



THE EFFECT OF THE INNOVATION PARADIGM ON ENGINEERING EDUCATION

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Outline:

- Motivation
- Industry 4.0
- Triple Helix – Cluster – Innovation Ecosystem
- Learning Factory



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Motivation:

The Learning Factory Concept

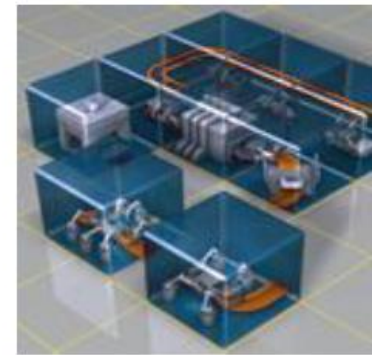
What is it? How to apply it?

Teaching and learning in higher education – according to **technological advancements** – need innovative practices, in order to increase student engagement rates, improve learning outcomes, and increase flexibility.

Novel approaches include:

- a movement to online learning technologies,
- blended learning (i.e. the combination of traditional learning and online learning), and
- **innovations in practical teaching and learning**, such as student-centred and project-based learning.

Industry 4.0 – The rapid development of the industry



Local automation technology

Communication-based automation

Optimization of the entire production process with innovative software systems

Organization and optimizing of the production through cyber-physical systems (CPS) ("Industrie 4.0")

Characteristics of the four industrial revolutions

Industry 4.0 – Smart Factory, Internet of Things, Cyber-physical systems

Industry 4.0 facilitates the vision of the **Smart Factory**.

Within the modular structured Smart Factories of Industry 4.0, **Cyber-physical systems** create a virtual copy of the physical world, and monitor the physical processes making decentralized decisions (see next Figure).

Over the **Internet of Things**, Cyber-physical systems communicate and cooperate with each other and humans in real time.

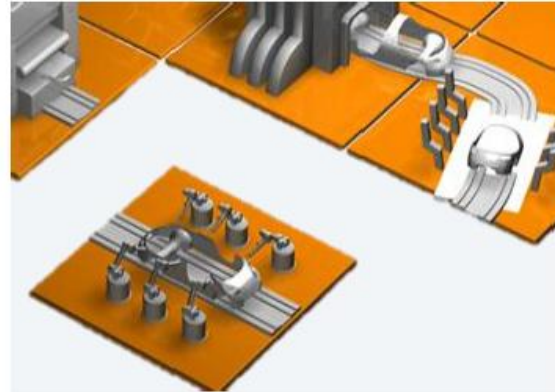
Via the **Internet of Services**, both internal and cross-organizational services are offered and utilized by participants of the value chain.

Industry 4.0 – The key elements of Industry 4.0 (Siemens AG, 2014)



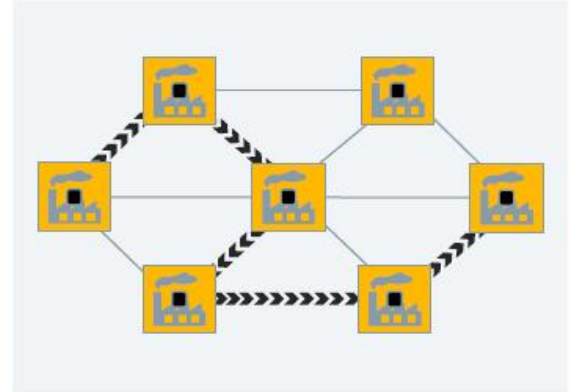
Fusion of virtual and real world

Integration of product design and production engineering based on a common **Digital Enterprise Platform**



Cyber-physical systems

Production units with complete virtual image enable migration towards a "plug 'n' produce,, integration of automatization

