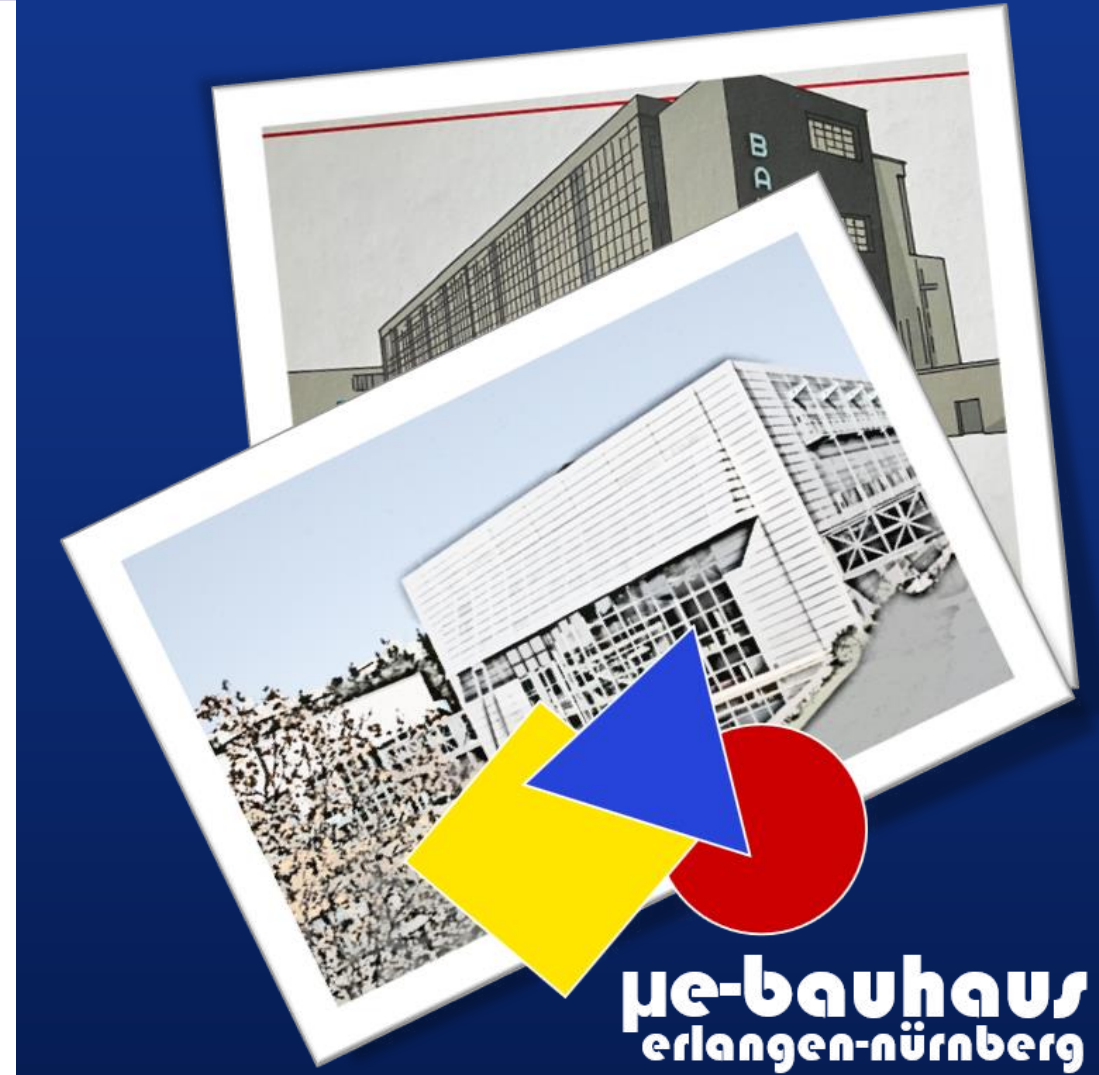


Challenges in Advanced Computing and Functionalities International Cooperation on Semiconductors

Rethinking Education and Training for nowadays semiconductor manufacturing by adapted Bauhaus Education Philosophy

Sabrina Anger, Markus Pfeffer, Katharina Gleich, Jan Frederik Dick, Jörg Schulze

- I. Motivation - Framework and consequences
- II. STEM* education – Status quo
* Science, Technology, Engineering, and Mathematics
- III. Bauhaus – a blueprint from history
- IV. μ e-Bauhaus teaching – building blocks and current implementation
- V. Outlook

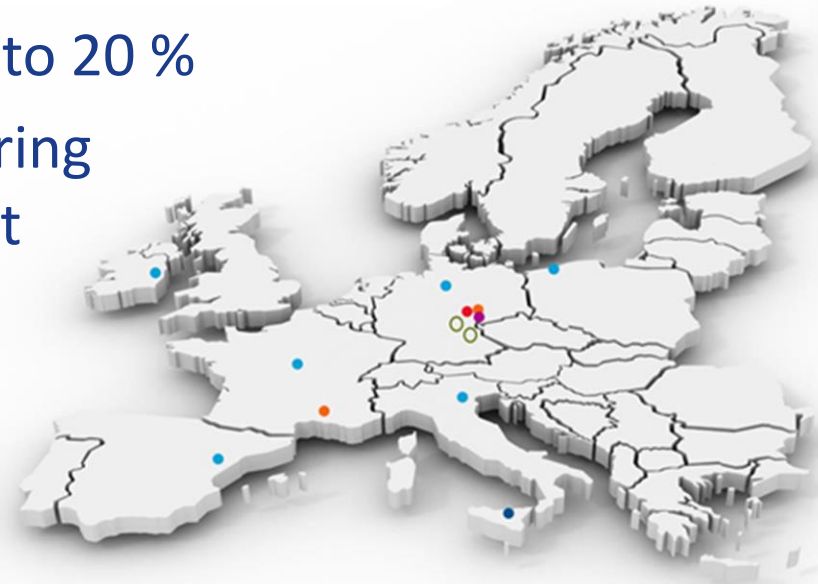


Motivation

I.

