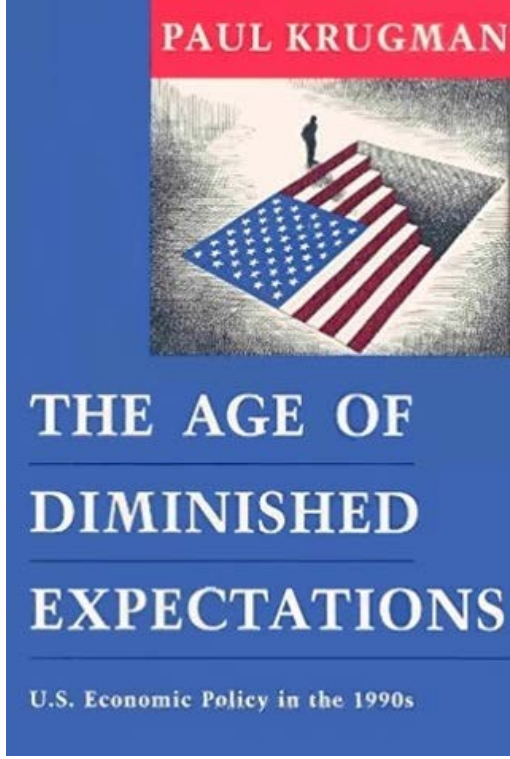
Serbian GDP Annual Growth from 2020 to 2020, Average 3.39%

WB: Serbia can become a fast-growing, sophisticated modern economy, driven by its private sector, if it maintains the hard-won gains of macroeconomic stability and advances the transformation in the following seven areas

1. Boosting investment. Increasing public investment to at least 5% of GDP and facilitating private investment to above 20% of GDP annually, would support stability of high growth rates. Ensuring quality is essential as well.
2. Financing for growing firms. Increasing credit to the private sector to the level closer to European benchmarks, including by enabling new financing instruments, would expand finance to young, small and medium enterprises, the new generation of firms. This could promote annual real GDP growth by about 1.3%.
3. Skilling workers. With over two-thirds of firms failing to find workers to implement expansion, improving education quality to produce skills relevant for the private sector could increase GDP growth rate by up to 1.3%.
4. Raising productivity. Increasing firm-level productivity and its annual growth from current low levels would enable higher value-added production, more jobs, and higher wages. A one percent increase in productivity could lead to 1% increase in GDP.
5. Promoting exports. Serbian exporters are on average twice as productive as other firms; increasing exports from 50 to 80% of GDP would boost growth. Improving infrastructure and removing behind-the-border constraints would increase both exports and FDI.
6. Enabling business. A better regulatory framework, including improved predictability and transparency of administrative procedures, could reduce costs for business by 0.9% of GDP annually. Better enforcement would strengthen business practices in private and public sectors.
7. Unleashing competition. Reducing government presence in the economy, especially through less ownership of or favorable treatment of SOEs, would reduce barriers to competition, eliminate distortions, and could save at least 1% of GDP in public funds for more productive use.

Nobel laureate Paul Krugman, wrote the following about productivity:

> *Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.*



The key word is productivity! But, related to the 'output per worker', there is another, equally important truth:

Productivity is primarily determined by technological progress and our ability to exploit that progress effectively!

- **Technological and innovation readiness** of Serbian factories, shift towards high value-added manufacturing sectors
- **Business readiness** of Serbian factories

Serbian manufacturing industry contribution to national GDP is just 13%!

Starting from this development framework of the **Serbia's New Growth Agenda**, it is possible to formulate the primary goal or, intended outcome of the UNIDO project:

The **primary goal of the UNIDO project** for fostering the development of the SMIH system in Serbia is to **contribute to the establishment of a fertile systemic environment** that would **support** SERBIA'S NEW GROWTH AGENDA from the perspective of **knowledge and the effective use of that knowledge through innovations in the field of manufacturing technologies** and thereby substantially contribute to the productivity/competitiveness growth of the Serbian manufacturing industry.

With this position, we can state that the UNIDO project for fostering the development of the Smart Manufacturing Innovation Hubs system in Serbia could have:

1. a deep RELEVANCE for the key development policies of Serbia,
2. the CAPACITY to support some of their priorities with the greatest degree of importance, and obviously
3. a **great potential degree of** IMPACT on future development / growth of Serbian economy, and accordingly to this, we can speak of a strong synergistic effects in case of its future implementation.

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Manufacturing industry is a complex Socio-Economic System

Back to making stuff ... FACTORY!

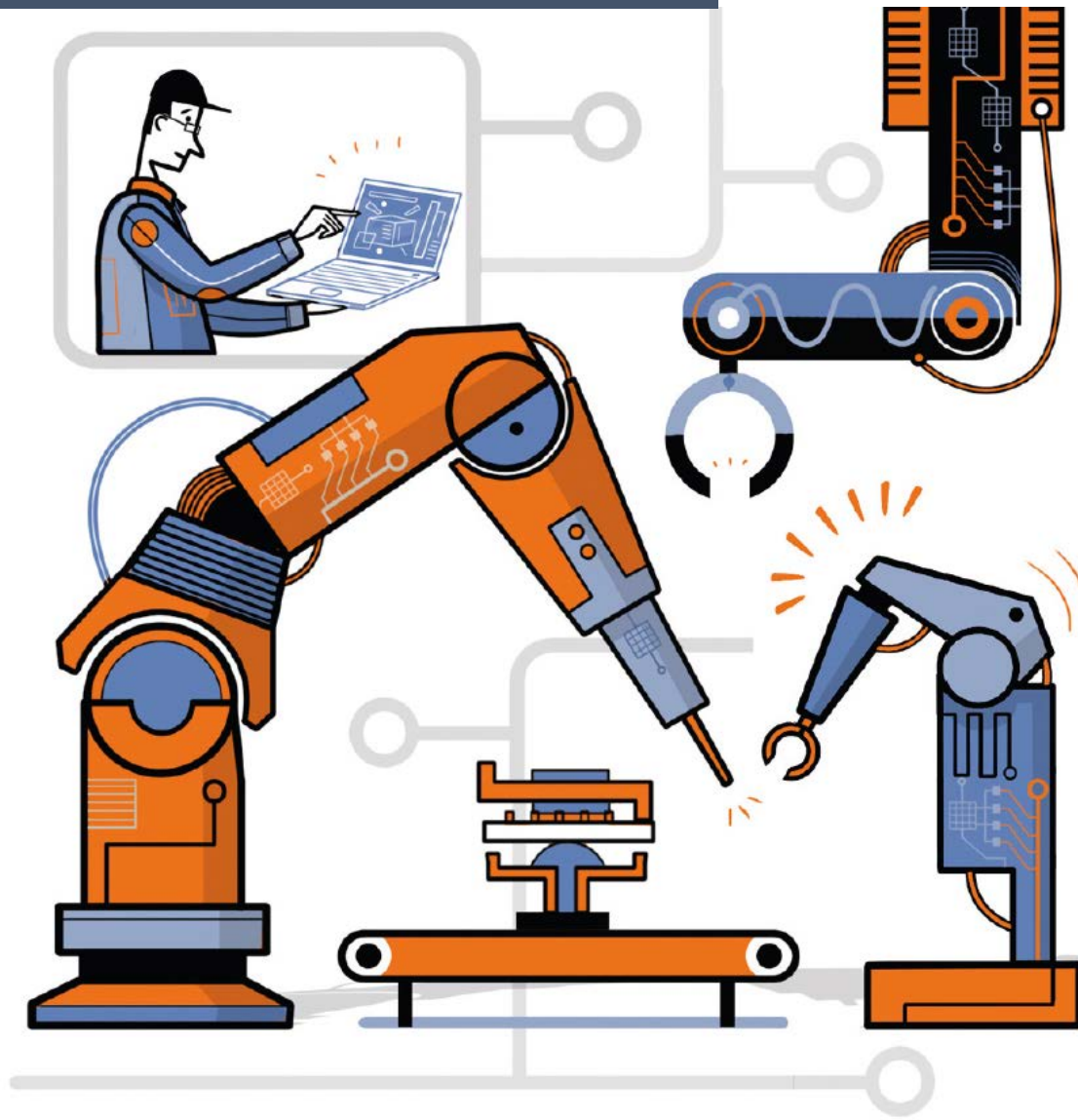
A major turning point in the development of the global manufacturing industry - REINDUSTRIALIZATION

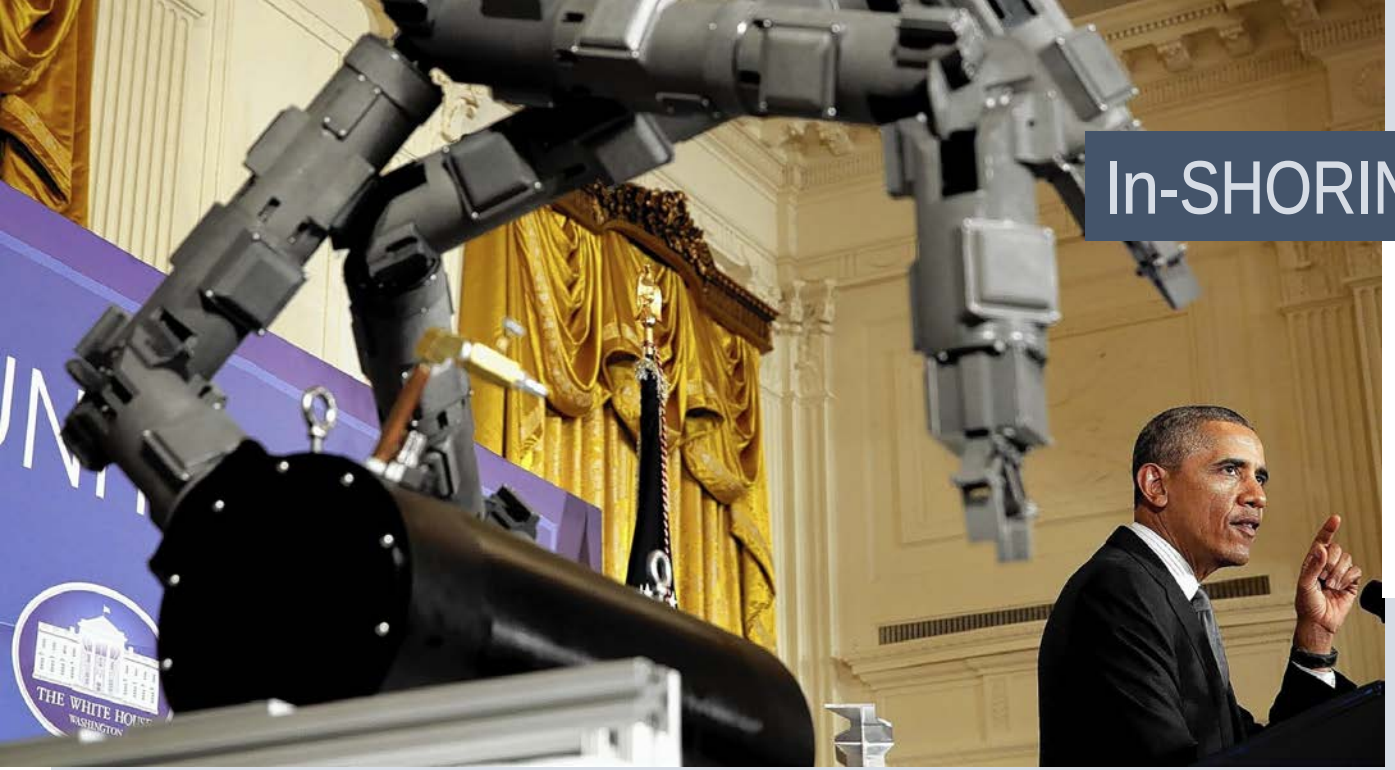
The biggest crisis since the **Big depression** from 1929

Our reality is the INDUSTRIAL ECONOMY, and a radical shift in economic policies was necessary in order to bring the global economic system back to normal; The FACTORY is a key construct of the industrial economy, the basis for sustainable growth and the well-being of society!

Global respond: REINDUSTRIALIZATION!

Challenge: How to effectively address the crisis and how to effectively engage academic and RTD&I community?





In-SHORING of US Economy

Manufacturing℠ USA

TWO STRATEGIES for Ensuring American Leadership in Advanced Manufacturing in the 21st Century:

- CREATE a **fertile environment for innovation**
  - tax and business policy,
  - robust support for basic research, and
  - training and education of a high-skilled workforce;
- INVEST to **overcome market failures**, to ensure
  - that new technologies and design methodologies are developed in USA, and
  - that technology-based enterprises have the infrastructure to flourish in USA.

President's Council of Advisors on Science and Technology:

'We **do not believe that the solution is industrial policy** in which government invests in particular companies or sectors. However, **we strongly believe that the nation requires a coherent innovation policy** to ensure U.S. leadership, support new technologies and approaches, and provide the basis for high-quality jobs for Americans in the manufacturing sector.'

Under the umbrella of the **Manufacturing USA**, administration decided to establish a network of **45 public-private institutes across the US**. The model was found in Europe, in the German network of 72 Fraunhofer institutes.

The main challenge for China is the **structural and technological transformation** of the manufacturing industry.

'Made in China 2025'

Inspired by Germany's "Industry 4.0" plan, and designed **to transform China from a manufacturing giant** into a **world manufacturing power** by 2049 - 100th anniversary of the founding of the People's Republic of China;

3 PHASES: Three 10-years plan

9 tasks:

1. Improving **manufacturing innovation**
2. Integrating information technology and industry
3. ...

10 key sectors:

1. New information technology
2. **Numerical control tools and robotics**
3. ...

5 major projects:

1. Establishing 40 **manufacturing innovation centers** by 2025.
2. ...

A New Start for Europe: My Agenda for Jobs, Growth, Fairness and Democratic Change

Political Guidelines

for the next
European Commission

Jean-Claude Juncker
President of the European Commission

A Deeper and Fairer Internal Market with a Strengthened Industrial Base

'*The objective of revitalization of the EU economy calls for the* ***endorsement of the reindustrialisation efforts*** *in line with the Commission´s aspiration of increasing the contribution of industry to GDP to 20% by 2020.*'

- European Economic Recovery Plan
- European Industrial Renaissance

New Platform for European Industrial Renaissance

A. Right framework conditions to stimulate new investment in new technologies and innovation
   - Six priority action lines,
   - Accompanying measures.

B. Access to markets
   Urgent improvements in the functioning of the Internal Market are needed.

C. Access to finance and capital markets
   Investment and innovation are not possible without adequate access to finance.

D. The crucial role of human capital
   Accompanying measures to increase investment in human capital and skills are key to the success of industrial policy.

The twin green & digital transition:

How sustainable digital technologies could enable a carbon-neutral EU by 2050

European Technology Platforms – ETPs

Scientific evidence-based policy making

Definition: ETPs are industry-led stakeholder fora recognised by the European Commission as key actors in developing long-term strategic research and innovation agendas for action at EU transnational and national level in a wide range of technology areas.

EUROPEAN TECHNOLOGY PLATFORMS

Vision for 2020: ETPs are a key element of the European innovation ecosystem and help to turn Europe into an Innovation Union. ETPS will have to take a holistic view, identifying the pathway to commercial deployment of research .... They mobilise stakeholders to deliver on agreed priorities and share information across the EU. ETPs are sector-focused structures, but also they foster networking opportunities.

1. Aviation Research and Innovation in Europe - ACARE
2. Association for R&D actors in Embedded Systems ARTEMIS
3. European Aquaculture Technology and Innovation Platform - EATIP
4. European Biofuels Technology Platform – EBTP

.....

9. European Robotics Technology Platform - EUROP

.....

16. E TP for Sustainable Chemistry - SusChem
17. European Technology Platform for Wind Energy - TPWind

.....

26. Future Manufacturing Technologies ManuFUTURE

.....

30. Photonics 21
31. Plants for the Future
32. Smart Grids European Technology Platform - SmartGrids

.....