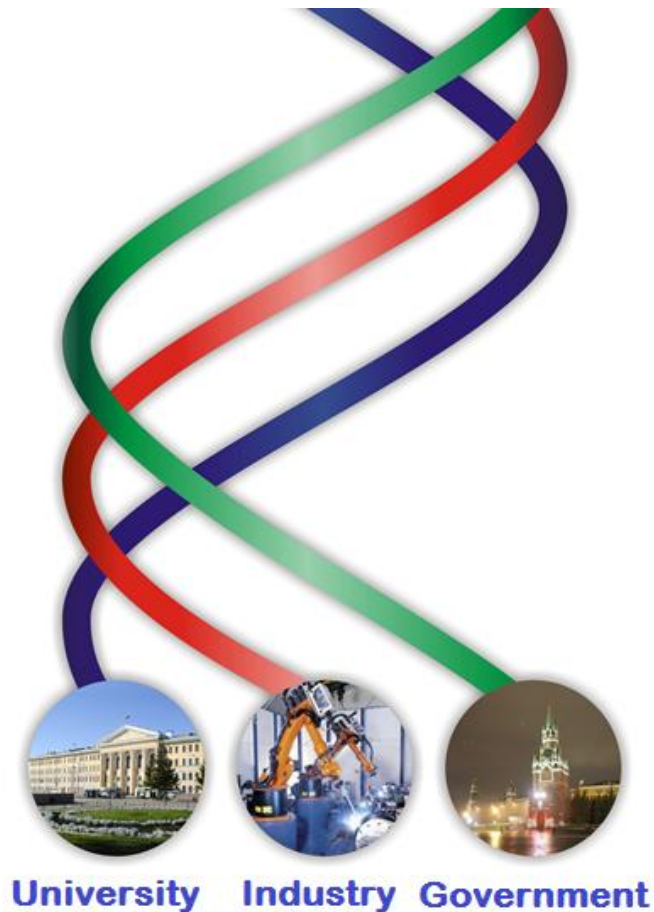


Dynamic production network

Flexible value chains with information available in realtime across company boundaries based on powerful **Manufacturing Operations Management**

Communication requirements →

The Triple Helix theory

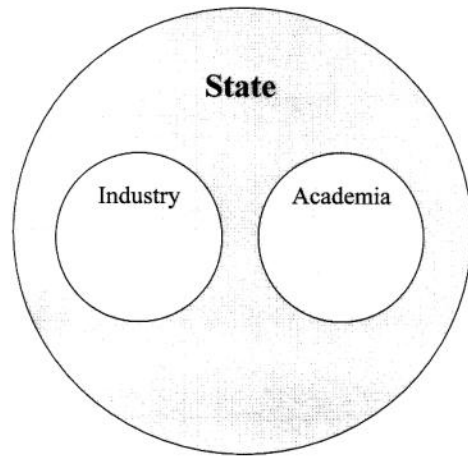


**Visualization of the
Triple Helix model**

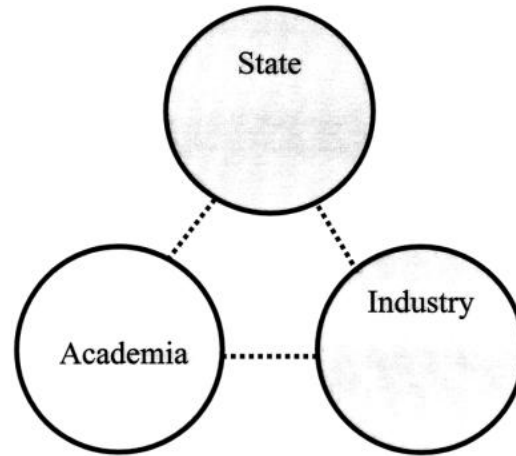
For sustainable development, to continuously renew the economy and the society, a **higher stage of cooperation** is needed between the Academia, Industry, and Government.

The Triple Helix model is to show that these three entities should work together to **stimulate knowledge**, which is generated in universities and research institutions, **to drive innovation** and end up in the marketplace.