The EU-Chips act and its impact on the economic landscape in Europe, esp. semiconductor industry

- Investment of > 40 bn EUR in EU-chips to increase European market share in chip production to 20 %
- New manufacturing facilities are built



STMicroelectronics to build integrated Silicon Carbide substrate manufacturing facility in Italy

Oct 5, 2022 Geneva, Switzerland

After a record 2022 fiscal year, Infineon significantly increases its long-term financial targets, and is planning a major investment in a new factory in Dresden; positive outlook for 2023

Nov 14, 2022 | Quarterly Report

Technology
Wolfspeed plans multi-billion dollar chip factory in Germany, Handelsblatt reports
Reuters
January 21, 2023 1:38 PM GMT+1 · Updated in

GlobalFoundries announces mega investment for semiconductor production in Dresden

Germany, Intel sign deal for chip factory in Magdeburg
06/19/2023

TSMC Plans for First German Chip Fab With Cost Up to €10 Billion

- TSMC's board could make investment decision in August
- Project is seeking state funds to build TSMC's first EU plant

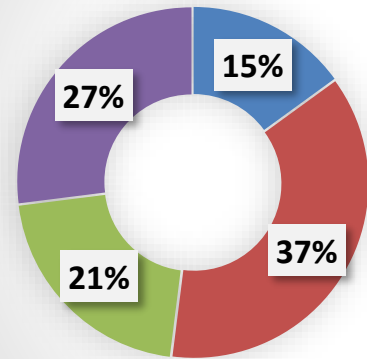
By Jillian Deutsch and Alberto Nardelli
3. Mai 2023 at 14:29 MESZ

Map of Announced-Planned Builds in Europe for 2023 – 2024. Source: FLMSolutions project tracker

<https://www.dpsgroupglobal.com/news-and-insight/european-chips-act-and-upcoming-eu-semiconductor-projects-for-2023-2024/>

- Increased amount of workforce in the relevant specialist areas (shop floor, maintenance, production planning and control)
- Lack of skilled labor
- Lack of training facilities
- Demand for short on-site training periods

Requirement level of the main occupational groups in the semiconductor industry



- Helpers w/o specific expertise
- Vocational trained specialists
- Specialists with further qualification (incl. B.Sc)
- Experts (M.Sc., Phd)

- according to IW specialist database, 2022



- Increased amount of workforce in the relevant specialist areas (shop floor, maintenance, production planning and control)
- Lack of skilled labor
- Lack of training facilities
- Demand for short on-site training periods

- Secure for the next generation of skilled workers
- Establish further education and training measures that are provided in German as well as in English language
- Create education contents and measures that are developed (and carried out) with close involvement of the local industry

- Statement of president of Bitcom e.V., 2023

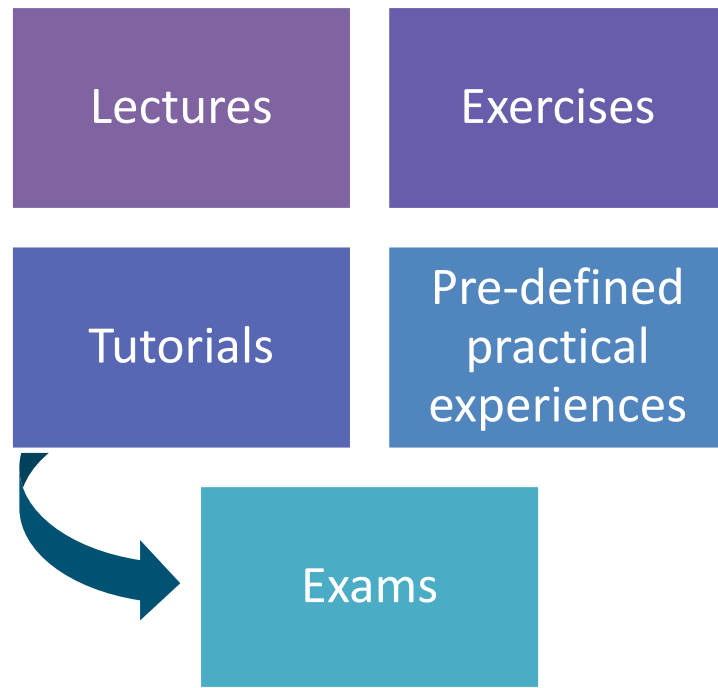
STEM education

II.

Common status quo in Germany for education in
**Science, Technology, Engineering, and
Mathematics**

Learning by repetition as basic principle

- Teaching aims at providing knowledge
- No freedom to create



Is this way of teaching sufficient and sustainable enough to overcome the challenges we face?