37. Waterborne Technology Platform - Waterborne
38. Zero Emission Fossil Fuel Power Plants - ZEP

EU PPP Factories of the Future

MADE IN EUROPE

EFFRA
EUROPEAN FACTORIES OF THE FUTURE RESEARCH ASSOCIATION

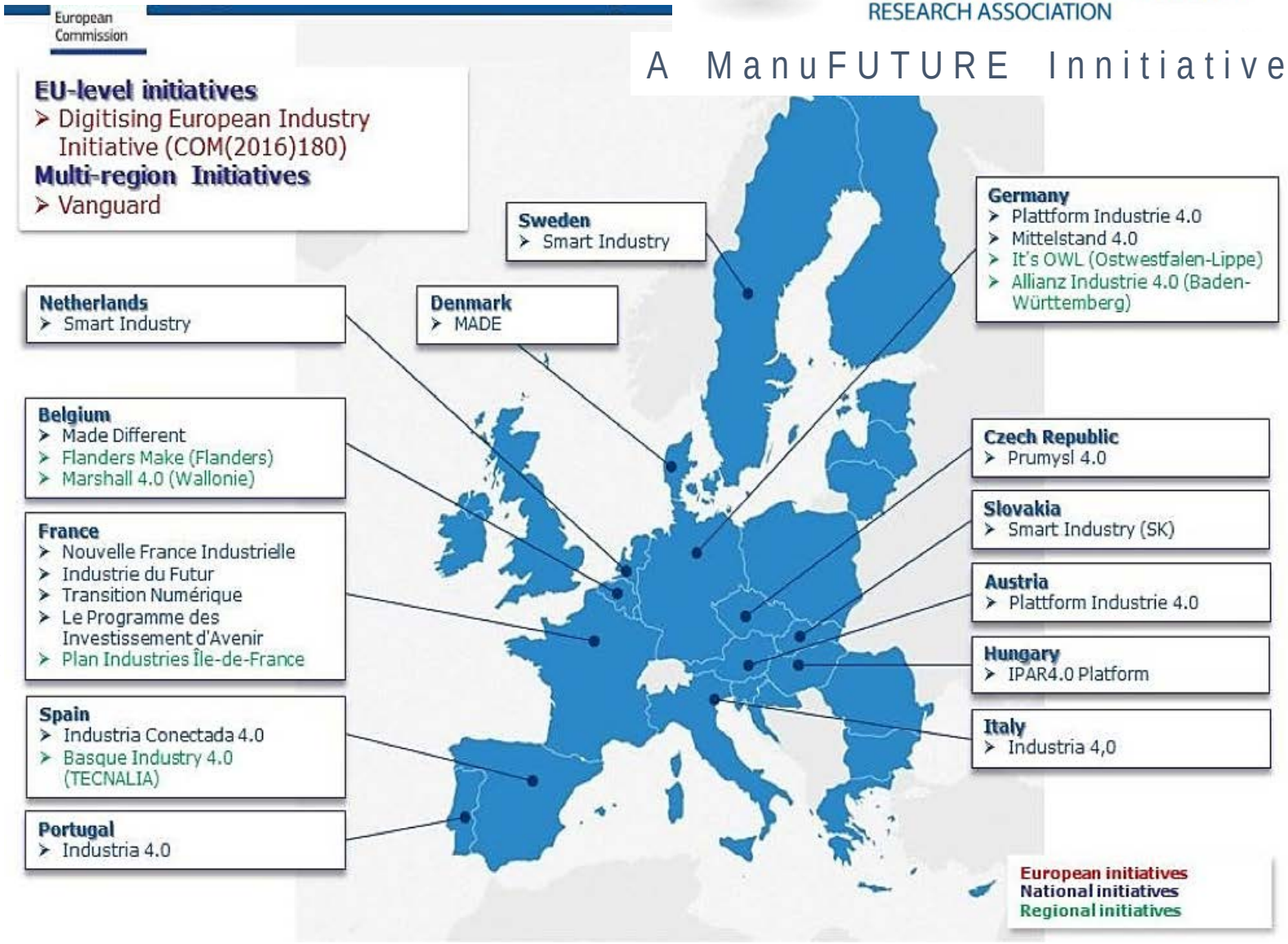
A ManuFUTURE Initiative

Specific Objective 1: Efficient, responsive and smart factories and supply chains

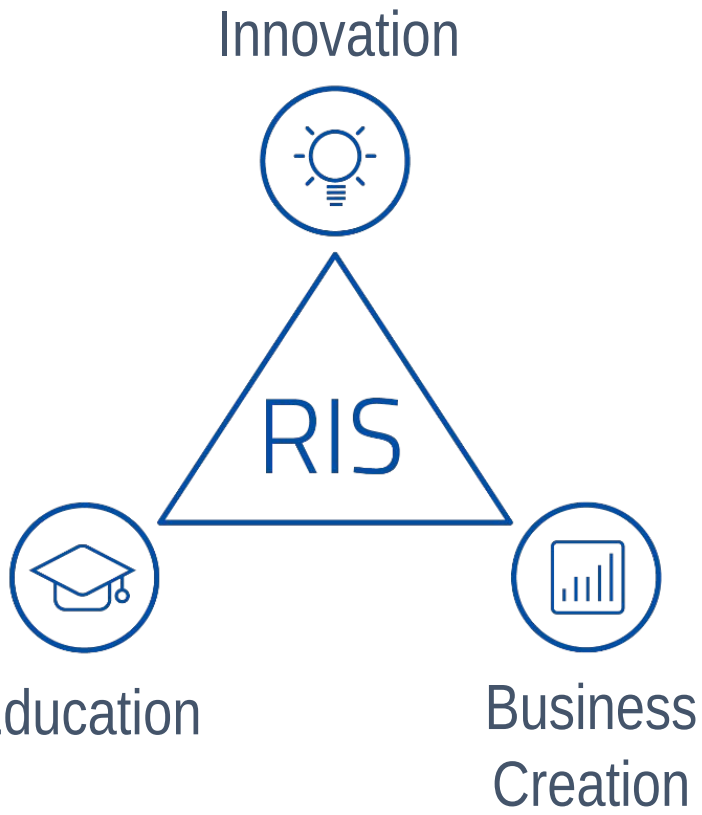
Specific Objective 2: Circular products & Climate-neutral manufacturing

Specific Objective 3: New integrated business, product-service and production approaches; new use models

Specific Objective 4: Human-centred and human-driven manufacturing innovation



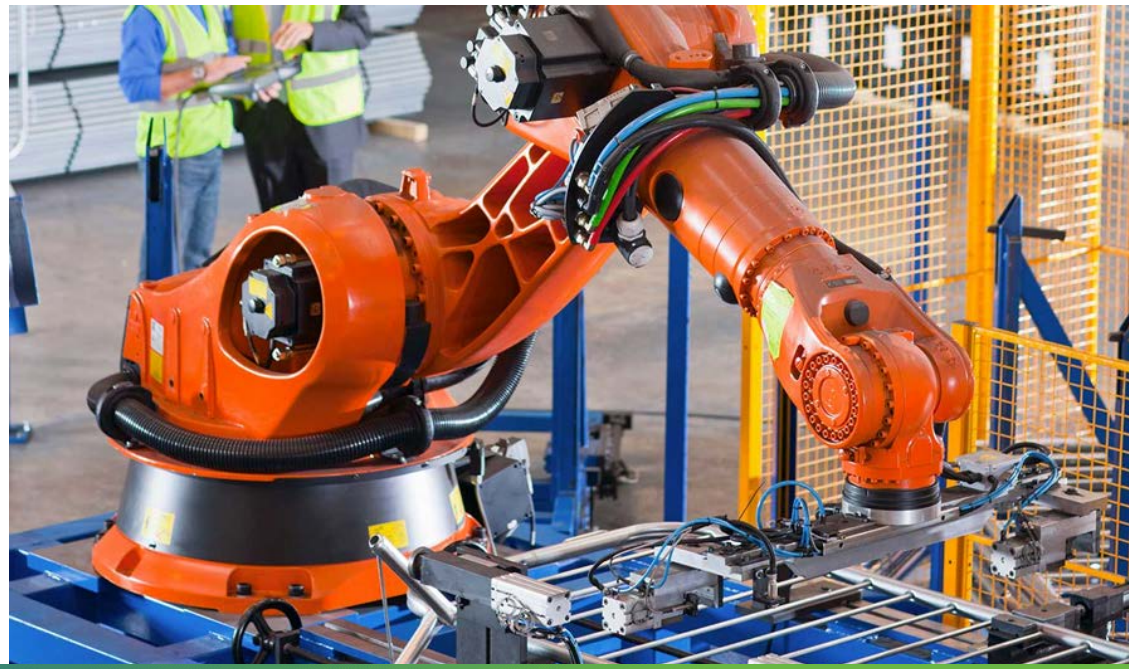
European Institute of Innovation & Technology



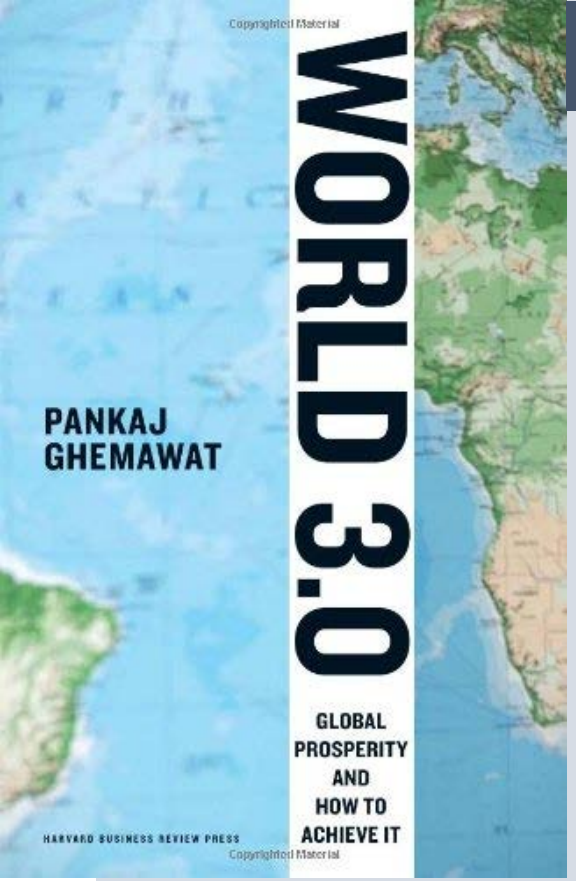
EIT Knowledge Triangle

EIT Manufacturing

This Innovation Community will help meet priorities in terms of advanced manufacturing and processing, and its specific objective of "transforming today's industrial forms of production towards more knowledge intensive, sustainable, low-emission, trans-sectoral manufacturing and processing technologies, to realize innovative products, processes and services".



Composition of the World We Live in



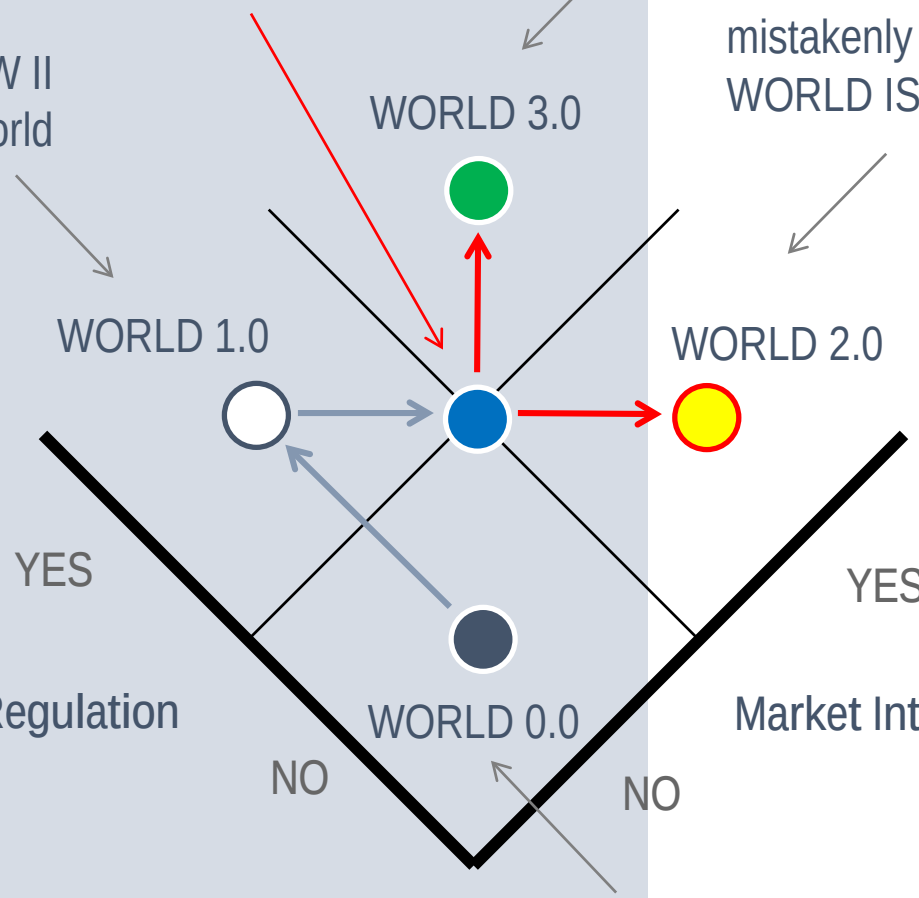
WORLD 3.0
Global Prosperity and How to Achieve it
by Pankay Ghemawat, 2011

Globalized world which Ghemawat believes exists today

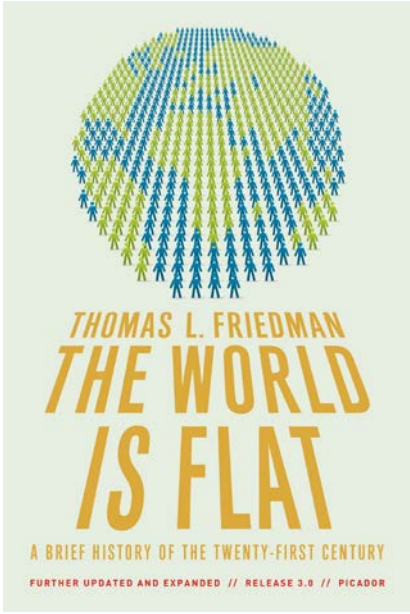
SEMIGLOBALIZED world Ghemawat predict to be existing in the future ... Sovereignties

World for which Thomas Friedman mistakenly believes already exists WORLD IS FLAT!

Post WW II nation-centric world



Traditional, self sufficient, highly localized segmentary societies (romantic atavism today)



The World Is Flat
A Brief History of the Twenty-first Century
by Thomas FRIEDMAN, 2007

ForumEurope

THE EU CHIPS ACT & TECHNOLOGICAL SOVEREIGNTY

Semiconductors & Europe's Strategic Interests

28 APRIL 2022

'This is not just a matter of our competitiveness. This is also a matter of tech sovereignty.'

Ursula von der Leyen

President of the European Commission, 2021 State of the Union address

European Commission

STATE OF THE UNION 2017

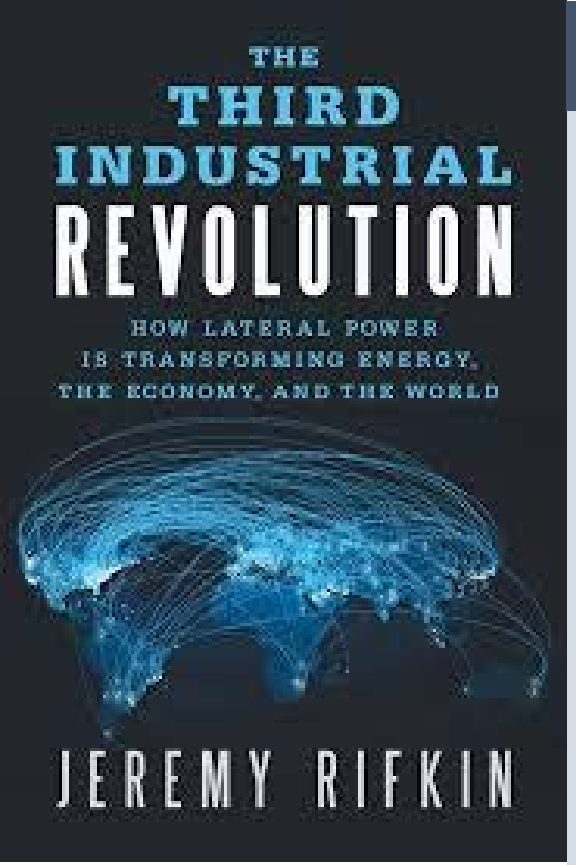
FOREIGN DIRECT INVESTMENT - AN EU SCREENING FRAMEWORK

'Let me say once and for all: we are not naïve free traders. Europe must always defend its strategic interests. This is why today we are proposing a new EU framework for investment screening. If a foreign, state-owned, company wants to purchase a European harbour, part of our energy infrastructure or a defence technology firm, this should only happen in transparency, with scrutiny and debate.'

European Commission President Jean-Claude Juncker, State of the Union Address, 13 September 2017

Welcoming foreign direct investment while protecting essential interests

Foreign direct investment from third countries is a source of growth and jobs. The **EU has one of the world's most open investment regimes**, as acknowledged by the OECD, and we will make sure that it will stay just as open in the future.



New Economic Paradigm

Our industrial civilization is at a crossroad. Fossil fuel-driven industrial revolution is sunsetting.

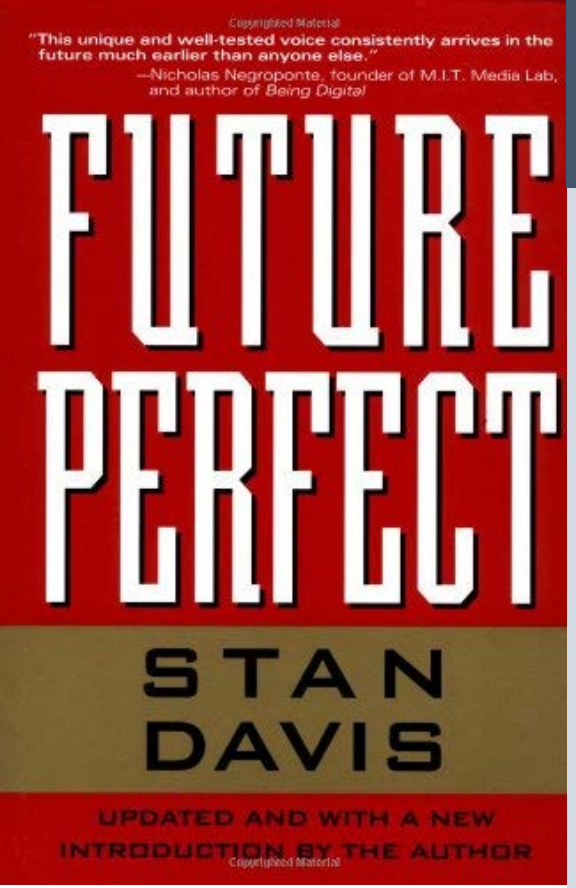
A new economic vision of our civilization is necessary

Collaborative age / revolution?