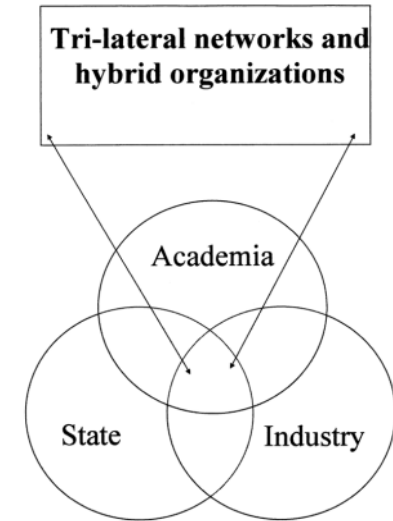
Triple Helix model visualized by circles



state ruled “military driven” innovation



“no intervention”



**Triple Helix:
“knowledge driven”
innovation by
cooperation**

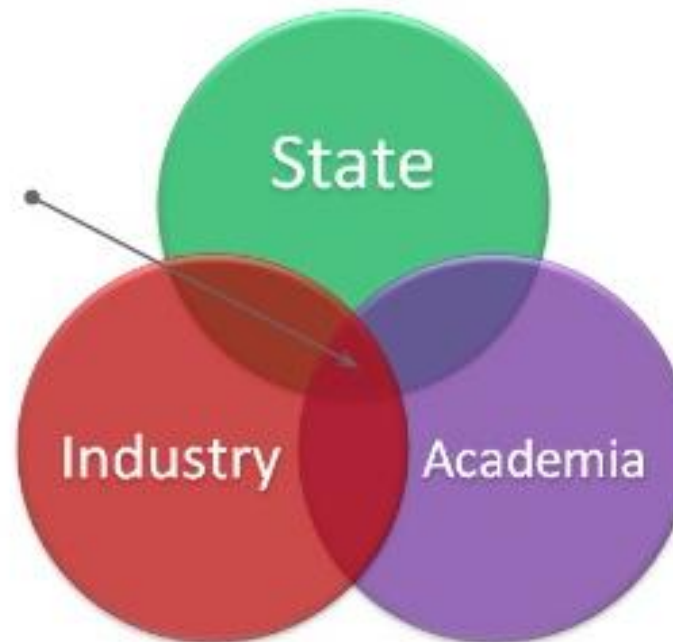
The formation stages of the Triple Helix model