Unattractiveness of STEM subjects

Ability required to solve problems creatively

Complex tasks vs. fragmented study programs

Declining student numbers

Small amount of female students

Need to foster innovation



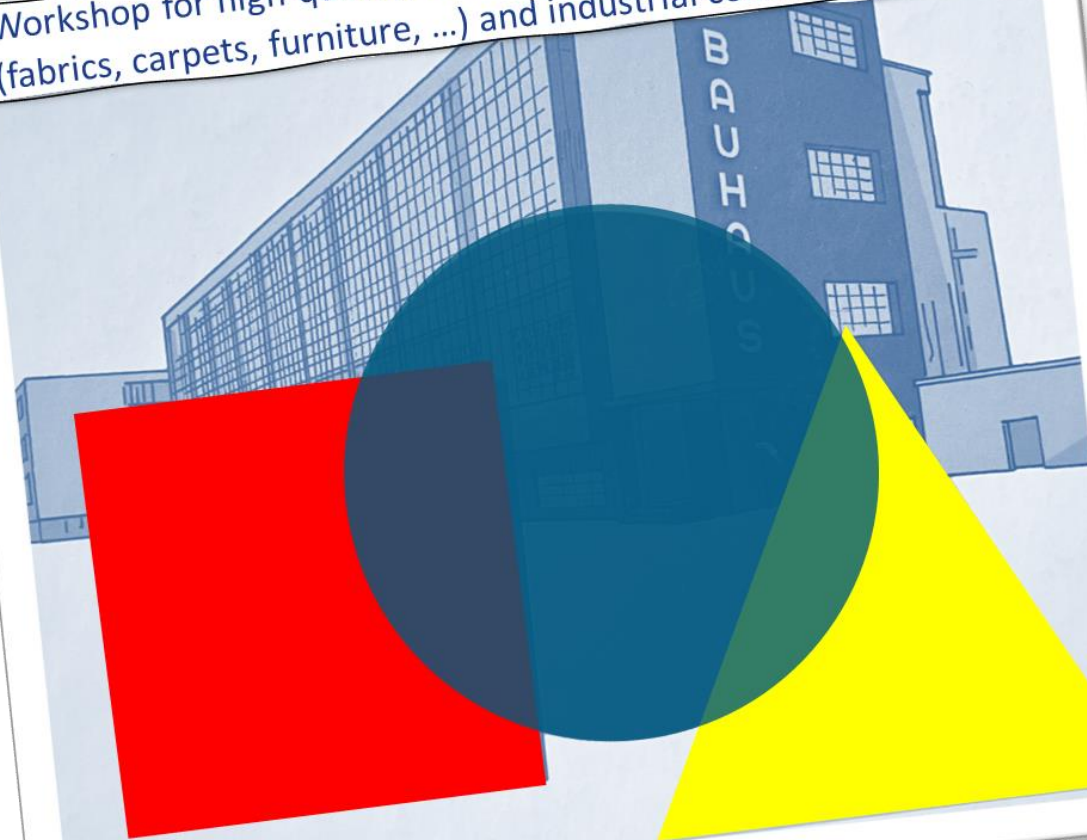
- How to overcome the challenges?
- How to increase attractiveness?
- How to excite and to enable engineering students to create innovative solutions?

Is there a blueprint in history?

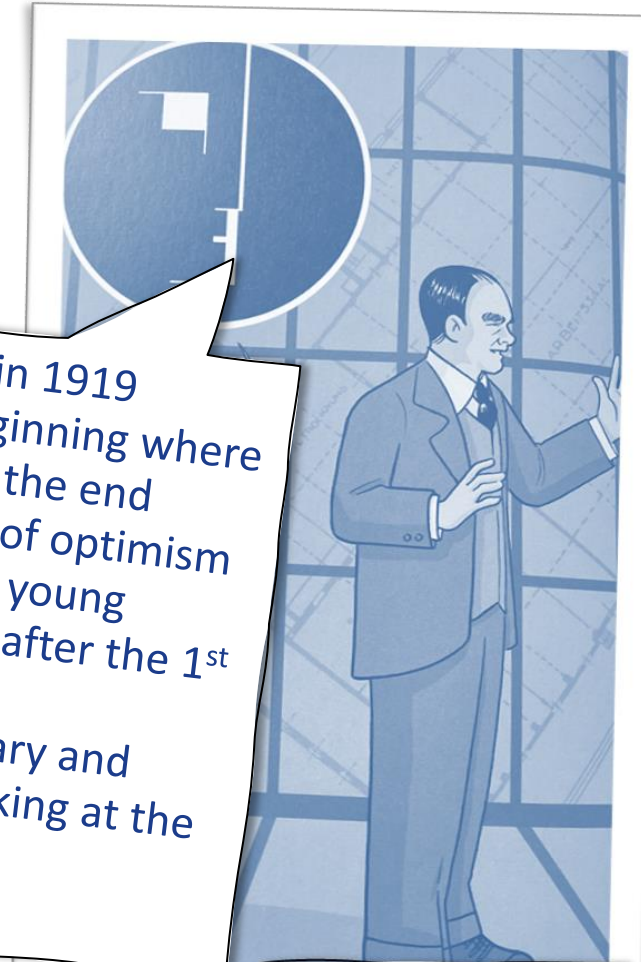


bauhaus – a look back into history

Workshop for high-quality, well-designed industrial goods (fabrics, carpets, furniture, ...) and industrial construction



- Founded in 1919
- A new beginning where many saw the end
- Reflection of optimism among the young generation after the 1st world war
- Contemporary and forward-looking at the same time



Walter Gropius

Graphics on this page:
Grande, V., Varbella, S. (2022). BAUHAUS – die illustrierte Geschichte (2. Ed.). Prestel.

The bauhaus manifesto

III.