The FIVE pillars of the Third Industrial Revolution

1. Shifting to renewable energy;
2. Transforming the building stock of every continent into micro-power plants to collect renewable energies on site;
3. Deploying the infrastructure to store intermittent energies;
4. Using Internet technology to transform power grid into an energy-sharing Intergrid that acts like Internet;
5. Transitioning the transport fleet to electric plug-in and fuel cell vehicles independent to fossil fuels.

THE THIRD INDUSTRIAL REVOLUTION
How Lateral Power is Transforming Energy, the Economy, and the World
by Jeremy Rifkin, 2011



Manufacturing PARADIGM SHIFT:

Individualism and MASS CUSTOMIZATION as driving forces of change

FUTURE PERFECT

by Stan DAVIS, 1997

Mass Customization = SMALL volumes and LOW unit costs

Mass Customization change the way we design, produce and sell.

Customer is in the focus / PRODUCT PERSONALIZATION.

Extremely shortened product manufacturing cycle, rapid-to-market is vital for success, individualism is a key driver (personalization through extremely variant production, modularization, low batch sizes including lot-size-ONE, ...)

MASS PRODUCTION vs MASS CUSTOMIZATION

Mass customization is an oxymoron (the putting together seemingly contradictory notions). The presence of this paradox in the economic world and the need to resolve it require the development of new technologies, i.e., the next generation manufacturing that can embrace this kind of contradiction.

Manufacturing foundations are evolving

Mass Production Paradigm
The FIRST Machine Age

Mass Customization Paradigm &
Smart Manufacturing Concept

Complexity level

The relevance of Chaplin's 'Modern Times'

AUTOMATION

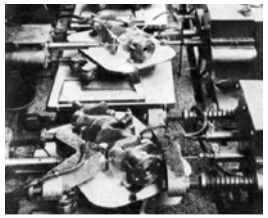
Machines and mechanization of production and FACTORIES

around 1750

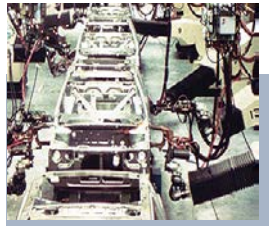
Division of labor, production lines and rationalization

around 1870

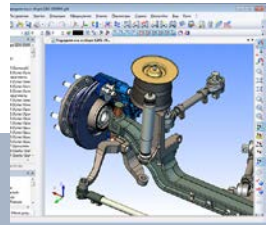
PHASE I
Mechanical and relay logic



PHASE II
Transistor and digital logic



PHASE III
Computer and networking



Digital revolution

PHASE IV
Cyber Physical Systems
INDUSTRY 4.0

ICT Revolution

PHASE V - Cyber Physical COGNITIVE Systems + Sustainability and Resilience + Human centricity = **Holistic thinking**
INDUSTRY 5.0

ICRT & Cognitive Revolution

Fifth Science and Technology Basic Plan, announced in 2016, the government of Japan aims to realize what it calls "Society 5.0," or "Super Smart Society."

The rise of AUTOMATION: Automatic Machines, Artificial Intelligence, Smart Machines

Transfer systems
around 1920

PLC, CNC, CIM, CAx, SCADA mass digitalization
around 1960

around 1980

Everything networked
around 2000

AI and SMART Systems
around 2016

18th c. | 19th cent. | 20th century | 21th century

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SMIH Programme structure

A. NATIONAL DIMENSION

National Program on Fostering Manufacturing Innovation Hubs System in Serbia

1. National Network for Manufacturing Innovation
   a. Design Requirements and Constraints
   b. Vision, Mission and Objectives
   c. Architecture
2. Characteristics of the Manufacturing Innovation Hubs
   a. Focus
   b. Innovation Functions
   c. Activities and Timeline
   d. Funding, Revenue, and Sustainability
   e. National and International Sources of Financing
   f. Partners and Members – Industry Served
   g. Engagement with Small and Medium-sized Enterprises (SMEs)
   h. Governance and Management
3. Implementation and Selection Process
4. Prerequisites and Risks

B. INTERNATIONAL DIMENSION

Networking of the Manufacturing Innovation Hubs' System in Serbia with Regional, EU and Global Networks and Initiatives

Design Requirement #1: COMPLEMENTARITY

The SMIH System should be a complement to the existing innovation ecosystem of Serbia with an explicit focus of innovation processes on the manufacturing industry of Serbia and in that context:

a. digital transformation of the manufacturing industry (Smart Manufacturing / Industry 4.0), and
b. considering the specificities of Serbia's industrial development pathway, recovery, reengineering and strengthening of its broader technological foundations (Advanced Manufacturing Technologies - AMS, i.e. holistic technological development)

as key prerequisites for improving Innovativeness and consequently, Productivity, Efficiency and Competitiveness of the Serbian manufacturing industry.

Design requirement #2: SYNERGY

The SMIH system should be **as much as possible aligned** with the efforts of the Government of the Republic of Serbia to, through the process of industrialization of the national economy:

a. recover and modernize the **national industrial infrastructure**,
b. support the New Growth Agenda – rising **productivity, efficiency and competitiveness** of the national manufacturing industry and thereby enable its deeper integration into global value chains,
c. support the Green Transformation - comply with the **most demanding standards for safeguarding the planet** (green, clean and lean as much as possible), including compliance with the UN 2030 Agenda for Sustainable Development (UN SDGs relevant to industrial development), and
d. strengthen and adapt the **national talent ecosystem** to the requirements imposed by the labor market in the manufacturing sectors (producing skills relevant for the private sector).

Design Requirement #3: OPENNESS

The SMIH System **should enable unfettered networking and interoperability with key regional, European and global communities** that specialize in innovation in the field of manufacturing technologies.

Design Requirement #4: FLEXIBILITY

The SMIH System should be **inherently adaptable and allow for future extension** to areas beyond the conventionally defined concept of Smart Manufacturing, especially towards the more holistic concept of **Advanced Manufacturing** and the **Industry 5.0** platform of the European Commission, which approaches the development processes of manufacturing technologies on a holistic basis, taking into account energy, climate, the natural environment, but also a number of social dimensions of modern economic development, including bringing human into the narrowest focus of contemporary industrial development and the industrial renaissance of Europe.

Design Requirement #5: INCLUSIVENESS

The SMIH system should **enable inclusivity**, from **gender equality** to **territorial / regional inclusivity**, which is of strategic development importance for the Republic of Serbia

Hub System Design: APPROACH and Methodology

A. Building the SMIH System INFRASTRUCTURE
   a. start with what Serbia already has,
   b. discard unnecessary / outdated content - unproductive wei
   c. modify and strengthen existing content that can match the new vision and mission,
   d. supplement the previous one with the missing content,
   e. reorganize the entire community and its RTDI infrastructure,
   f. integrate / network, and then
   g. put in a new function.

B. Building SYNERGY at the national level

C. Building a STRONG INTERNATIONAL COLLABORATIVE NETWORK – Regional collaboration and synergies, European collaboration and synergies, Global collaborations

Regardless of the chosen approach, building the SMIH system is a project of national scale, a project of long-term strategic importance, in which the state must play a key and leading role.

Hub System Design: The ARCHITECTURE

Serbian national BACKBONE for Innovation and innovation-based Entrepreneurship

STP NS

Cluster Novi Sad

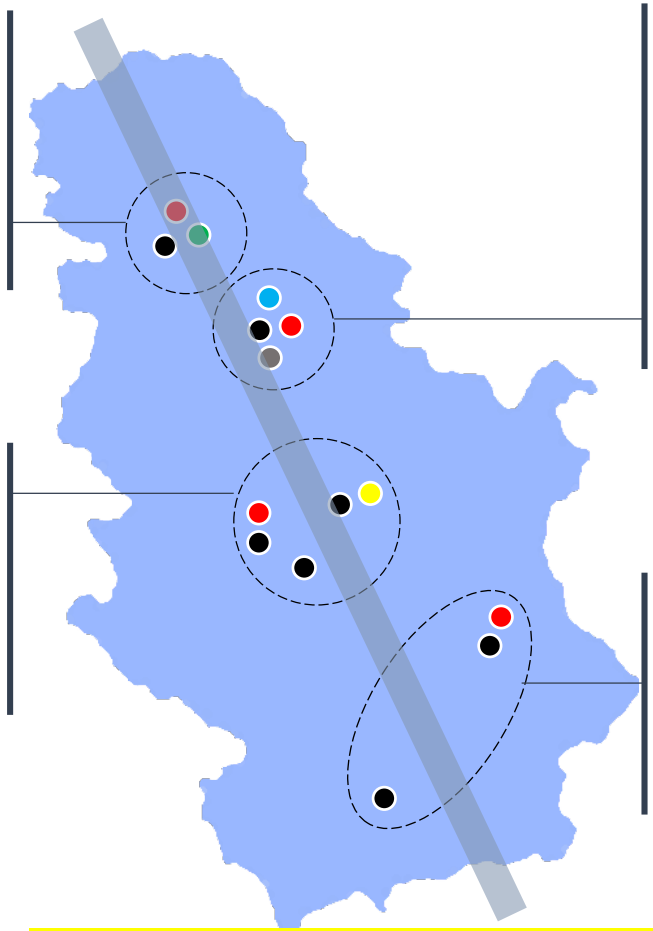
- University of Novi Sad
- Science and Technology Park Novi Sad

STP CH

Cluster Kragujevac

- University of Kragujevac
- Science and Technology Park Čačak
- State Data Center Kragujevac

SDC KG



Cluster Belgrade

- University of Belgrade
- Science and Technology Park Beograd
- Industry Park Mihailo Pupin
- LOLA Institute
- BIO4 Campus

STP BG

Cluster Niš

- University of Niš
- University of Priština
- Science and Technology Park Niš

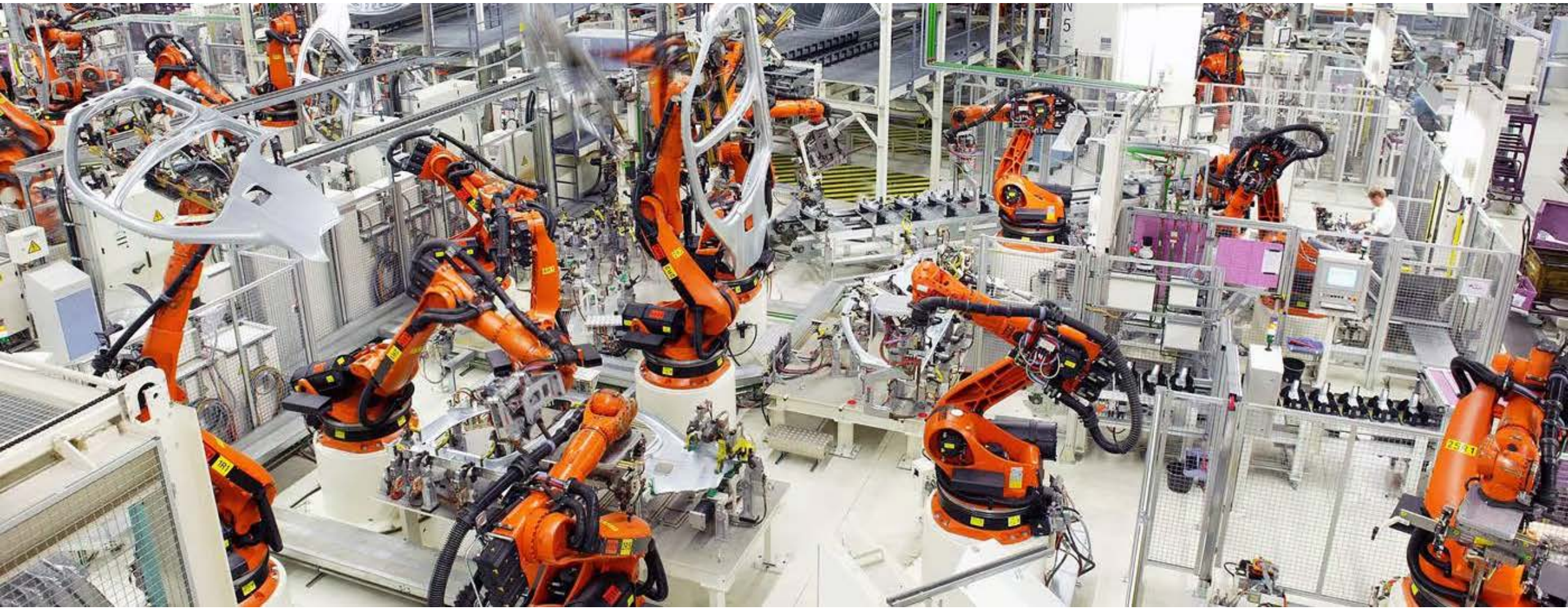
STP NI

The investments of the Republic of Serbia in innovation infrastructure projects from 2016 to 2022 were **more than 100 million euros**! And, will continue, even more intensively!
But, should be **more focused to manufacturing innovation**!

MANUFACTURING INNOVATION – OVERCOME the Silicon Valley myth!

The idea of a garage entrepreneur remains a romantic image, but not everything can developed like a software app.!!!

For advanced manufacturing especially, there are incredibly complex processes with an unfathomably complex and diversified equipment. Each of its components represents an opportunity to innovate, but not as a standalone proposition.



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Manufacturing innovation can't happen outside of the manufacturing environment!

or

Manufacturing innovation can’t happen in an office environment!

but

Manufacturing innovation requires close proximity to
MANUFACTURING knowledge / talent creators - the UNIVERSITY is here to play this crucial role!!

Hub System Design: The ARCHITECTURE

Serbian Academic Poles of Manufacturing Excellence – Education and Research

University of Novi Sad

Faculty of Technical Sciences in Novi Sad

a) Department for Production Engineering

b) Department for Industrial Engineering and Management

University of Kragujevac

a) Faculty of Engineering, Department for Production Engineering (Kragujevac)

b) Faculty of Mechanical and Civil Engineering – Department for Production Technologies (Kraljevo)

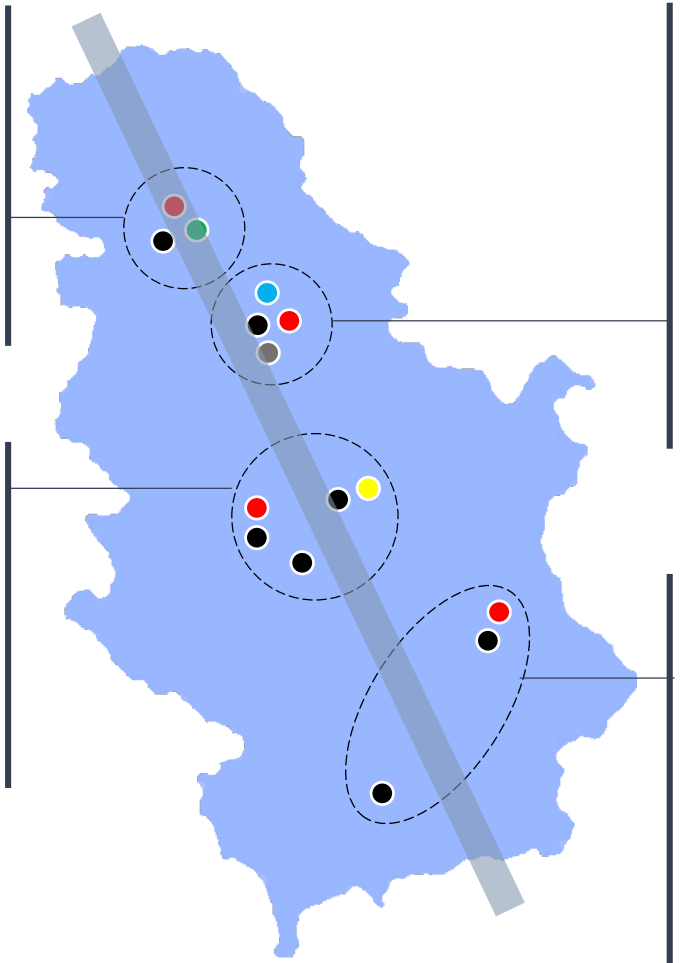
c) Faculty of Technical Sciences Čačak, Department of Mechatronics (Čačak)

Cluster Novi Sad

- University of Novi Sad
- Science and Technology Park Novi Sad

Cluster Kragujevac

- University of Kragujevac
- Science and Technology Park Čačak
- State Data Center Kragujevac



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- LOLA Institute
- BIO4 Campus

Cluster Niš

- University of Niš
- University of Priština
- Science and Technology Park Niš

University of Belgrade

a) Faculty of Mechanical Engineering, Production Engineering Department

b) Faculty of Electrical Engineering

LOLA Institute, Belgrade

University of Nish

a) Faculty of Mechanical Engineering Department for Production and Information Technologies

b) Faculty of Electronic Engineering

University of Pristine

Faculty of Technical Sciences – Department for Production Engineering, (Kosovska Mitrovica)

In contrast to its great importance for the development of the Serbian manufacturing industry, this community is quite invisible. In all aspects. Nevertheless, Serbia is not an exception. But things are changing rapidly.

Serbian Association of Scientific and Research Institutions for Production Engineering

Established in 1965, on the initiative of the Department of Production Engineering of the Faculty of Mechanical Engineering at the University of Belgrade.

Dedicated to strategic aspects of **advancements in manufacturing technologies** and **manufacturing industry development** in Serbia, as well as **education** of a new generation of engineers, the **future technology leaders and technology managers**, specialized in the area of new production technologies, robotics and mechatronics.