The model with emphasize on cooperation

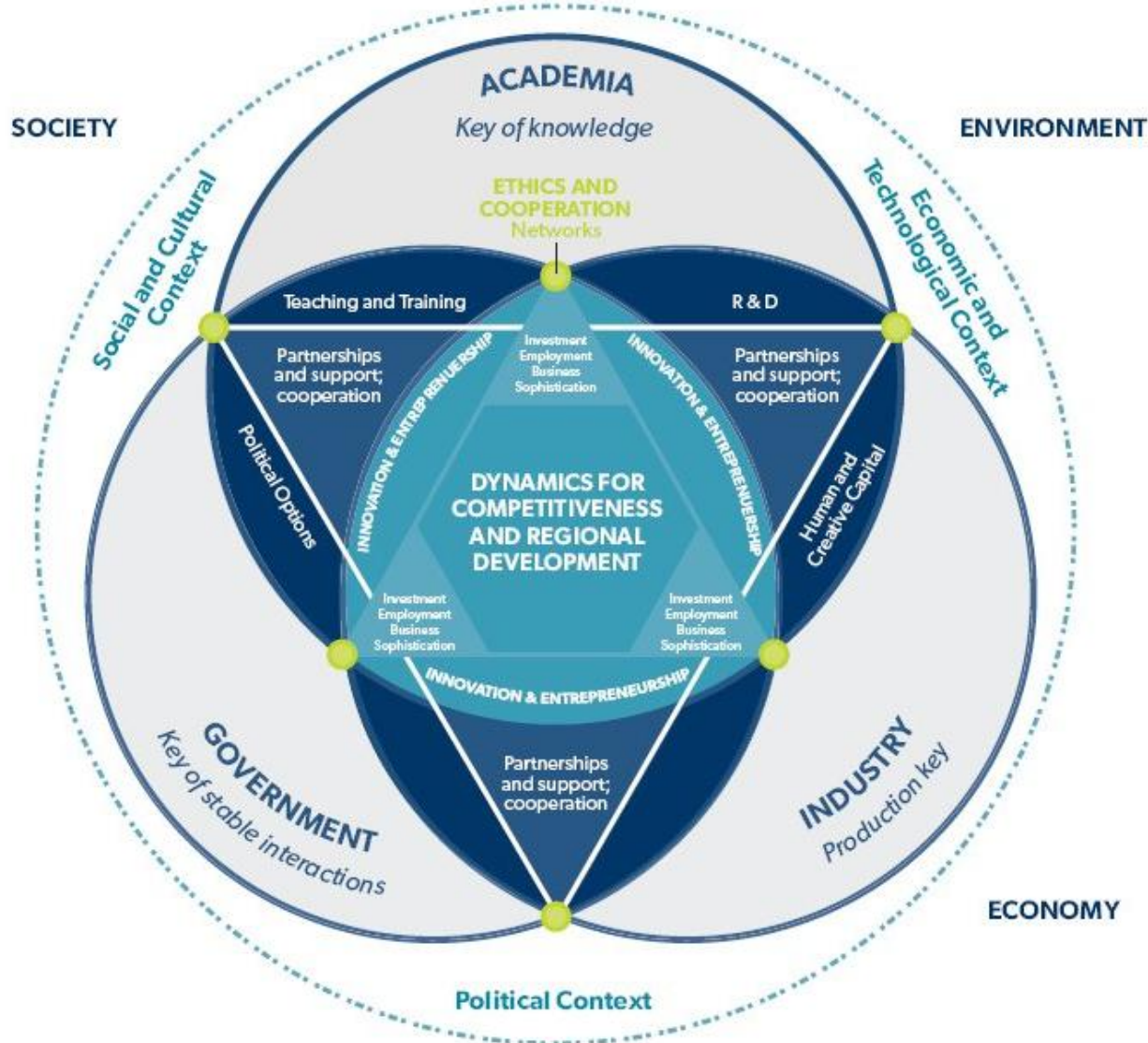
The visualization of the model with the Triple Helix illustrates the elements of the system and the helical feature of the development of the economy, but more complex models are needed and have been developed to visualize the necessary cooperation between the three elements of the Triple Helix.

this is where, Industry, university, government intertwined by taking the following important roles into consideration:

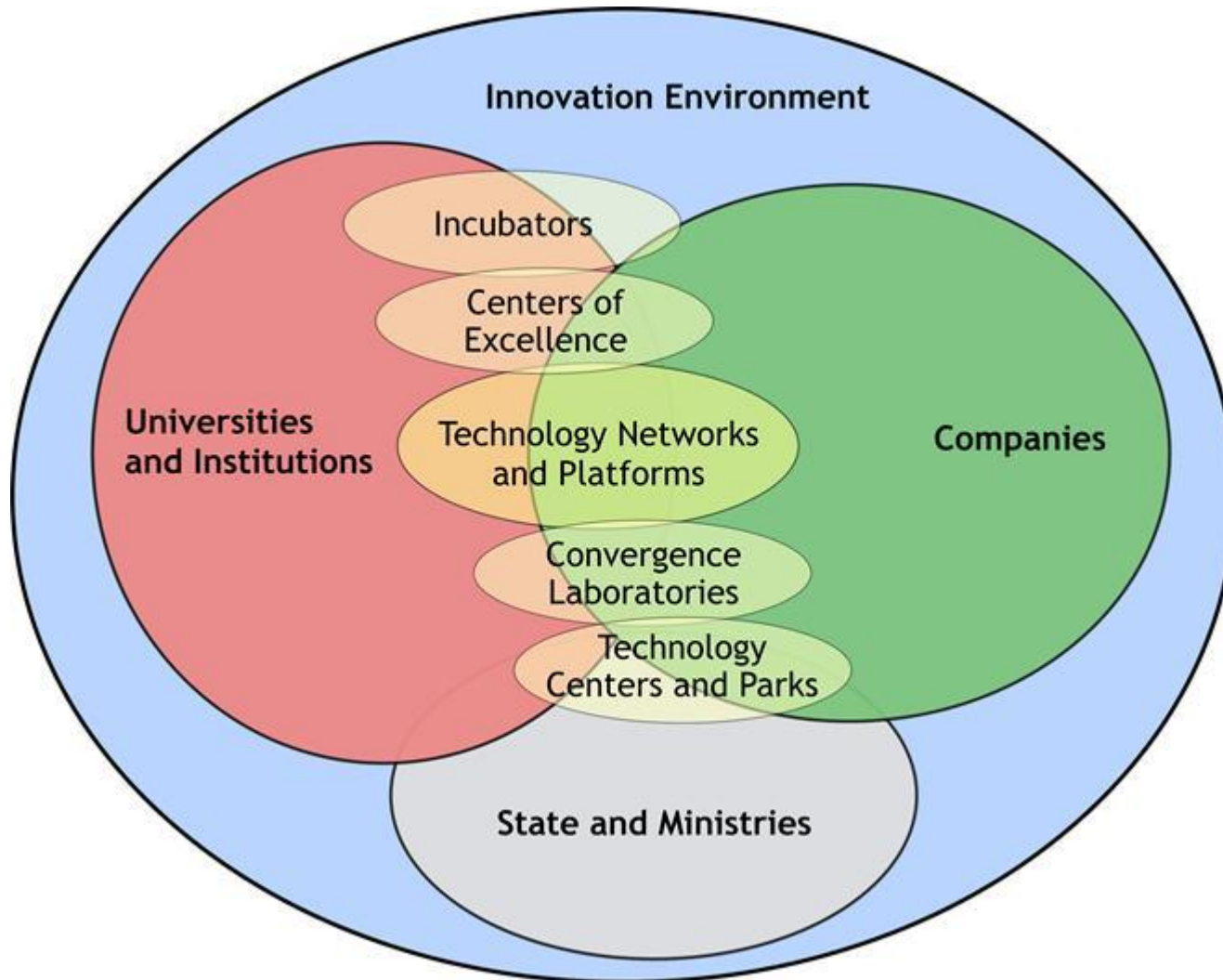
- *“Enhancing existing roles”*
- *“Taking the role of the other”*



An advanced complex Triple Helix model



The asymmetric Triple Helix model shows the main aspects of cooperation



Knowledge (technology) based innovation is driven by 1st universities and 2nd industry, where knowledge is mostly generated.

Triple Helix, Cluster, Innovation Ecosystem



Innovation strategies usually refer to Michael Porter's Cluster theory. **Clusters** bring R&D institutions, companies, suppliers, and government entities together around a common agenda to **enable innovation and speed productivity growth**. Cluster is becoming **a new way of thinking about economies** and organizing economic development efforts.

Innovation Ecosystem is a more accurate description for the „Cluster”, as it implies an interaction between members of the ecosystem, whereas a Cluster is a term based more or less on observation.

Triple Helix, Cluster and Innovation Ecosystem all describe the same structure of cooperation, but each term conveys something special.