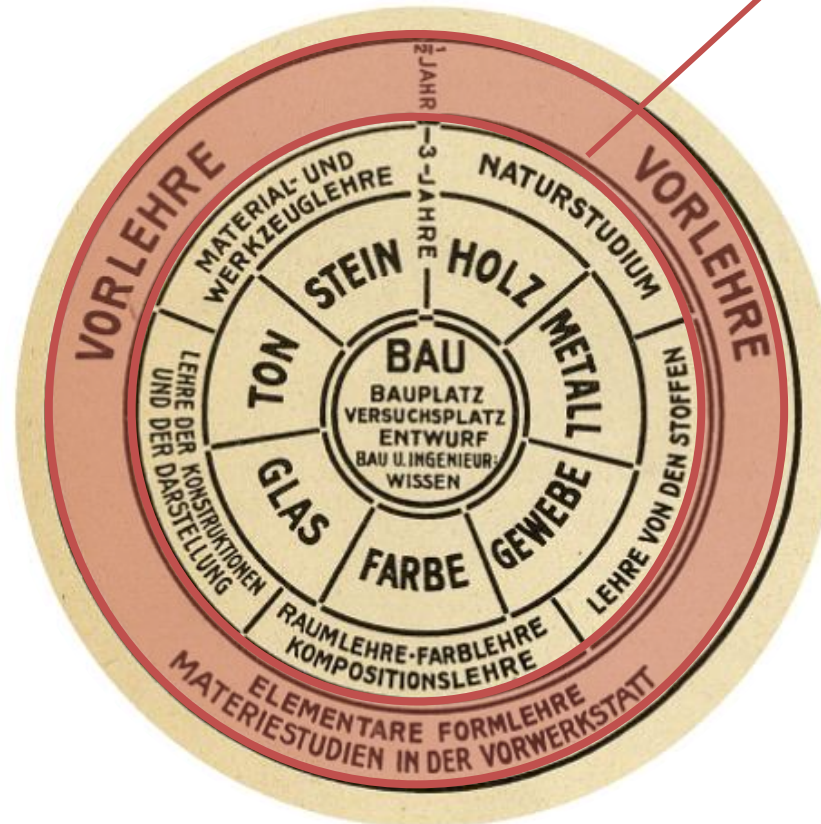
Unity of craft, technology, art, and industry –
a new form of teaching and practical training

Self-conception:

The ultimate goal of all artistic activity is construction.

Principles

- Art cannot be taught itself, but the craft behind it can be.
- Simultaneously develop the student's creative substance through encouragement on the one hand and their intellect through rigorous studies on the other.



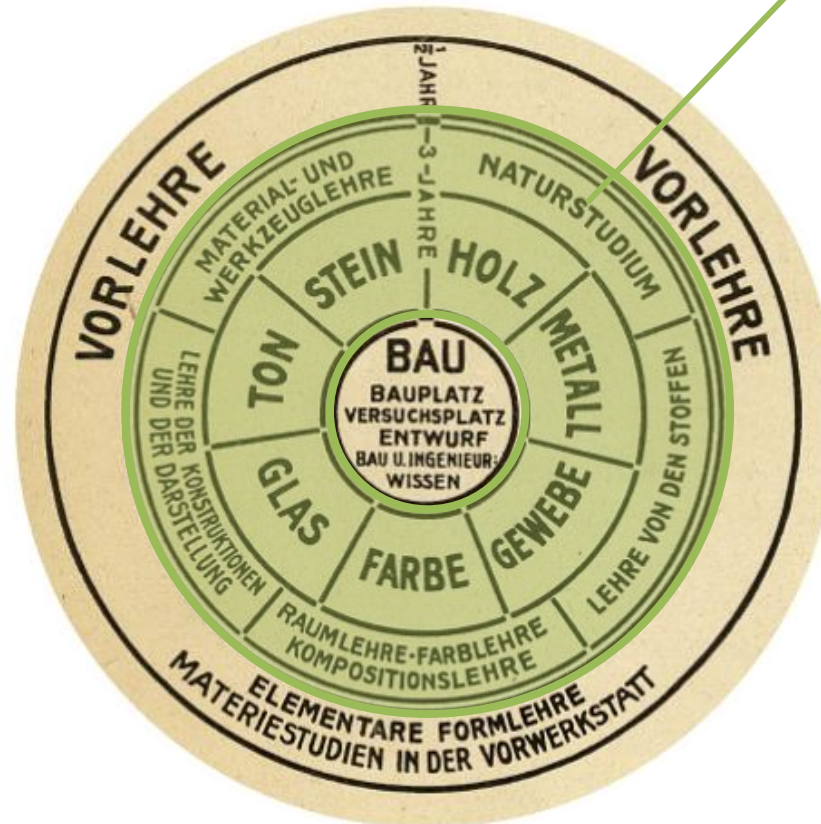
Preparatory course –

the prerequisites creator for further education

- Exploration of student personality and creativity
- Addressing the elementary aspects and requirements of creation without specific purpose:
 - Materials
 - Shaping and presentation options
 - Constructions and respective methods