The mission:

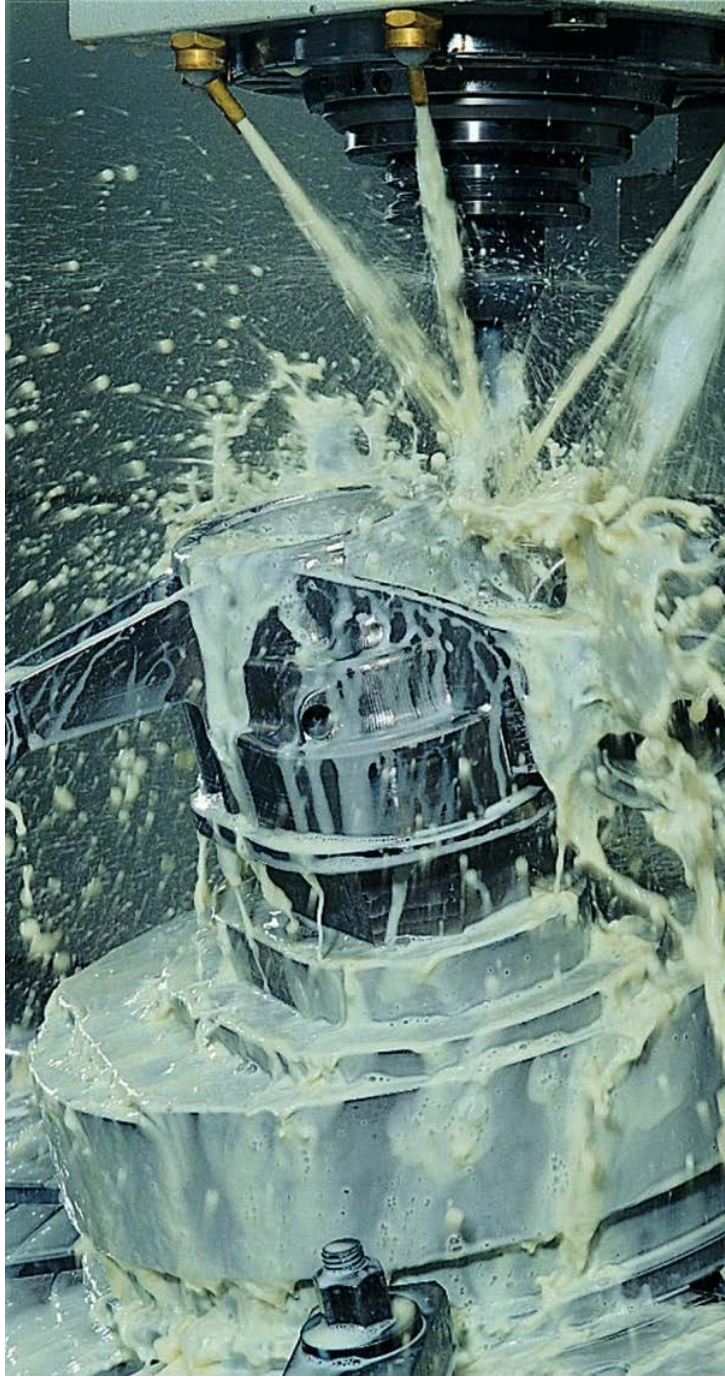
- ➔ To FOSTER **scientific research, and technology development** in the field of manufacturing technologies and production engineering, and
- ➔ To NETWORK and HARMONIZE research **programmes and initiatives** which are highly relevant for both the science and engineering practice, important for the Association members, but first of all **well aligned with societal needs** and with a **high social** RELEVANCE / **impact**.

50 Years of PRODUCTION ENGINEERING Association (1965-2015)

50 Years of PRODUCTION ENGINEERING Association

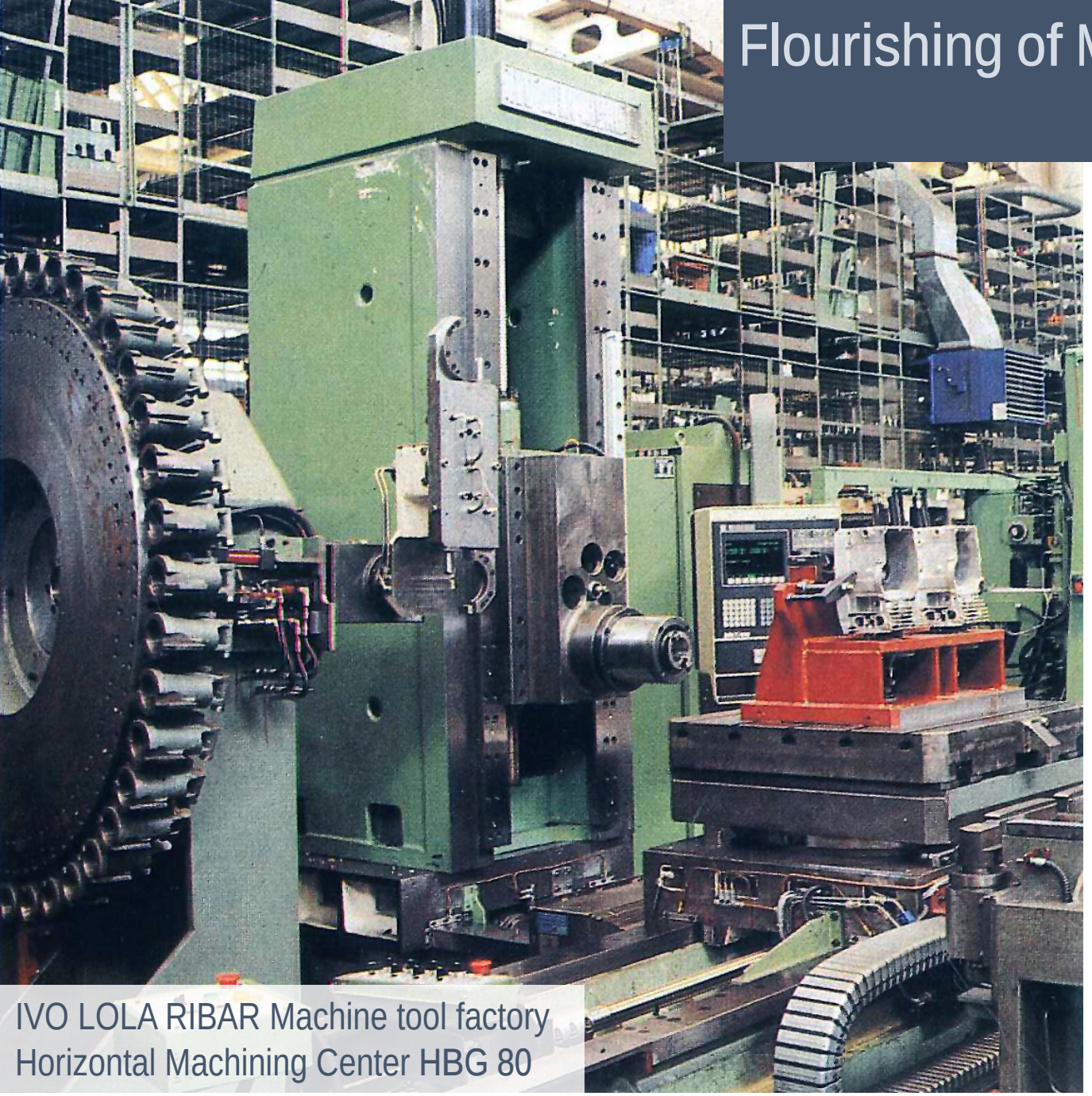
In more then 50 years of existence and activity, the Association has strongly contributed to the manufacturing industry and society through:

1. Education of WORLD-CLASS ENGINEERS specialized in Production Engineering and Advanced Manufacturing Technologies;
2. Building up the national knowledge base for Advanced Manufacturing Systems / Technology Theory (intellectual capital for manufacturing): 35 Scientific Conferences with more then 2500 published pear reviewed papers;
3. Modernization of the technological basis of Serbian industry, by pioneering of a wide range of advanced manufacturing technologies, such as: technology of Numerically Controlled machine tools (CNC) and Flexible/programmable Manufacturing Systems (FMS), unconventional and emerging manufacturing technologies, Computer-Integrated Manufacturing (CIM), CAD / CAM and related computer-aided tools for engineering design of products and processes.
4. Digital transformation of Serbian industry through a wide spectrum of transformative programmes, based on extensive implementation of ICT, especially Factory Automation, Industrial Robotics, and Manufacturing Cybernetics.



Flourishing of Machine Tools Industry

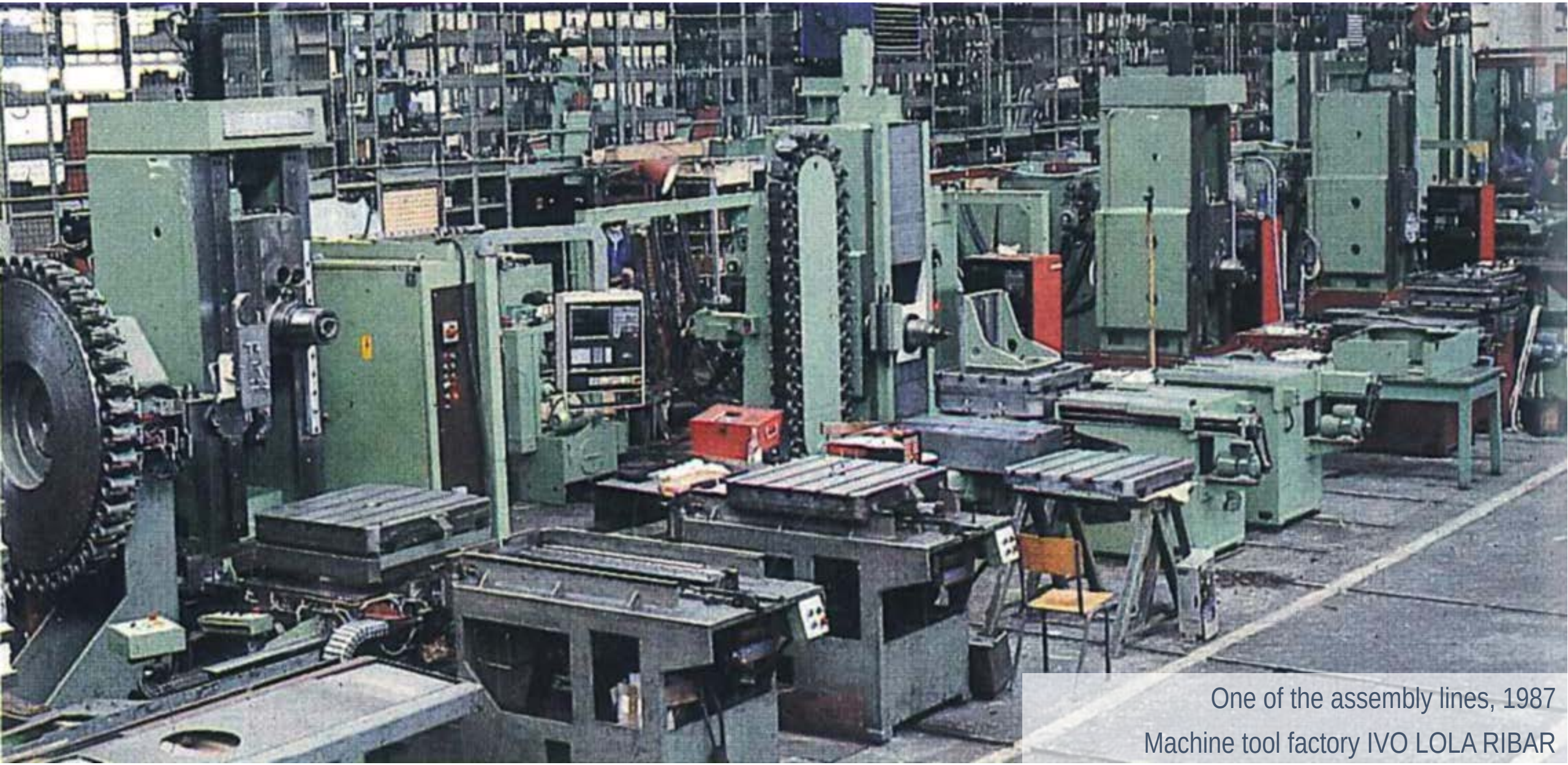
1985: More then 16.000 Workers, 29 Factories!



IVO LOLA RIBAR Machine tool factory
Horizontal Machining Center HBG 80

IVO LOLA RIBAR Machine tool factory
Flexible Machining Cell FLEXI 106

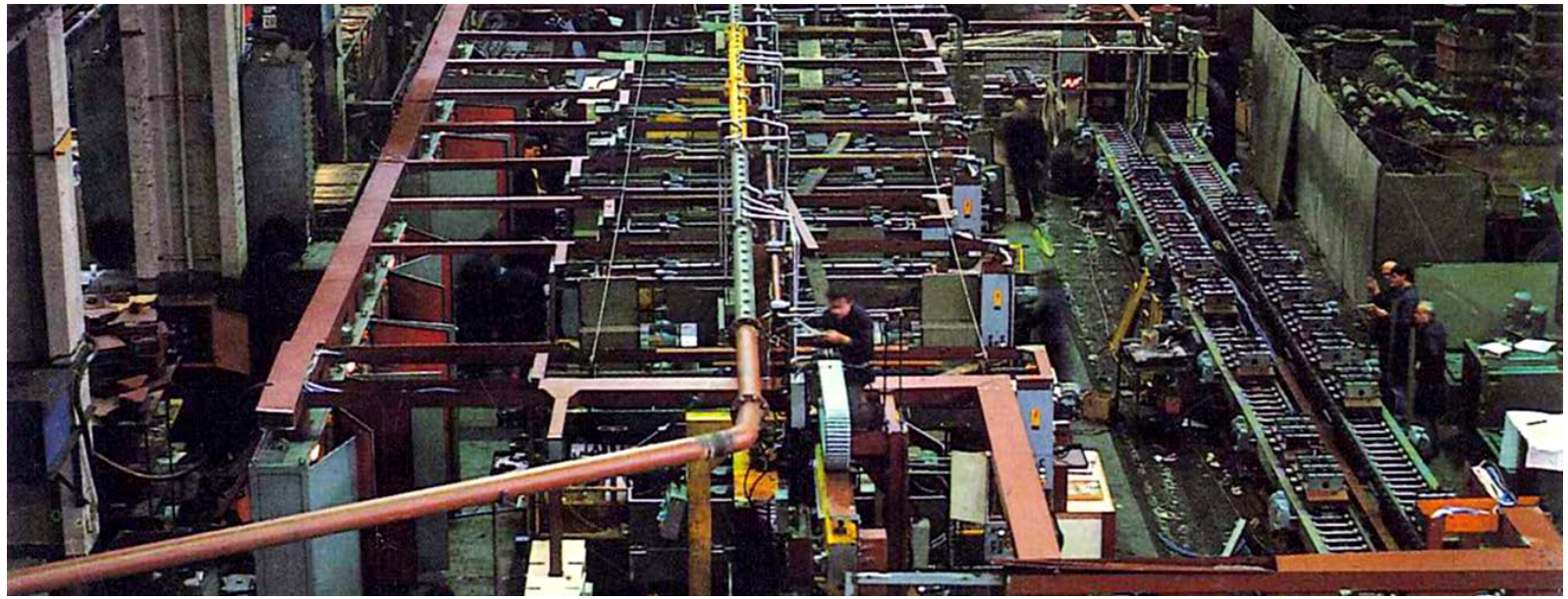
Mass production end export of CNC Machine Tools and Machining Centers to USA market



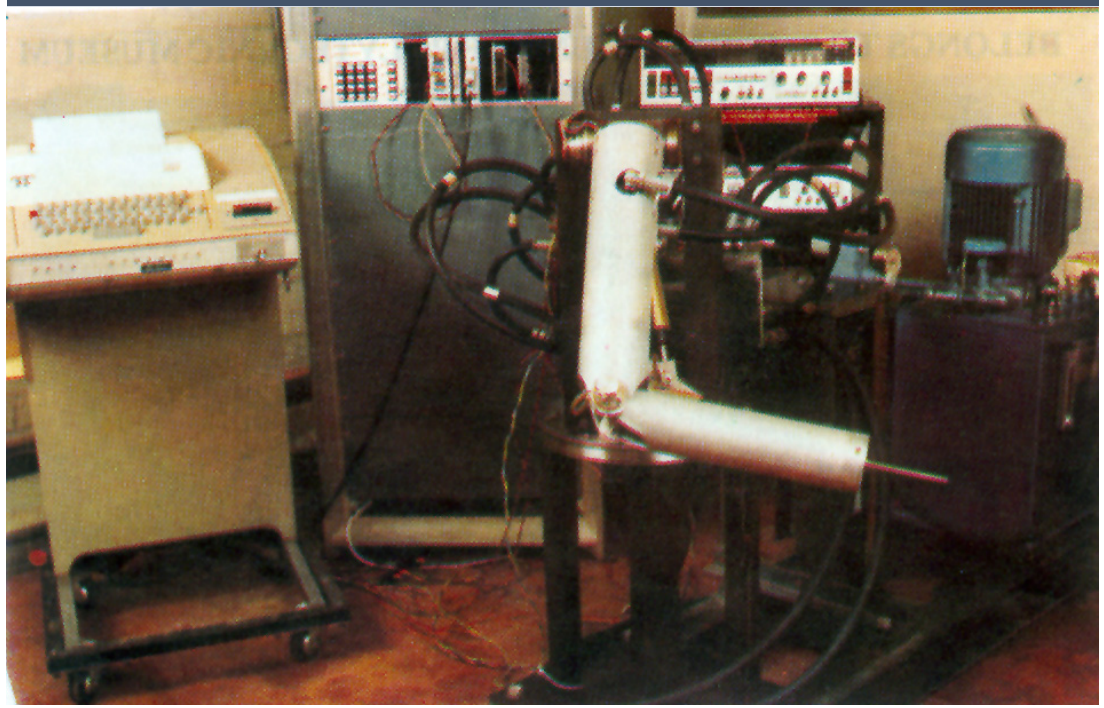
One of the assembly lines, 1987

Machine tool factory IVO LOLA RIBAR

TRANSFER LINES ..... an ultimate level of complexity and engineering knowledge and skills required!