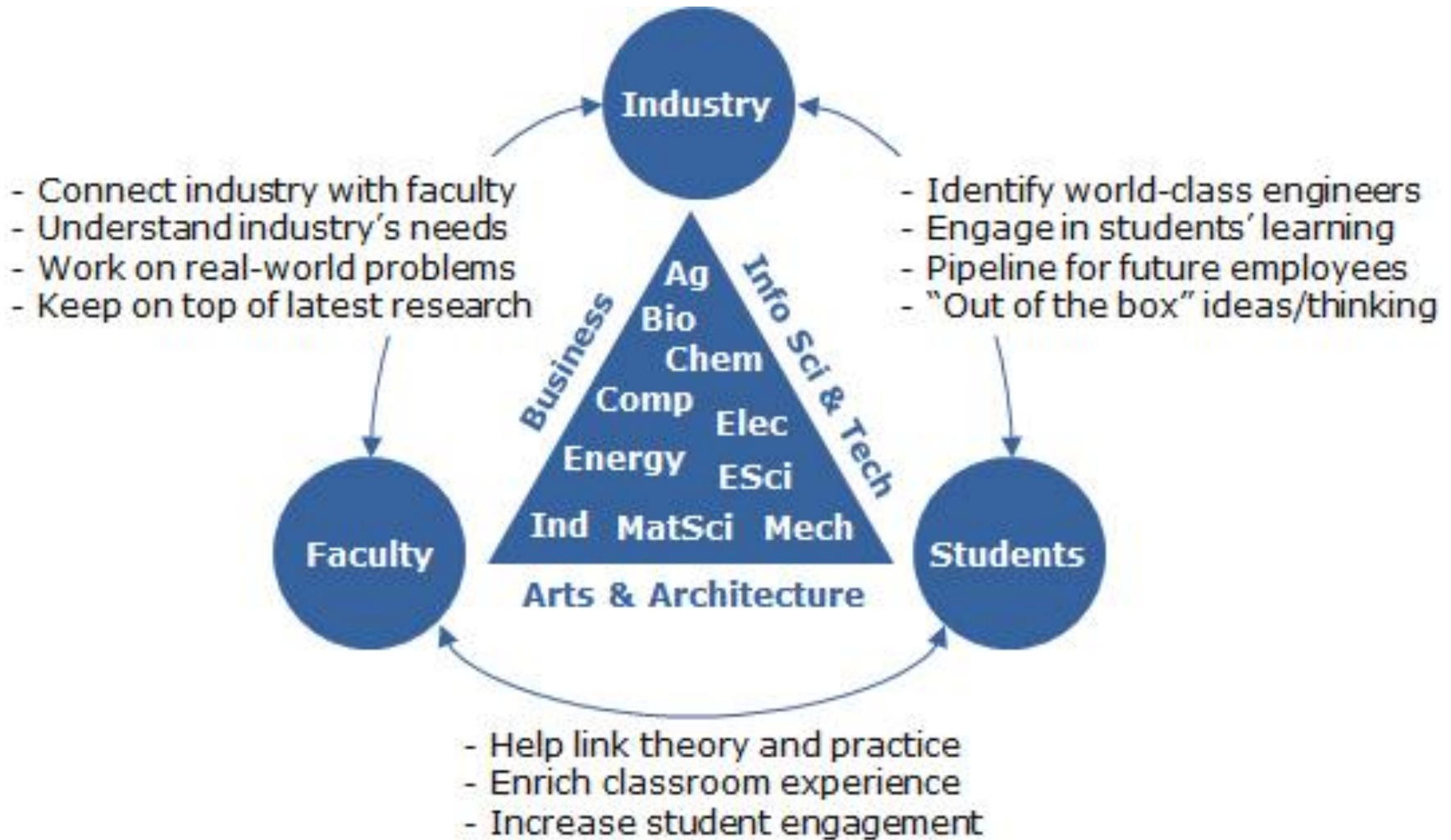
The Learning Factory

More and more educational organizations promote hands-on training models to prepare their students for professional life, taking into account the requirements of the Fourth Industrial Revolution and following the best practice of cooperation manifested by the Triple Helix theory.

The **Learning Factory** is a hands-on training site, whose mission is to help bring the real-world into universities and provide engineering students with **practical experience through design and realization projects**, proposed and sponsored by industrial companies.

Learning Factories provide University-Industry partnerships where **industrial sponsors** interact with **students** and university **faculty** to help create world-class engineers through students' projects for the benefit of industrial clients.