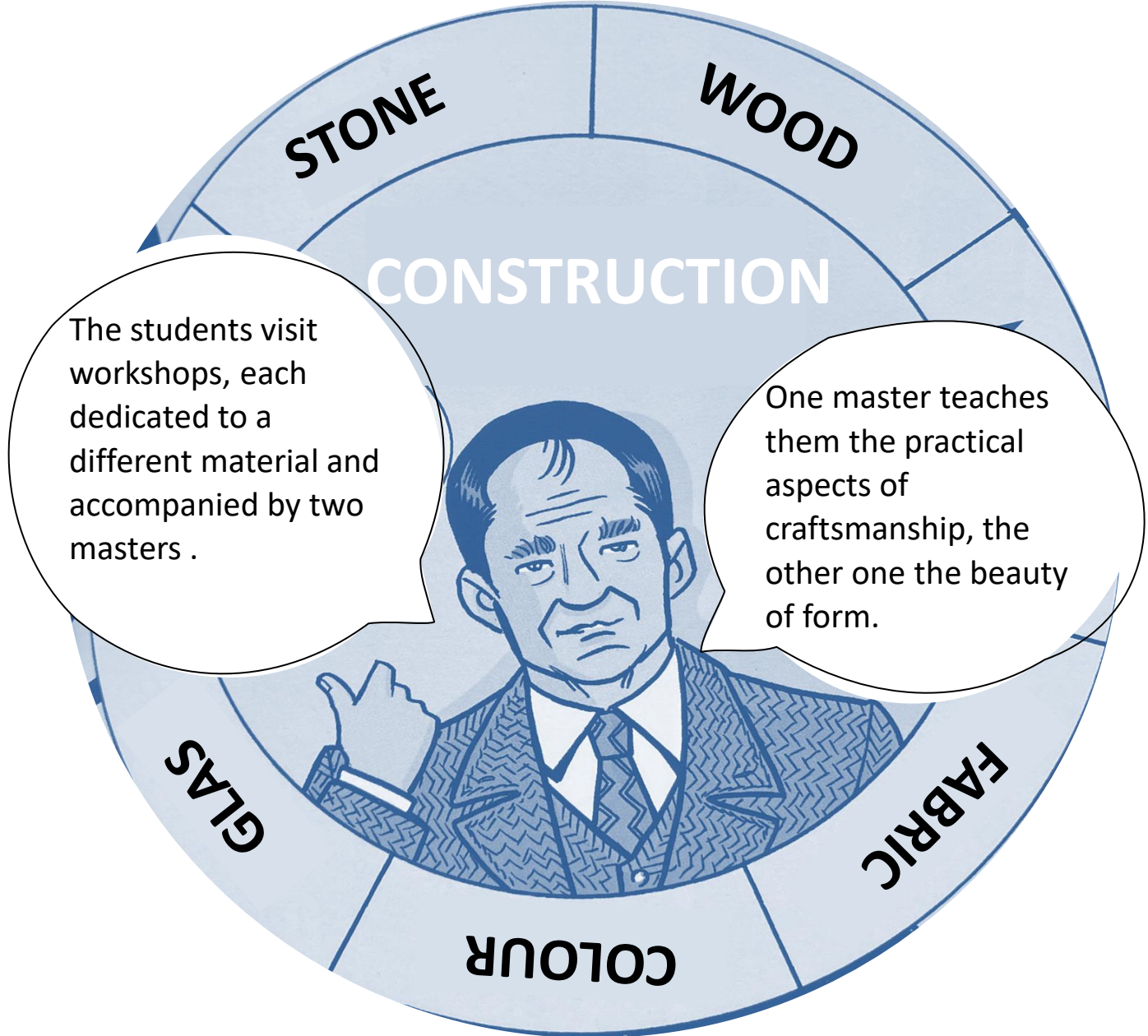
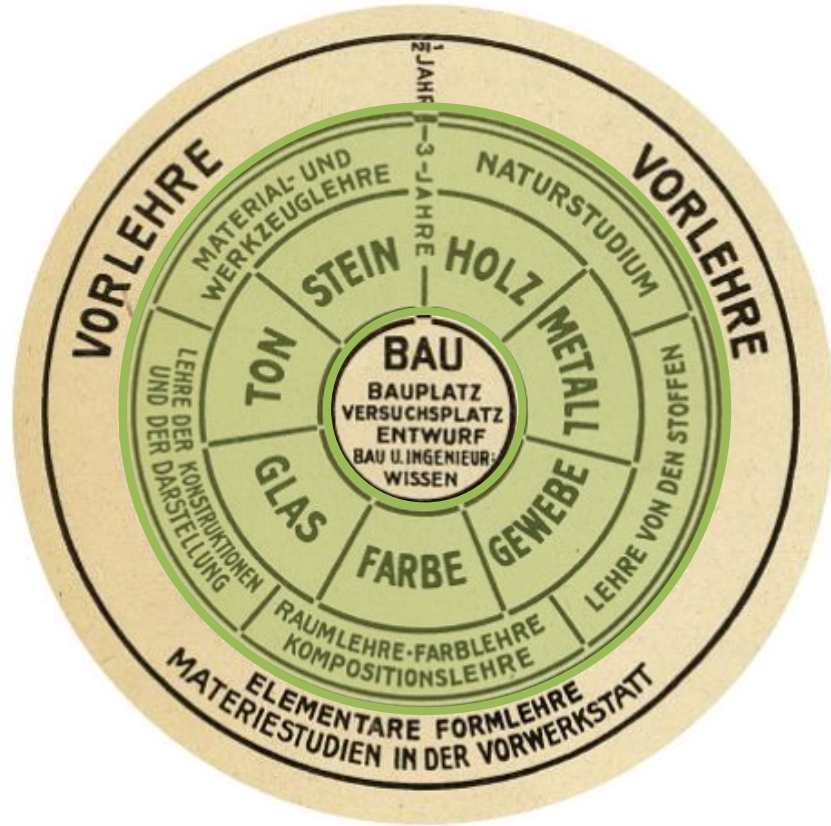
Principles

- Artists and craftsmen must work together to create new total artwork; both skills are required.
- Form follows function.
- Intelligently use resources.