Production Engineering: INDUSTRIAL ROBOTICS



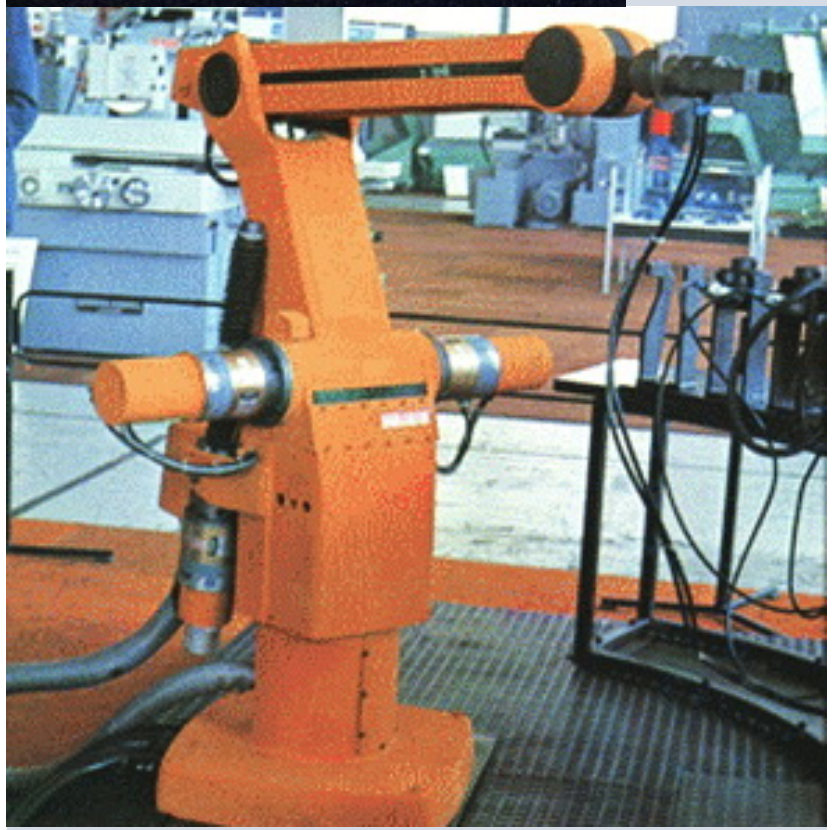
Robot arm UMS-1

The first **all-electric industrial robot** designed and produced in Serbia (1978, Mihailo PUPIN Institute, Robotics Lab.).

Used for industrial applications (robotic assembly operations of small parts) and for education and research purposes.

Articulated robot designed at Faculty of Mechanical Engineering, University of Belgrade and produced by GOSA Company in 1985. **Students from Production Engineering Dpt. are actively participated in design** of this robot and production of manufacturing documentation.

IVO LOLA RIBAR
MACHINE TOOL FACTORY

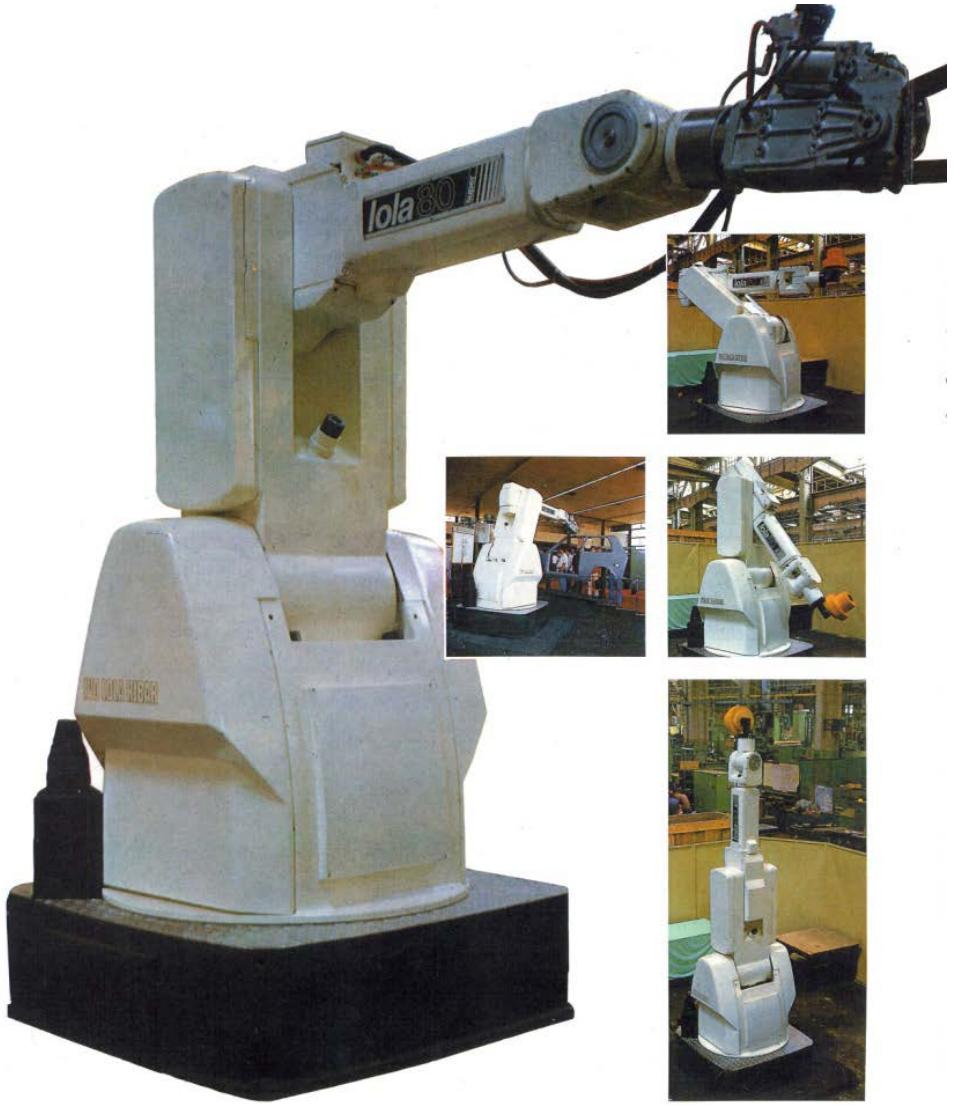


ILROT 5

5dof and 5kgs articulated robot produced in 1981 by IvoLolaRibar Machine Tools Company (inspired by ASEA IRB6 revolutionary robot)

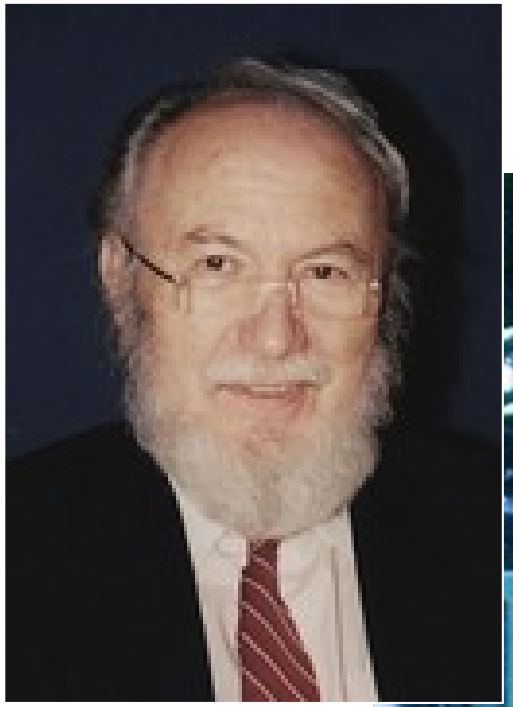
LOLA 50 / 80 / 100

A family of 6dofs articulated robot arms designed in LOLA Institute and manufactured in IVO LOLA RIBAR Company in 1986. Very robust design for heavy-duty industrial use, probably the best robot ever made in Serbia.



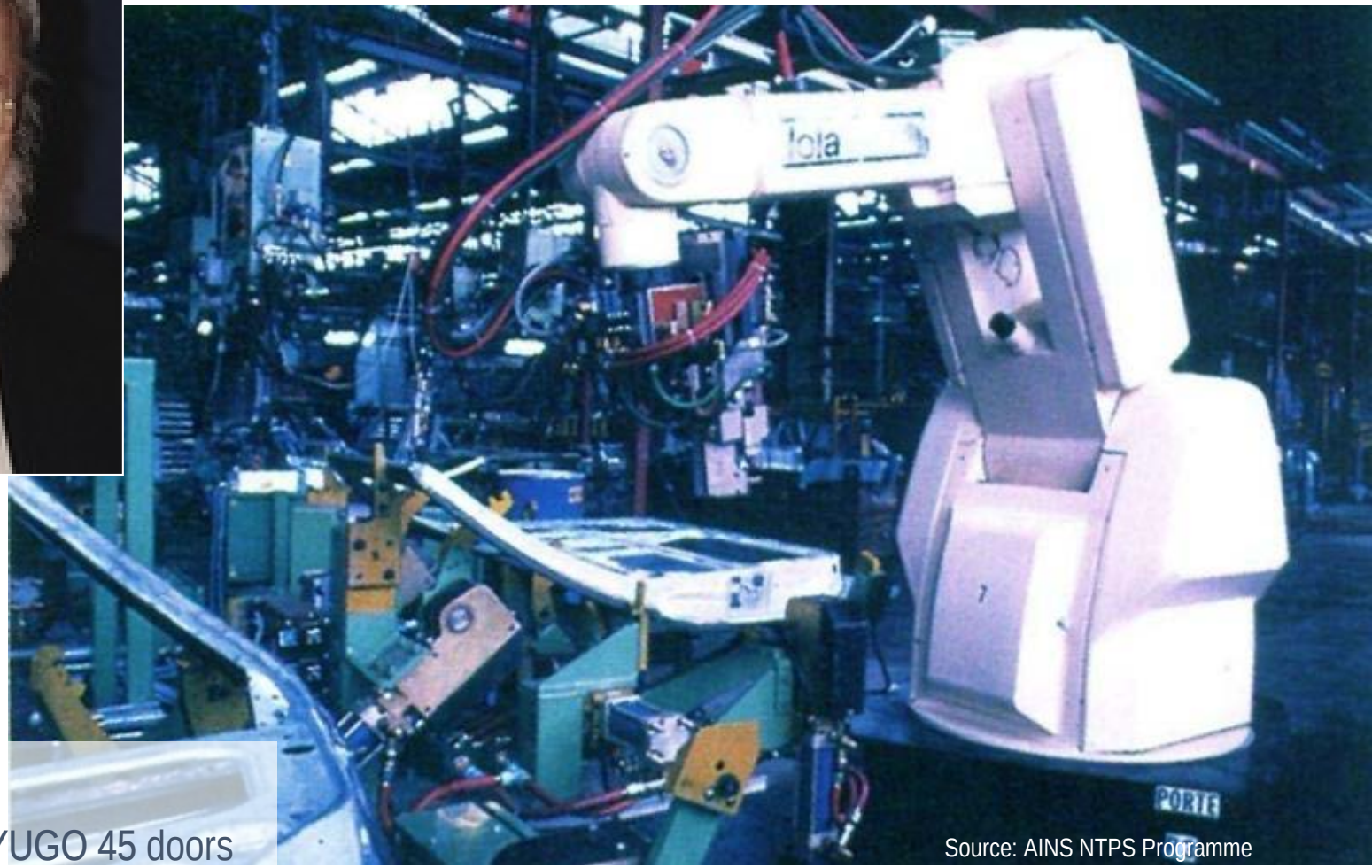
LOLA 50 Robot assembly workplace; Mech. eng. Mile BENEDETIC, Chief Designer, surrounded by the assembly workers and control engineers, 1987/88

Strong development in the **field of robotics**, including industrial robotics (including robot control systems, CNC control systems, PLC controllers, and other mechatronics components for industrial automation).



Belgrade school of robotic lead by **Prof. Dr Miomir Vukobratovic** from Robotics Laboratory of the Mihailo PUPIN.

Professor Vukobratovic was founder and the first President of AESS.



Kragujevac 1987: LOLA Robot

Robotic assembly cell for spot welding of YUGO 45 doors

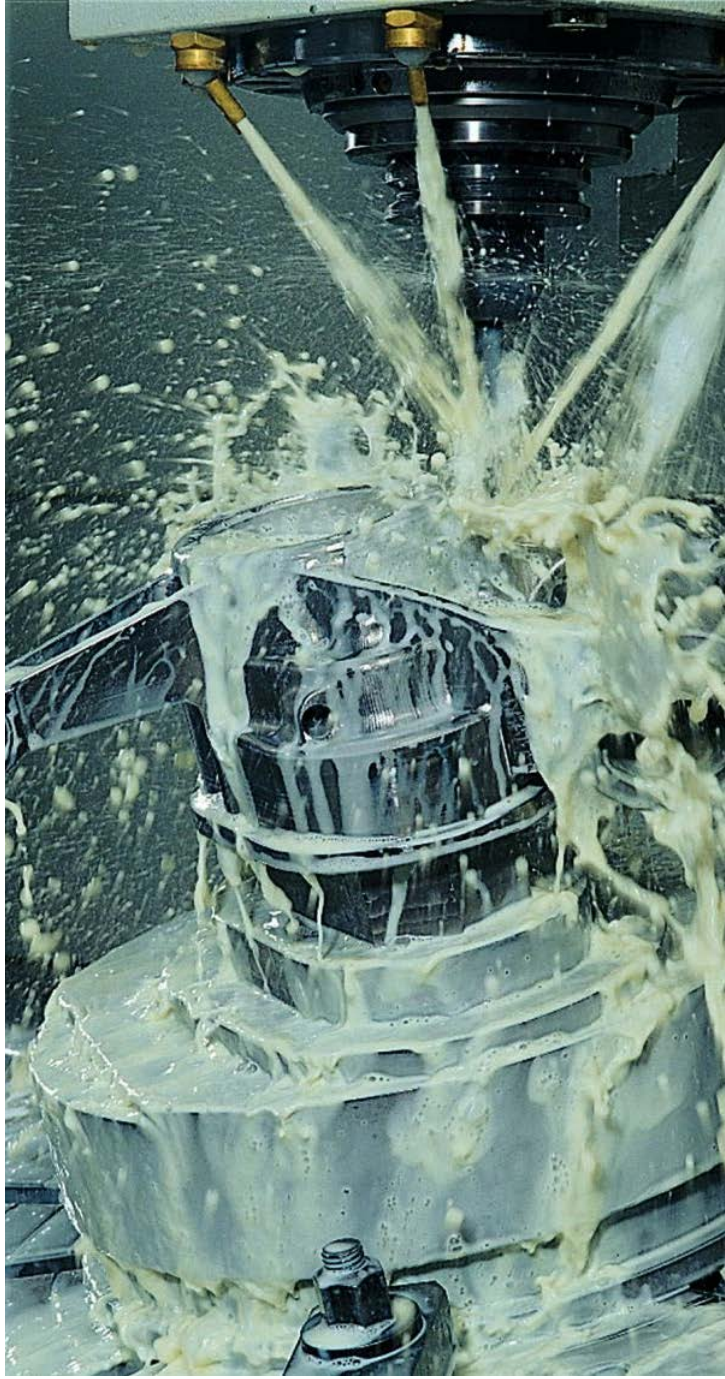
Source: AINS NTPS Programme

50 Years of PRODUCTION ENGINEERING Association

Serbian Association of Scientific and Research Institutions for Production Engineering

This association could be particularly valuable asset for the SMIH system. But it **requires to be MODERNIZED to meet the demands of the 21st century.** The Association should be:

1. REVITALIZED and REORGANIZED to be able to accomplish a new mission,
2. EQUIPPED with appropriate infrastructure and state-of-the-art RTDI equipment, and then,
3. ENGAGED to a new mission - active support of SMART INDUSTRIALIZATION of Serbian economy, through appropriate programnes.