The Learning Factory triangle



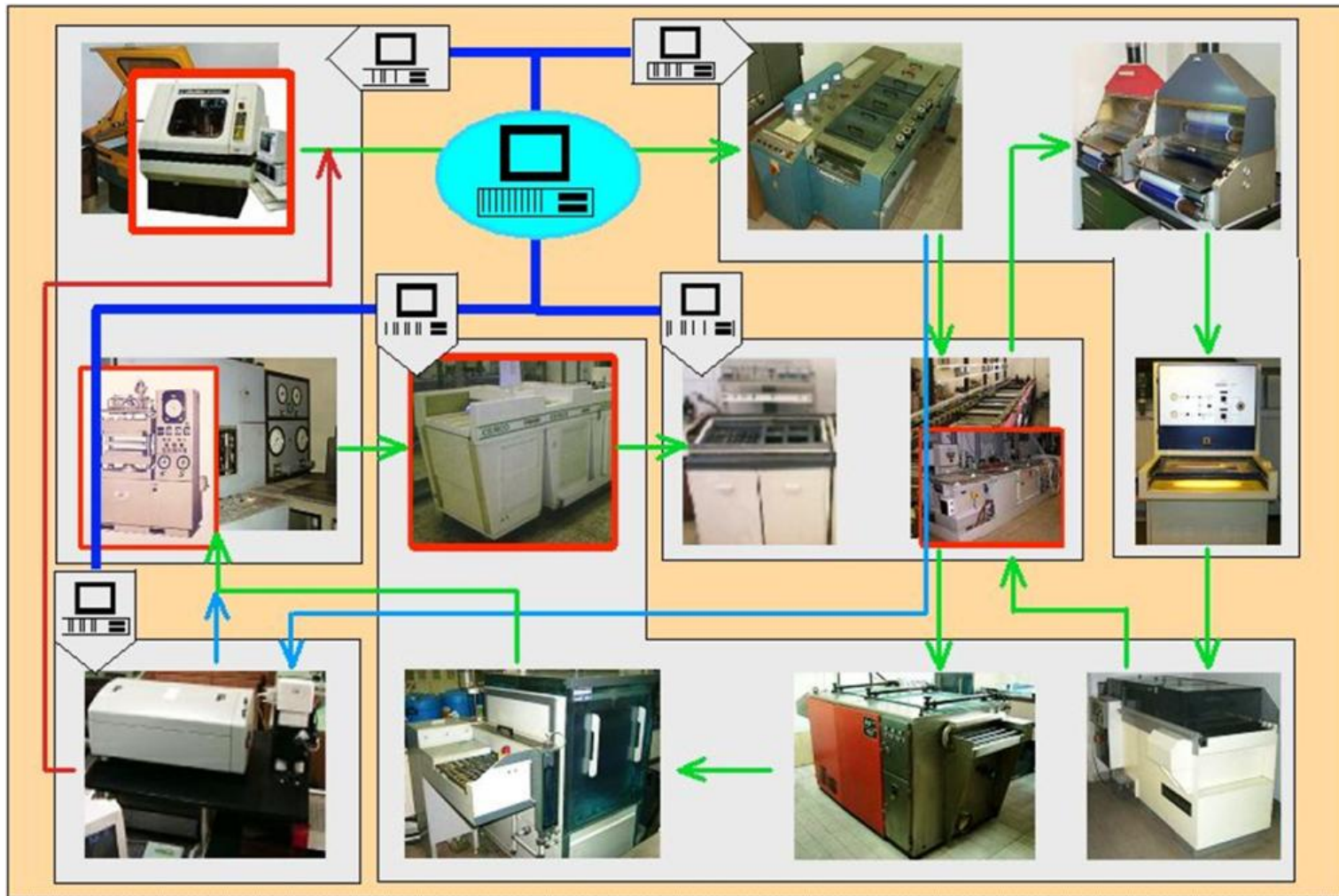
Learning Factories and Conferences



The Learning Factory “filling plant” at the Ruhr University Bochum.

There are annual conferences on Learning Factories.

Conclusion: the PCB Prototyping Line of BME-ETT is a Learning Factory



The process flow of the PCB Learning Factory at BME-ETT