Workshop training – practical work and training as apprentices and education in accompanying subjects

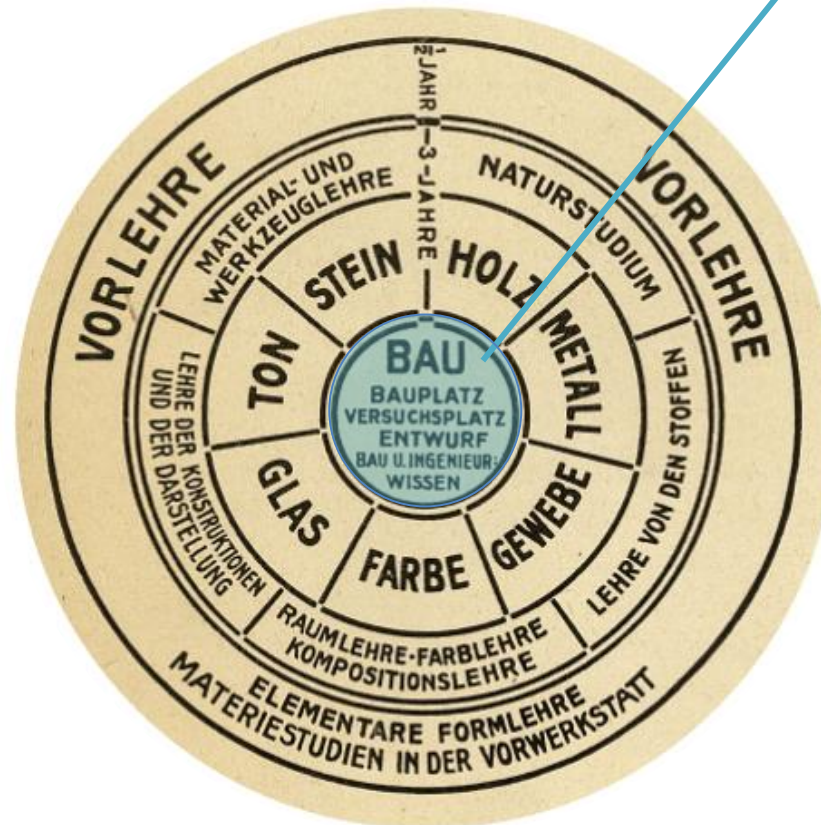
- Explorative work to gain precise knowledge of materials and work processes by trial and error
- Focus on different materials and tools and how to use them to create designs for standard items for everyday use
- Synthesis of all arts
- Joint planning and realization of projects by students and masters
- Use of recent and adequate technology



Graphics on this page:
Grande, V., Varbella, S. (2022). *BAUHAUS – die illustrierte Geschichte* (2. Ed.). Prestel.
Droste, M. (2019) // Bauhaus-Archiv: Bauhaus 1919-1933, Taschen

Principles

- Focus on simplicity and effectiveness.
- Stay on the pulse of society.
- Foster ongoing progress and development.



Examined and most talented students were admitted to apprenticeship in construction

Enabled to shape the future through education based on three pillars reflected in Bauhaus symbolism

- Static body at rest
 - Matter
 - Mind in motion
 - Creativity
 - Rational thinking and clear mind
 - Intellect
-

How to adapt to excite and to enable engineering students to create innovative solutions?

The μ -bauhaus teaching



The μ e-bauhaus manifesto

IV.

The building blocks:

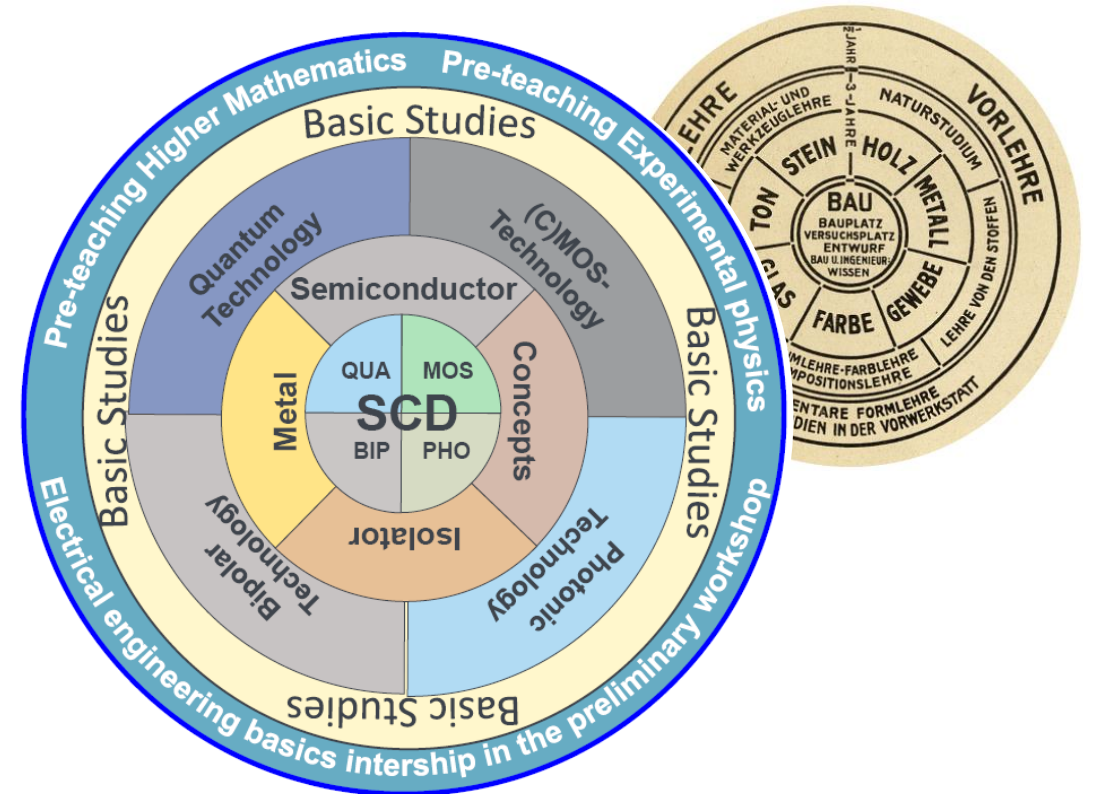
Unity of theoretical knowledge in material and technology and skills for semiconductor manufacturing

Self-conception:

The ultimate goal of semiconductor engineering and technology is the manufacturing of the semiconductor chip fulfilling the specified electronic functions and operations under the predetermined parameters.