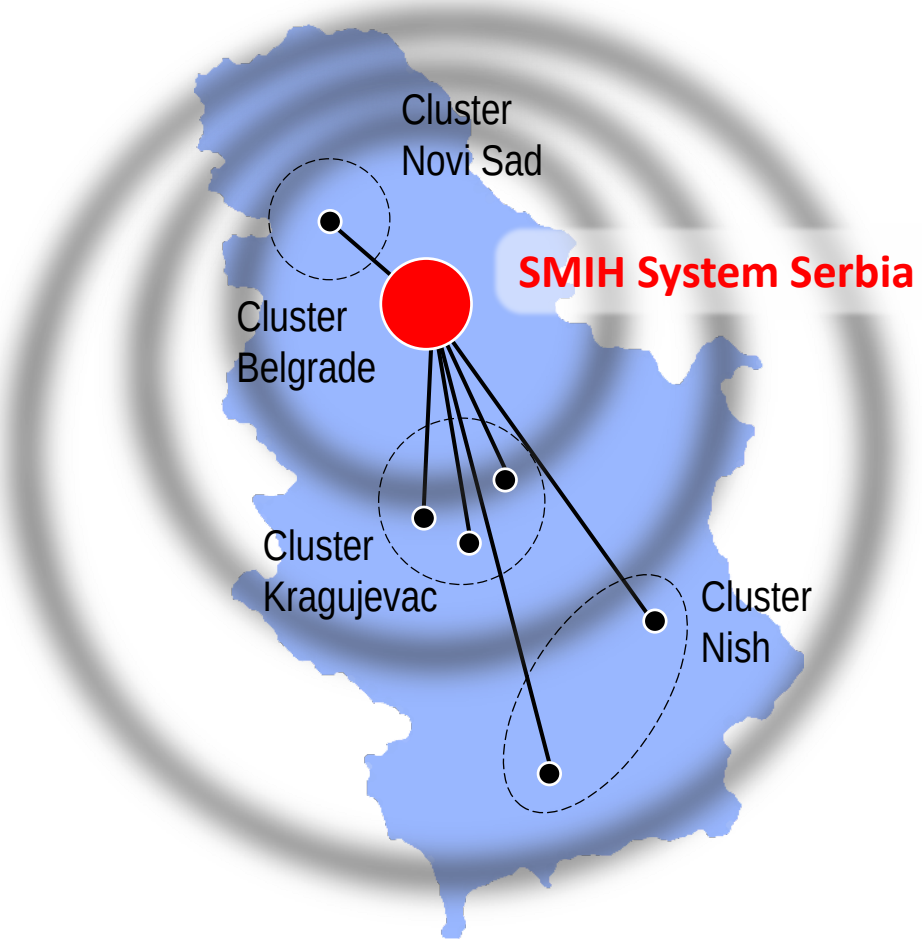
Solution #1: MONOCENTRIC Hub System – ONE serves ALL!

- Lean organization
- Minimal investment / funding of operation
- Minimal setting-up time – rapid to operation
- Potentially weak service capacity due to insufficient proximity to distant / regional clusters, risk of congestion of communication channels, and risk of tendency/bias of turning towards pure bureaucratization of the hub function.

The entire area of the Republic of Serbia is covered by the one simple hub that is not further structured and that interacts directly with all stakeholders.

In order to effectively interact with distant clusters (local geographic agglomerations of various stakeholders from industry and the academia), it may, if necessary, have an internal organizational division into departments or similar forms that would be specialized to handle distant clusters.

Hub's office space can be located at university, ST park, or in some other spaces dedicated for business. It should be closely linked with the Serbian association of production engineering.

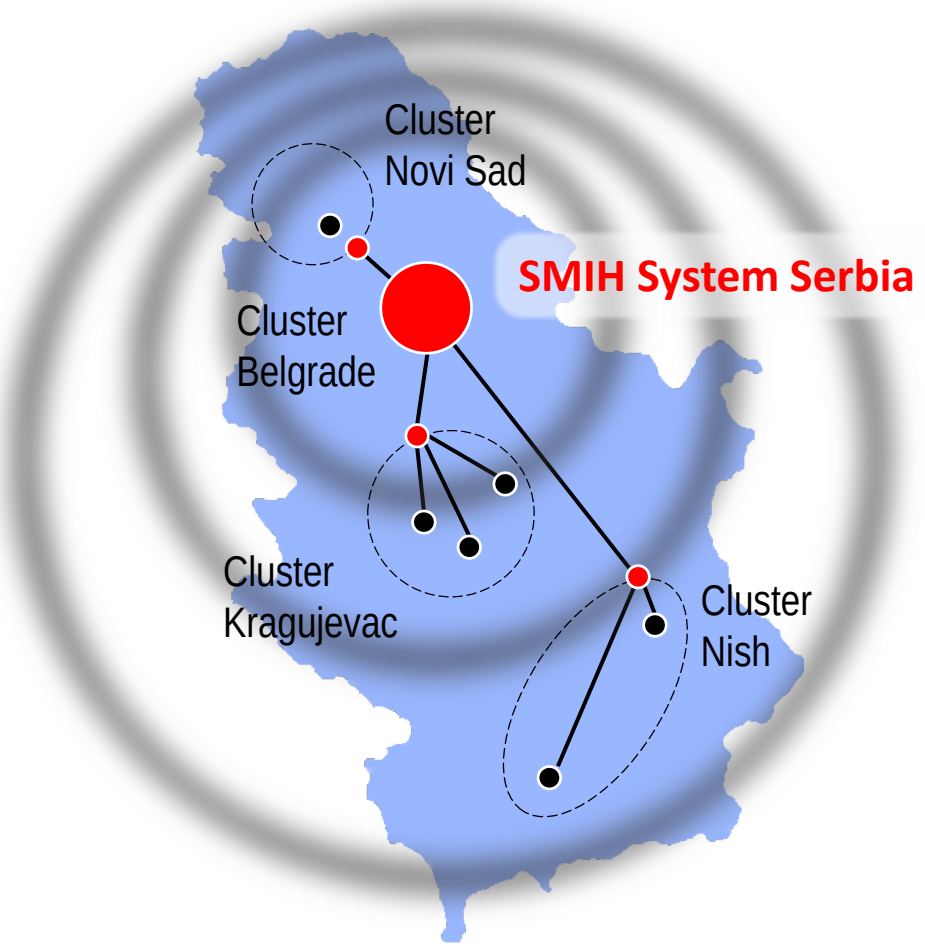


Solution #2: MONOCENTRIC Hub System with Gateways

- Lean organization
- Small investment / funding of operation
- Small setting-up time
- Increased service capacity by dislocated interaction points
- But still burdened with the risk of congestion of communication channels, and especially the risk of an inherent tendency to bureaucratize the entire function of the hub.

Gateways are spatial organizational extensions of the central hub, implemented in the form of dedicated regional offices (remote organizational units with the function of proxy interface points) with the primary goal of solving the inherent weakness of the monocentric hub topology in terms of achieving physical proximity to local stakeholders, especially to remote local industrial agglomerations in cities or districts. Improving affinity towards growth poles and their local activities.

The gateway can also be understood as a kind of accelerator, that is, an instrument that facilitates interactions and consequently accelerates the entire function of the hub. They cannot physically be considered a remote innovation hub (due to their very modest operational portfolio.



Solution #3: POLYCENTRIC Hub System with a Dominant Central Hub

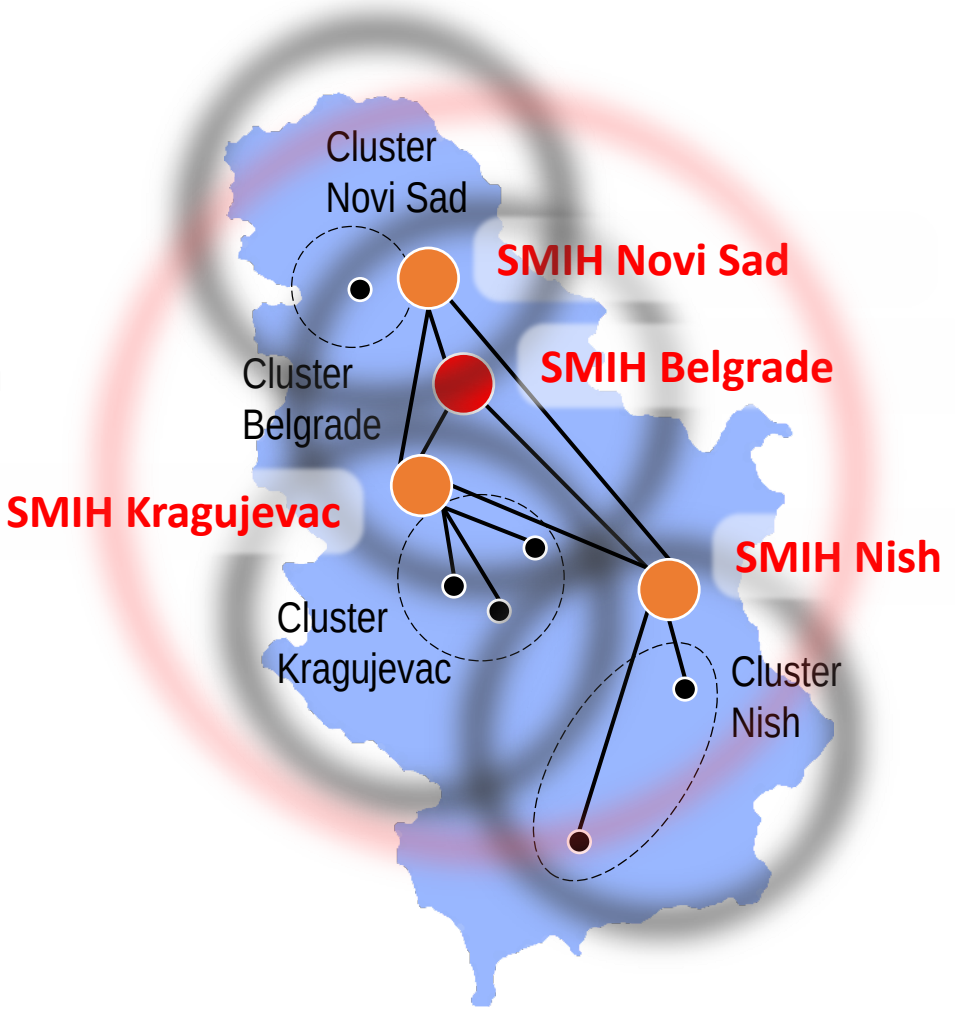
- Comprehensive organization – network of hubs (networks), but stratified
- High investment / funding of operation
- Long setting-up time
- Significantly improved service capacity

A stratified architecture that completely solves the issue of geographical proximity to the members of the SMIH System, and therefore strongly aligns the hub system with the concept of **economic poles of growth**.

This architecture enables a **high degree of local specialization** of hubs, strictly following the infrastructure of local clusters, their programs and innovative and other business activities, including education (improvement of competencies / upskilling and reskilling).

The existence of one dominant hub ensures a high degree of **coordination** on the entire national space, which has numerous advantages, especially significant in the early stages of the development of the SMIH system (management is still centralized to a significant extent). Also **synergy and critical mass** for action.

Stratified systems always provide greater capacity for coordination, and thus efficiency in carrying out the adopted mission.

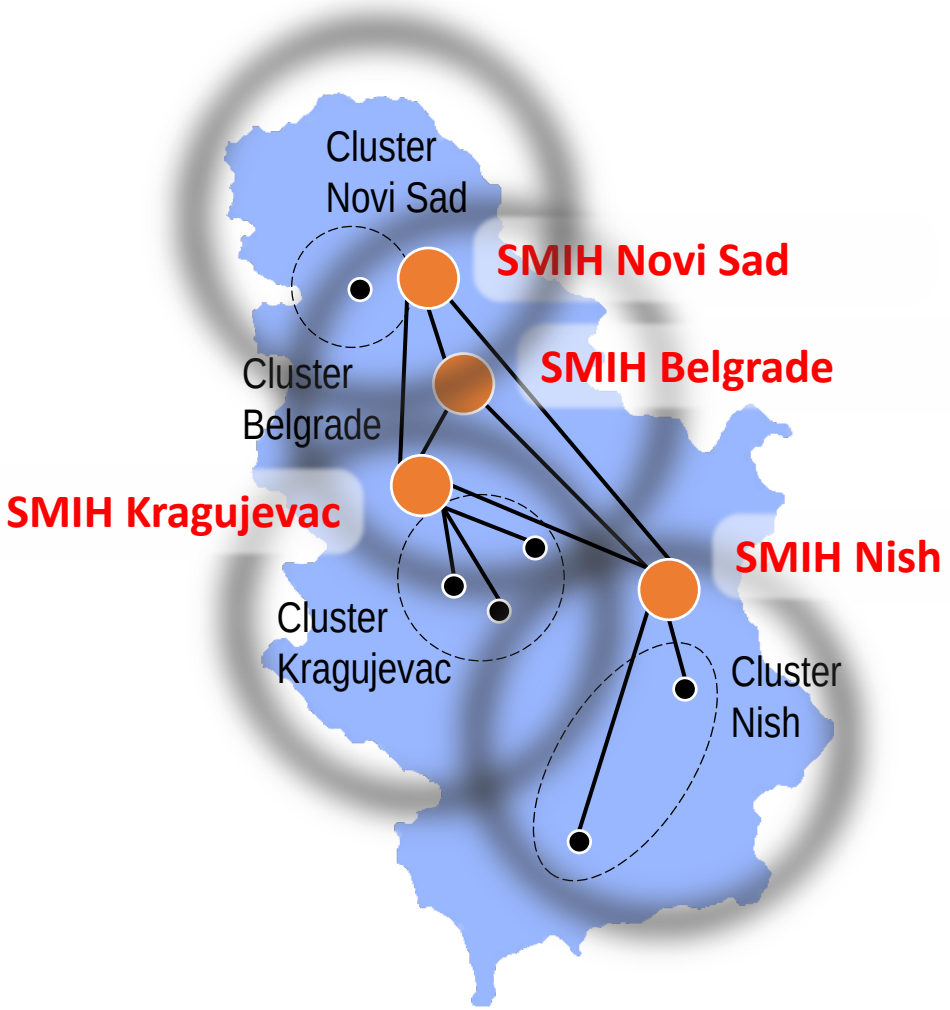


Solution #4: POLYCENTRIC Hub System non-stratified

- Comprehensive organization – Network of networks
- High investment / funding of operation
- Long setting-up time
- Significantly improved service capacity at the regional/local level

The highest degree of decentralization, dominantly driven by the idea of further highlighting the importance of local needs. Especially suitable for effective implementation of **regional development policies**. The existence of direct channels of interaction between hubs enables the integration of all hubs at the level of the national SMIH system.

Management function is completely decentralized. Only the level of strategic management is common to the entire SMIH system. The highest degree of operational autonomy, the highest degree of responsiveness to the needs of local actors and finally, the most effective support for development within the concept of poles of economic growth. Optionally, in order to achieve the necessary systemic synergy, it is possible to establish a **joint office**, as a kind of headquarter, which would exclusively deal with issues of strategic management of SMIH.



Regional inclusiveness / leveling of the SMIH System

A very important issue for the economic and overall social development of Serbia.

Administrative divisions of Serbia

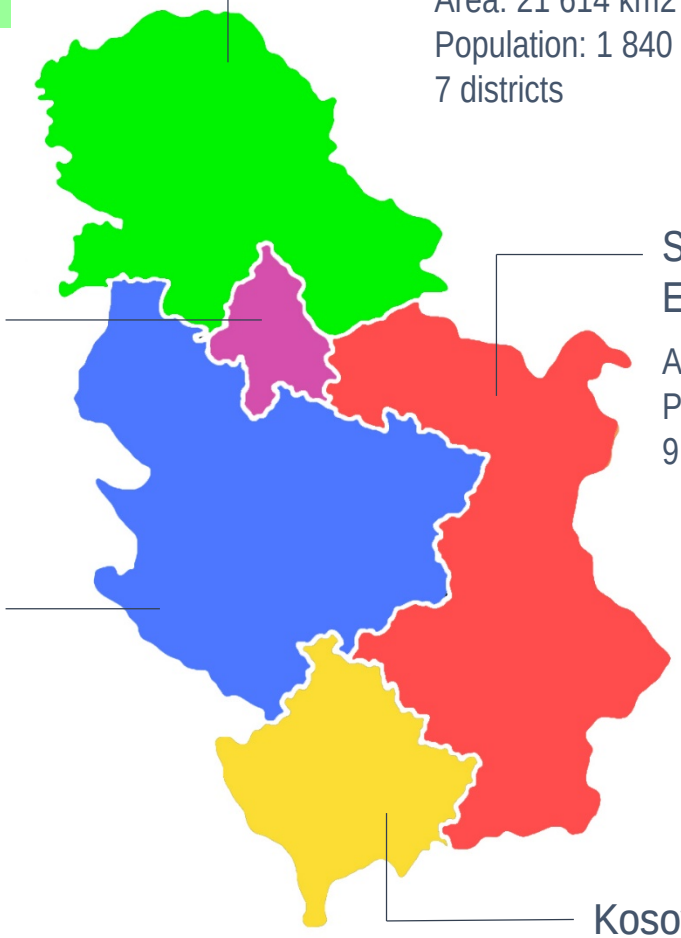
Geography, economy / industry, but also culture, history, policy, politics, ...

The **five statistical regions** (not administrative!) of Serbia are (EU NUTS-2 level / NUTS -2 regions usually have between 800,000 and 3 million inhabitants):

- Vojvodina.
- Belgrade
- Šumadija and Western Serbia
- Southern and Eastern Serbia
- Kosovo and Metohija.

Serbia is divided into **29 districts** - EU NUTS-3 level (18 in Central Serbia, 7 in Vojvodina, 5 in Kosovo and Metohija, while the city of Belgrade presents a district of its own).

Each district has its own local administrative powers (so-called local administration), coordinated from the state/republic level of the central administration.



Vojvodina
Area: 21 614 km2
Population: 1 840 852
7 districts

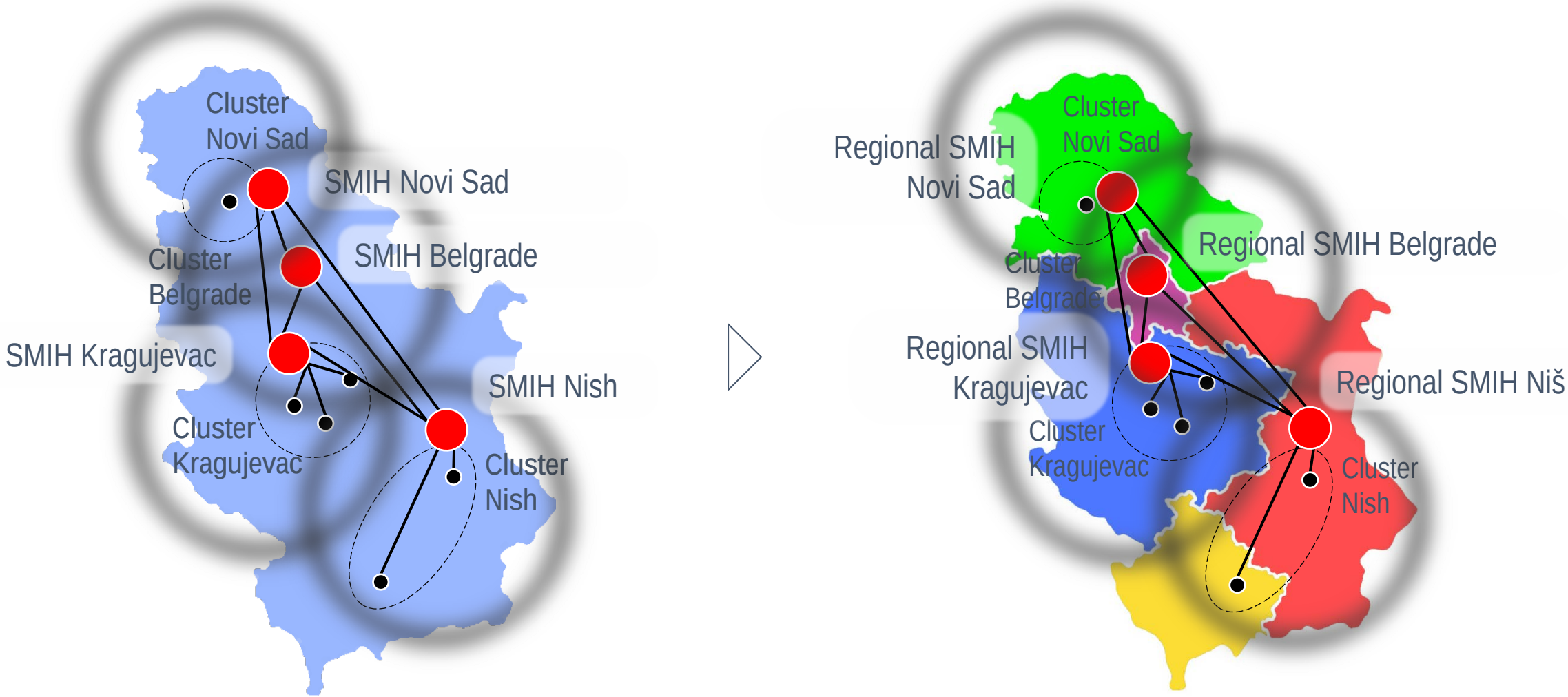
Belgrade
Area: 3 234km2
Population: 1 694 480
1 district

Southern and Eastern Serbia
Area: 26 248km2
Population: 1 473 345
9 districts

Šumadija and Western Serbia
Area: 26 493km2
Population: 1 890 449
8 districts

Kosovo and Metohija
Area: 10 910km2,
Population: ?,
5 districts

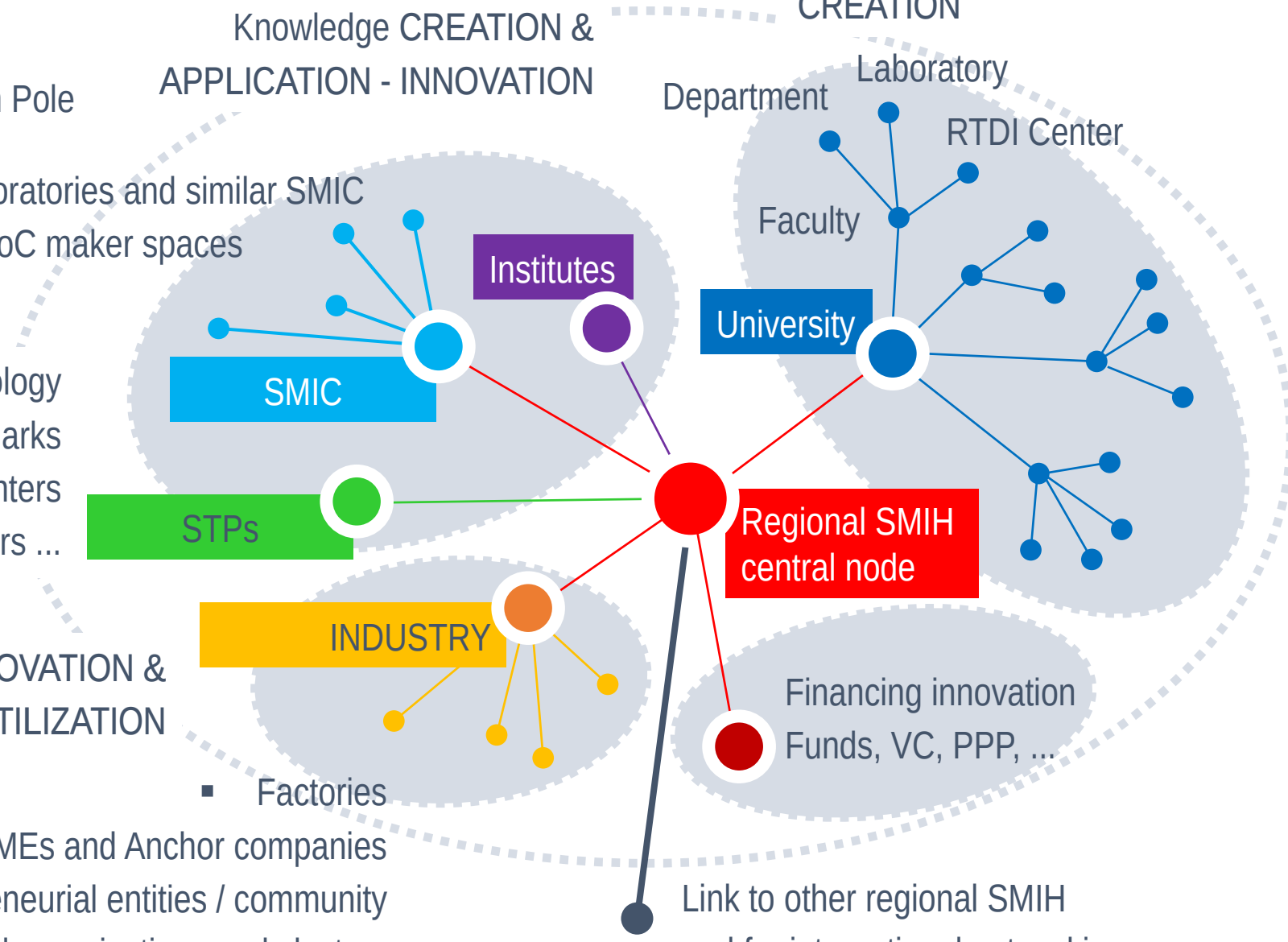
Further research is needed!
Economic Growth Poles approach should be used



SMIH System Architecture

Regional Hub organization

SMIH regional hub organized as an Economic Growth Pole



SMIH System Architecture

Regional Hub SMIH Novi Sad

RT-RK Institute for computer based systems

Institute BioSens

FTN - Faculty of Technical Sciences

- Dpt. for Production Engineering
- Dpt. for Industrial Engineering and Management
- Dpt. for Computing and Control Engineering

Faculty of Agriculture

University of Novi Sad

Science ant Technology Park Novi Sad

UNIDO SMIC Pilot

Continental

INDAS

Regional SMIH Novi Sad

SMIH System Serbia

SMART Manufacturing Innovation Hubs System S E R B I A

Link to other regional SMIH and for international networking

UNIDO SMIC **Pilot** is a pilot phase of the Smart Manufacturing Innovation Center that will be established within the project 200037 as a proof of concept activity

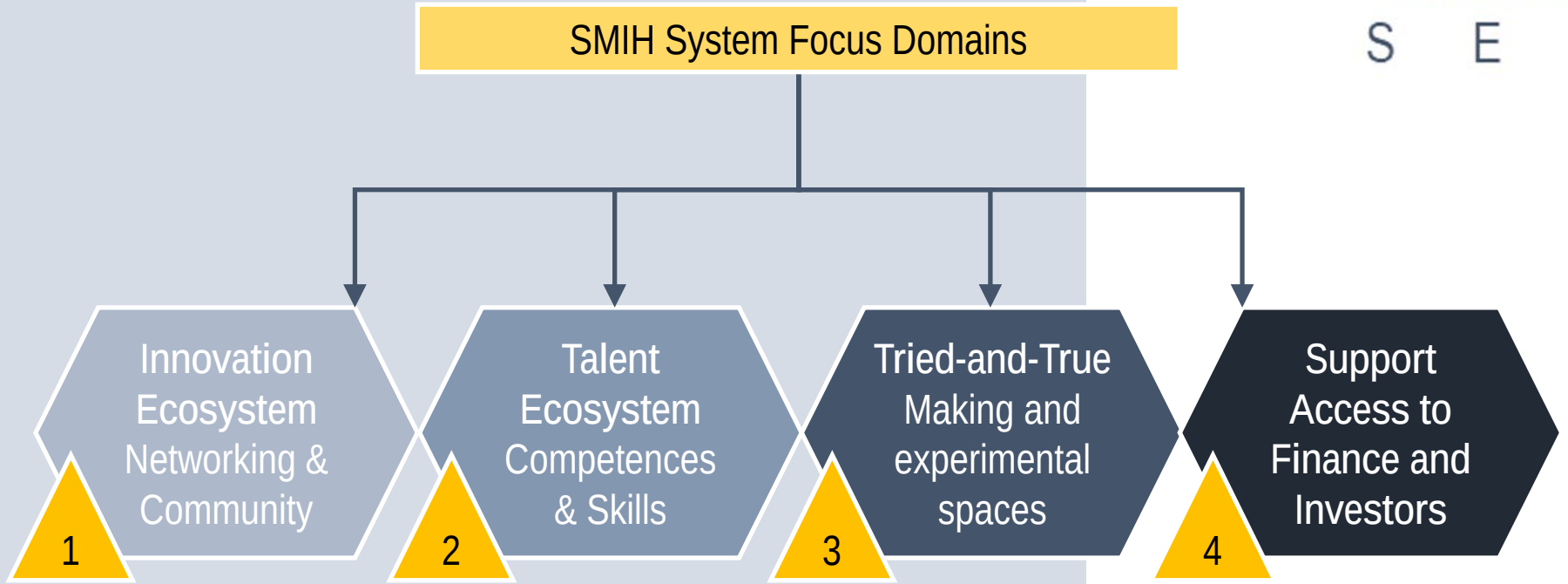
SMIH System FOCUS – Industry Driven

To be PRODUCTIVE, operation of the SMIH System should be focused to FOUR CORE DOMAINS:

1. Innovation ecosystem
2. Talent ecosystem
3. Tried-and-True (or test-before-invest Smart Manufacturing MAKER SPACES)
4. Access to finance and investors

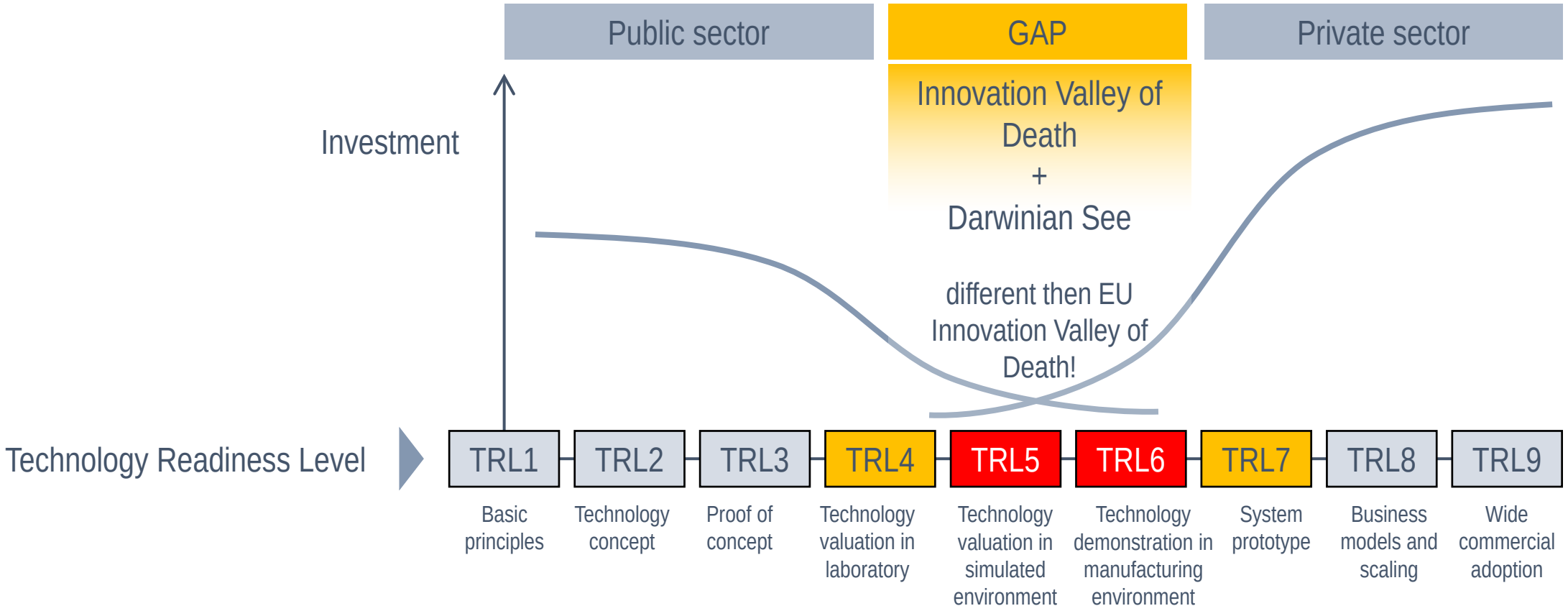
SMIH System Serbia

SMART Manufacturing Innovation Hubs System SERBIA



SMIH System FOCUS – Industry Driven

- The GAP between a good idea and a successful commercial product is known as the “Innovation Valley of Death”.
- To be effective, the SMIH System should operate primarily within the “Innovation Valley of Death” to accelerate and de-risk technology development and scale-up manufacturing through an ecosystem consisting of government research institutions, universities, and private sector industry members. Collectively.
- The SMIH System is crucial vehicles to help transition of manufacturing ‘leap-ahead’ technologies through Research, Design, Prototyping, and Production / Manufacture, all together a Manufacturing Innovation



SMIH Hub System Innovation Domains as a response to global and national challenges

Challenges & Opportunities

- Manufacturing the products of the future
- Sustainability
  - Economic sustainability of manufacturing
  - Social sustainability of manufacturing
  - Environmental sustainability of manufacturing

UN SDGs

SMIH Research & Innovation Priorities

Domain 1:
Advanced Manufacturing processes

Domain 2:
Adaptive and Smart Manufacturing systems

Domain 3:
Digital, virtual and resource-efficient factories

Domain 4:
Collaborative and mobile enterprises

Domain 5:
Human-centred manufacturing

Domain 6:
Customer-focused manufacturing

Technology & Enablers

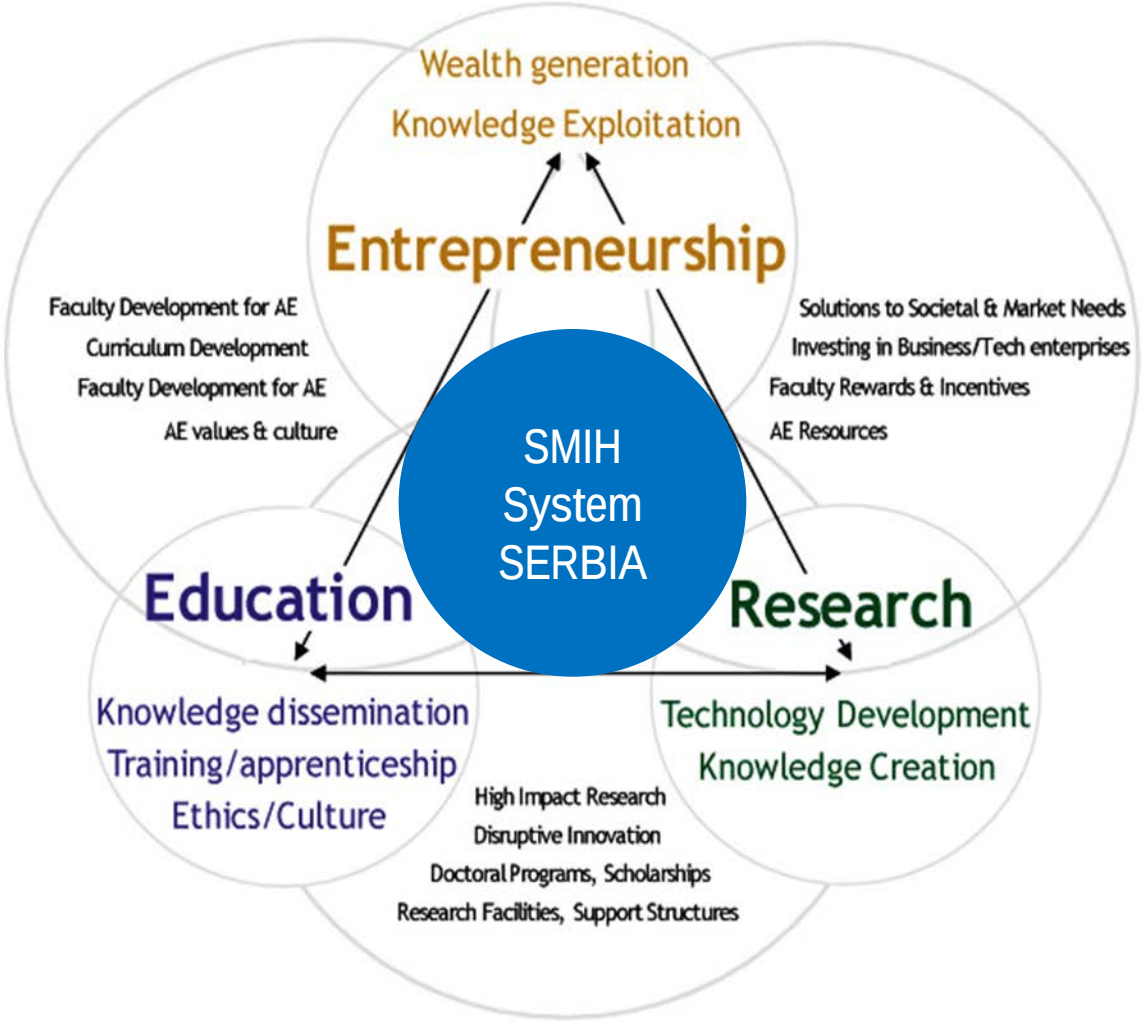
- Advanced manufacturing processes
- Mechatronics for Advanced Manufacturing Systems
- Information & Communication Tehnologies
- Manufacturing Strategies
- Knowledge Workers
- Modelling, Simulation & Forecasting

SMIH System OPERATIONAL MODEL

SMIH System operational model should be based on so called Knowledge Triangle

The knowledge triangle refers to the interaction between research, education and innovation, which are key drivers of a knowledge-based society.