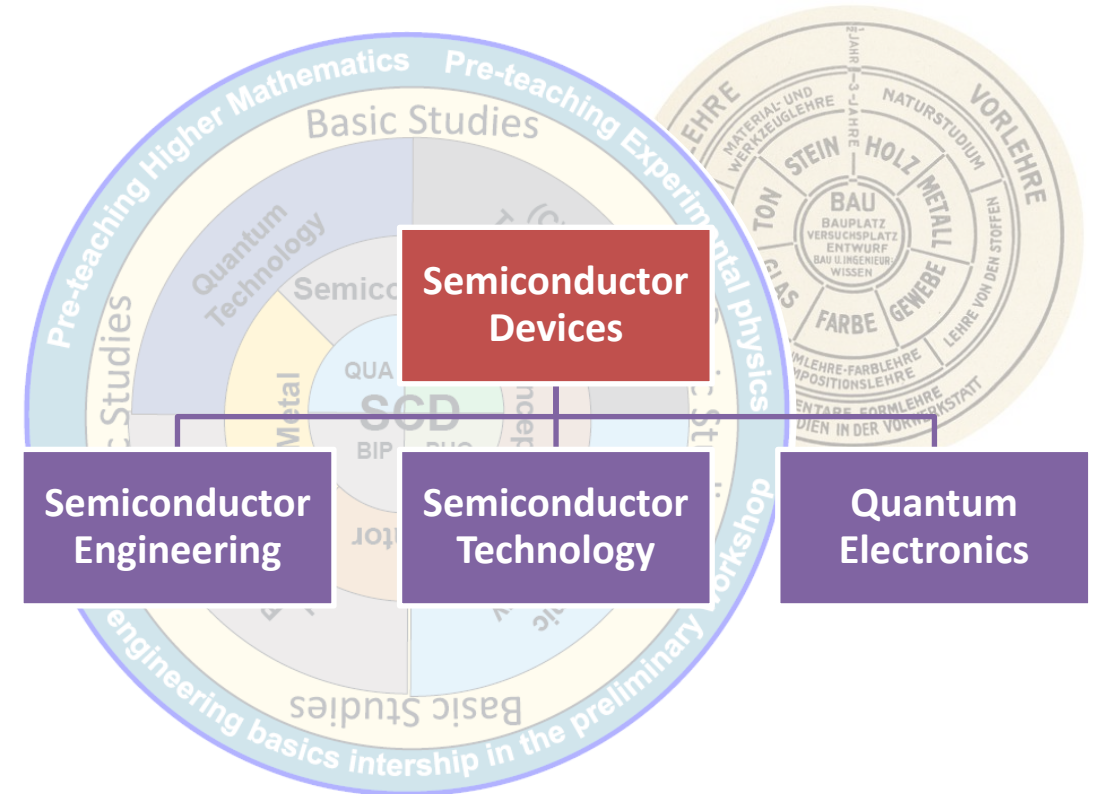
What needs to be understood – the academic teaching part

- Basic knowledge in STEM subjects and fundamental experimental methods
- In-depth study of current semiconductor technologies (bipolar, (C)MOS, photonic, quantum)
- Understanding of electronic, mechanical, thermal and chemical properties of relevant materials (semiconductors, metals, isolators)
- Conceptual knowledge regarding circuits and semiconductor devices.



The technical sound education

- Targeted final state: 4 different theoretical lecture series modules which build on each other, available for hybrid teaching, all in German and English language
- Structured, retraceable design and symbolism used
- Curriculum development, learning module design and creation is currently ongoing