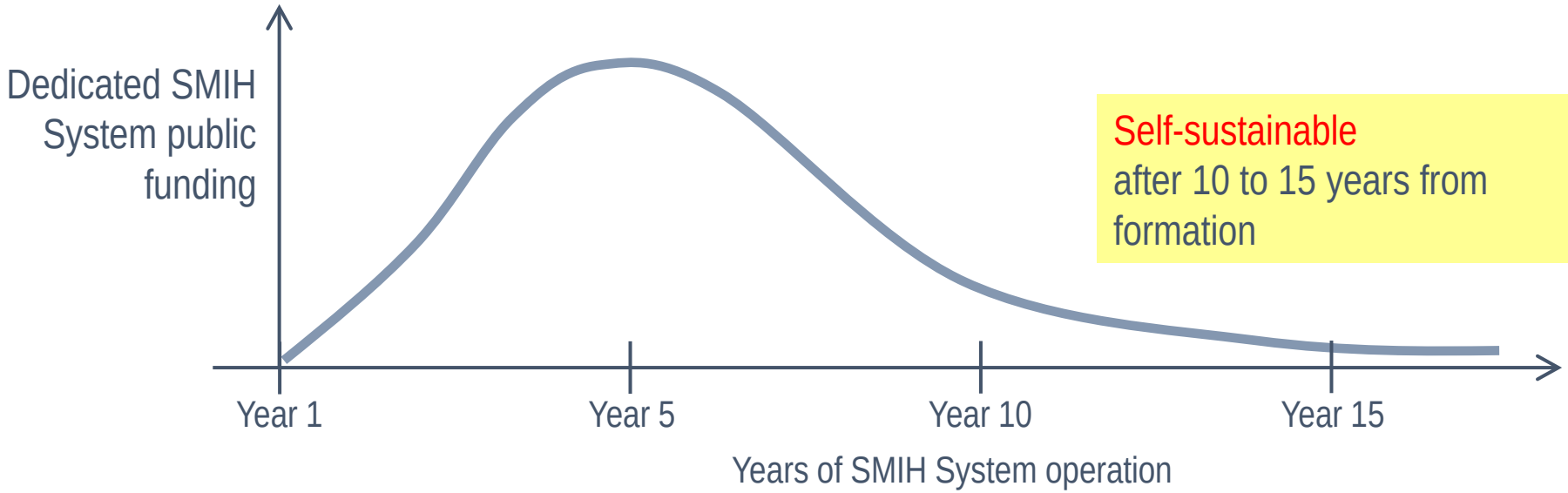
In the European Union, it also refers to an attempt to better link together these key concepts, with research and innovation already highlighted by the creation of the European Institute of Technology (EIT).



SMIH System Funding model

- **Funding model:** Public funding & high degree of commitment of partners - Serbian government funding max. 25% of SMIH hubs total budget overtime; 75% to be attracted from other sources, both public and private, at national and international level (EU funds, EU Regional funds and bilateral collaboration funding);
- **Synergies** with national, regional and EU funding instruments
- **SMIH System public funding dedicated** for:
  - Community/Partnership Building,
  - Building Infrastructure for Networking,
  - Access to Equipment,
  - Accelerate Innovation, and
  - Hub System Operation

Dedicated SMIH System public funding (max 25%) + Other sources of SMIH System funding (75%) = Total SMIH System funding (100%)



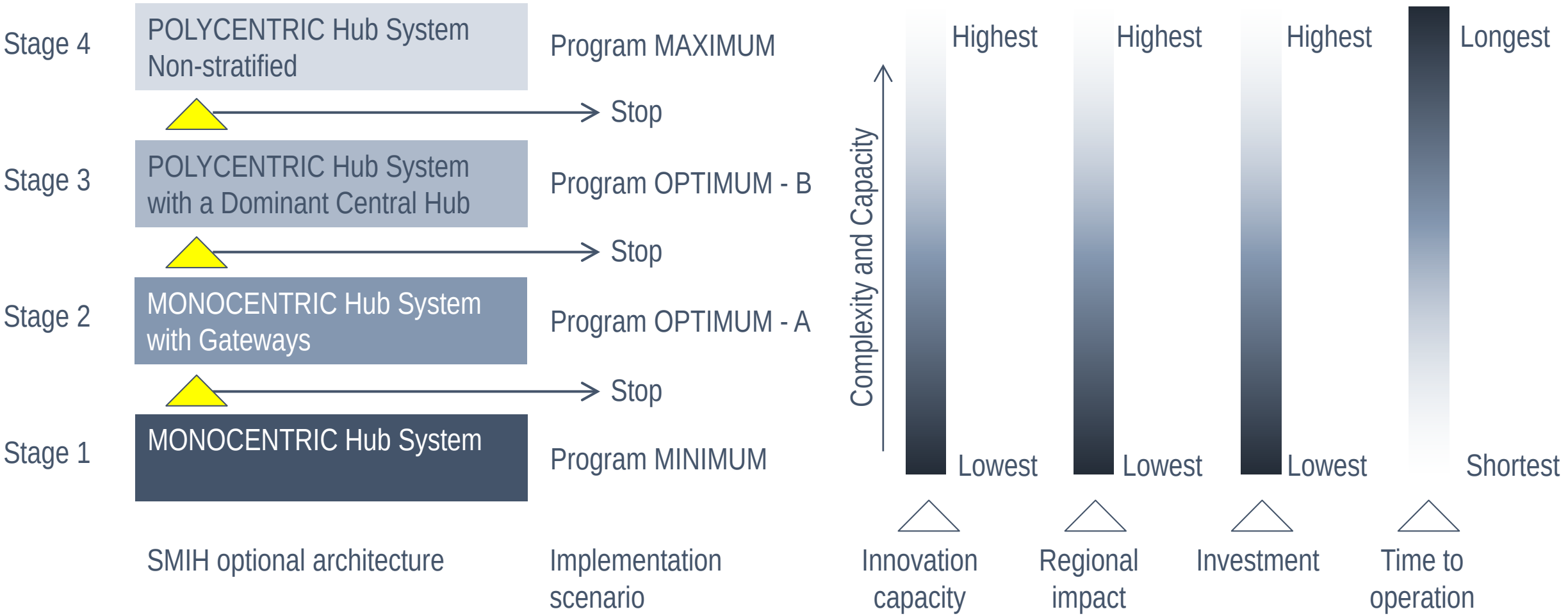
Self-sustainable
after 10 to 15 years from formation

How to achieve self-sustainability:

- Ensure long-term involvement of partners
- Incentivize financial commitment from partners
- Provide a catalyst for investment in innovation

The choice depends on what we actually want to achieve?

Flexible solution: The previously defined 4 variant architectures enable the technical integration of these scenarios into a single development process that can be stopped at any time without jeopardizing the functionality of the results achieved up to that point.



SMIH System Regional / EU / Global Collaboration

- Regional level
  - Bilateral collaboration within the Western Balkans region
  - Open Balkan Initiative – extending present economic collaboration to domain of Manufacturing Innovation
  - UNIDO Western Balkans SMIH System - TENTATIVE
- EU level
  - EU Regional Innovation Scheme (RIS)
  - EU EIT + EIT Manufacturing
  - EU FP Horizon Europe ...
  - EU ETP ManuFuture + EFFRA + euRobotics
  - EU Danube Region Strategy
  - EU Regional Innovation Valleys
  - European billaterals
- Global level
  - Bilateral collaboration
  - UN SDGs programmes

EIT Manufacturing
Paneuropean Innovation Community within the European Institute of Innovation & Technology (EIT) – that connects the leading manufacturing actors in Europe.

MADE S.C.A.R.L. - Competence Center Industria 4.0

MADE is one of the 8 Italian Competence Centers, officially acknowledged as Digital Innovation Hub by the European Union. MADE's vision is to lead companies towards their digital and sustainable transformation. MADE provides a set of knowledge, methods, technical, and managerial skills on digital technologies to support companies in their digital transformation. Thanks to the large demo-center of 2500 square meters, it provides an I4.0-based pilot production facility for test, demonstration, and development project realization. MADE accomplishes this mission by: informing and showing Industry 4.0 technologies, explaining them through specific training activities, then transferring and implementing technological solutions through projects (Test Before Invest). MADE is a public-private consortium attracting investments composed of more than 48 partners clustered in: universities, research facilities, manufacturing companies, including software technology providers, and one public entity. MADE coordinates EDIH Lombardia, within the European Digital Innovation Hub network - a consortium of 15 partners supporting industry digital transformation in the EU.

https://www.made-cc.eu/en/news-en/square-meter-digital-and-sustainable-industry/

Thales' two-day training in person at MADE- Competence Center i4.0 ended on Tuesday 10th May.

Participants were able to discover our **technological areas** and their demonstrators: Virtual Reality experience in CAVE, Lifecycle Management, Logistics 4.0 and Digital Twin, Orchestration systems for production, Industrial and Collaborative Robotics, Smart System for worker assistance, BIG Data, Data Hub.

https://www.made-cc.eu/it/news/formazione-thales-made/

MADE – Competence Center Industry 4.0 and the Abu Dhabi Department of Economic Development (ADDED) have signed a memorandum of understanding to enhance the UAE's i4.0 ecosystem.

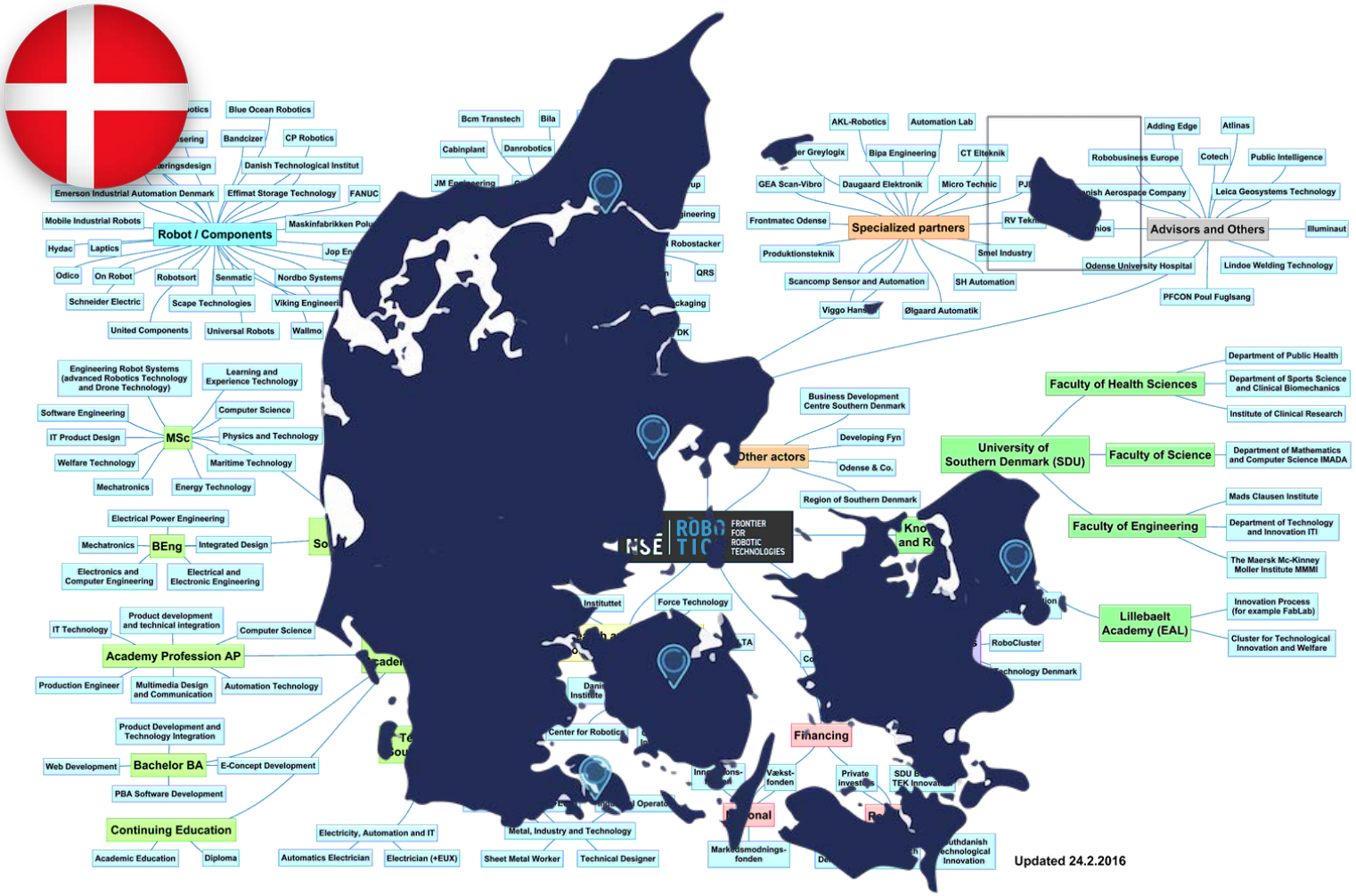
Milan, September 15th 2022 –
Abu Dhabi Department of Economic Development (ADDED) signed with MADE – Competence Center i 4.0 a memorandum of understanding for several initiatives in the context of Industry 4.0, aimed at supporting the growth of digital competencies in the local ecosystem and establishing a Competence Center in Abu Dhabi.

https://www.made-cc.eu/en/news-en/enhance-the-uaes-i4-0-ecosystem/

ODENSE robotics - National cluster

Denmark's cluster for robotics, automation and drones

Denmark's national robot, automation and drone cluster – Odense Robotics – brings together the entire ecosystem to drive innovation and growth in the industry nationwide.



ODENSE robotics - National cluster

Denmark's cluster for robotics, automation and drones

The cluster has **regional hubs** in Aalborg, Aarhus, Copenhagen, Odense and Sonderborg, with the cluster secretariat in Odense.

The cluster is founded on partnerships with **leading knowledge institutions**: Aalborg University, Aarhus University, Kolding Design School, Danmark's Technical University, FORCE Technology, the University of Southern Denmark and the Danish Technological Institute.

As of 2022, **more than 1 billion USD has been invested in Odense robotics companies**. The collaboration between local government (the City of Odense), knowledge institutions, and industry representatives makes for a rare, innovative ecosystem matched by few other cities in the world.

It is **structured as an ecosystem** designed with a nationwide setup with regional hubs across the country, bringing together 418 **robotic, automation and drone companies** across the country which employ around 10,700 people in Denmark and 3,800 abroad. The number of employees working for companies within the Odense Robotics cluster is forecast to reach 23,000 by 2025, with new ventures starting up every year.

Quote: Peter Rahbæk Juel, Mayor of Odense

"Developing a world-class robotics environment right here in Odense has been a City Council top priority for years, and it shows up in everything ...;

UR co-founder and Cobot pioneer Esben Østergaard

Automation for anyone. Anywhere.

Universal Robots is an innovative robotics company of over 1,000 employees united behind a common vision – to create a world where people work with robots, not like robots.

Since the sale of our first collaborative robot in 2008 our technology, along with that of our partners, has been changing the way work is done across the world.

SMIH System Serbia
SMART Manufacturing Innovation Hubs System SERBIA

Conclusions:

- We live in an industrial economy. The manufacturing share of 13% in Serbian GDP is at an alarmingly low level and such a situation requires a decisive reaction. A strong manufacturing sector is imperative for further successful growth and stability of the Serbian economy, strong manufacturing sector is a key generator of quality jobs, prosperity and societal well-being.
- Manufacturing is a complex socio-economic system. A holistic approach is necessary. Future of Serbian manufacturing should be determined by the framework of the twin transformation - Digital and Green.
- Serbian innovation ecosystem should be more explicitly focused on manufacturing through:
    1. Building a national infrastructure that is explicitly dedicated to manufacturing innovations - Smart Manufacturing Innovation Hubs system
    2. Development and implementation of strategic long-term national programmes for manufacturing innovation with a strong focus on interaction between industry and academia
    3. Strengthening regional and EU cooperation and partnerships in the field of manufacturing innovations and vertical transfer of manufacturing technologies. UNIDO could be one of the key partners in that process.

SMIH System Serbia

SMART Manufacturing Innovation Hubs System SERBIA

Thank you for your attention!

Questions, suggestions ...