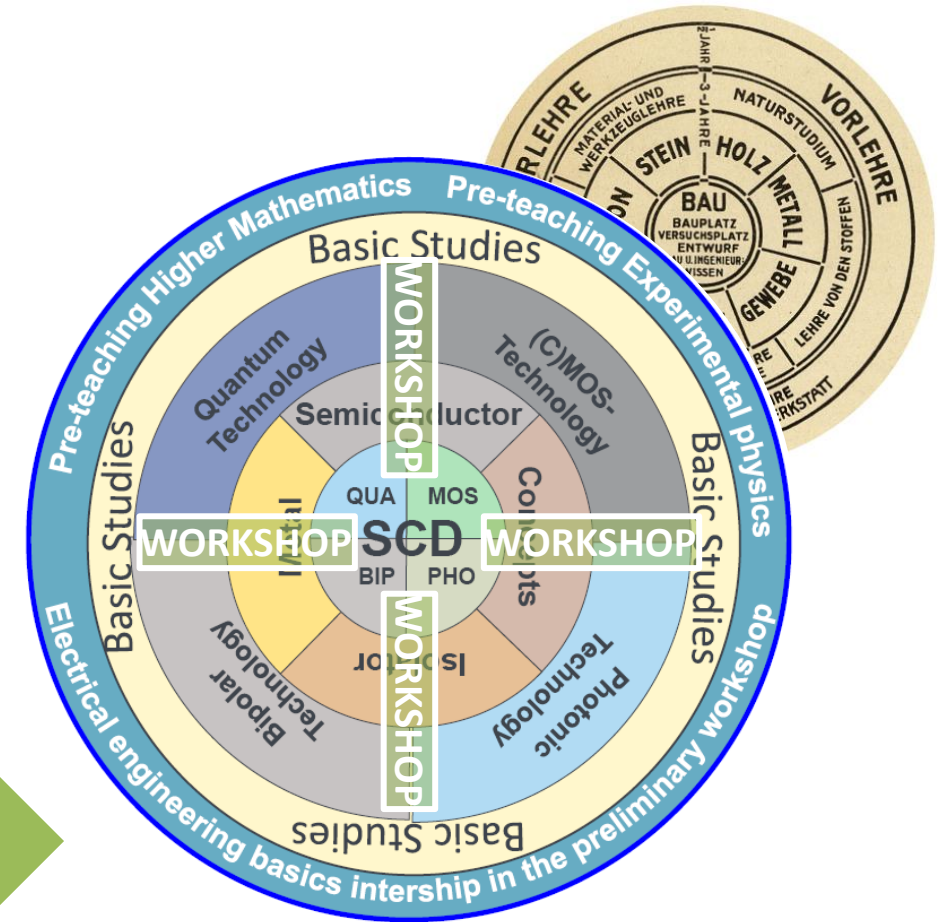


Partly developed within the FMD-QNC project, WP 11 on microelectronic academy

Complement theoretical education with “hands-on” training in workshops:

- concept development for innovative ideas
- out-of-the box thinking
- jointly finding solutions

From the first idea towards a prototype.





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The workshop – the cleanroom

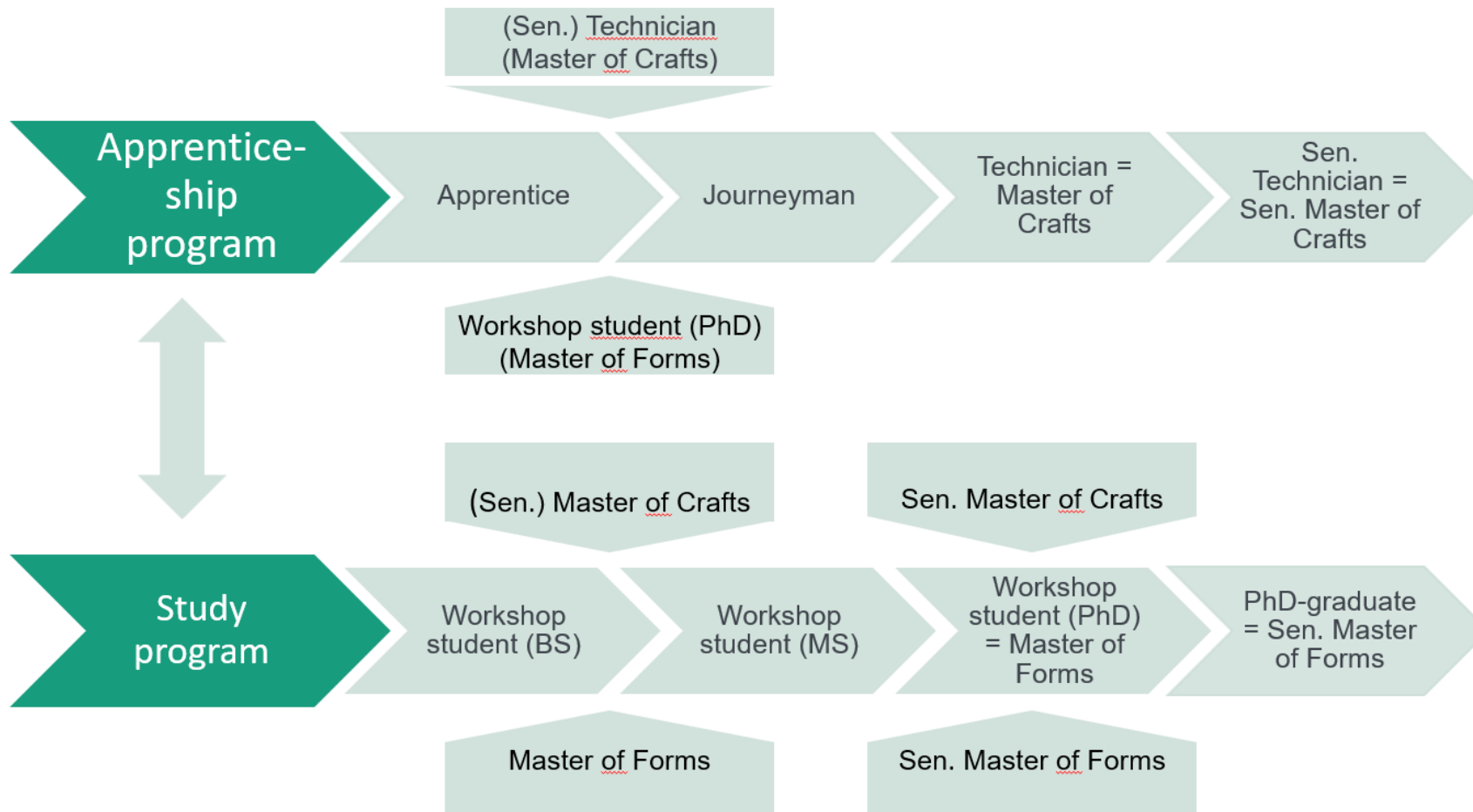
The practice-oriented part in everyday application



Integrate learners into everyday
R&D and prototype manufacturing

Pictures: © Fraunhofer IISB

Education & training concept of μ -Bauhaus Erlangen-Nuremberg

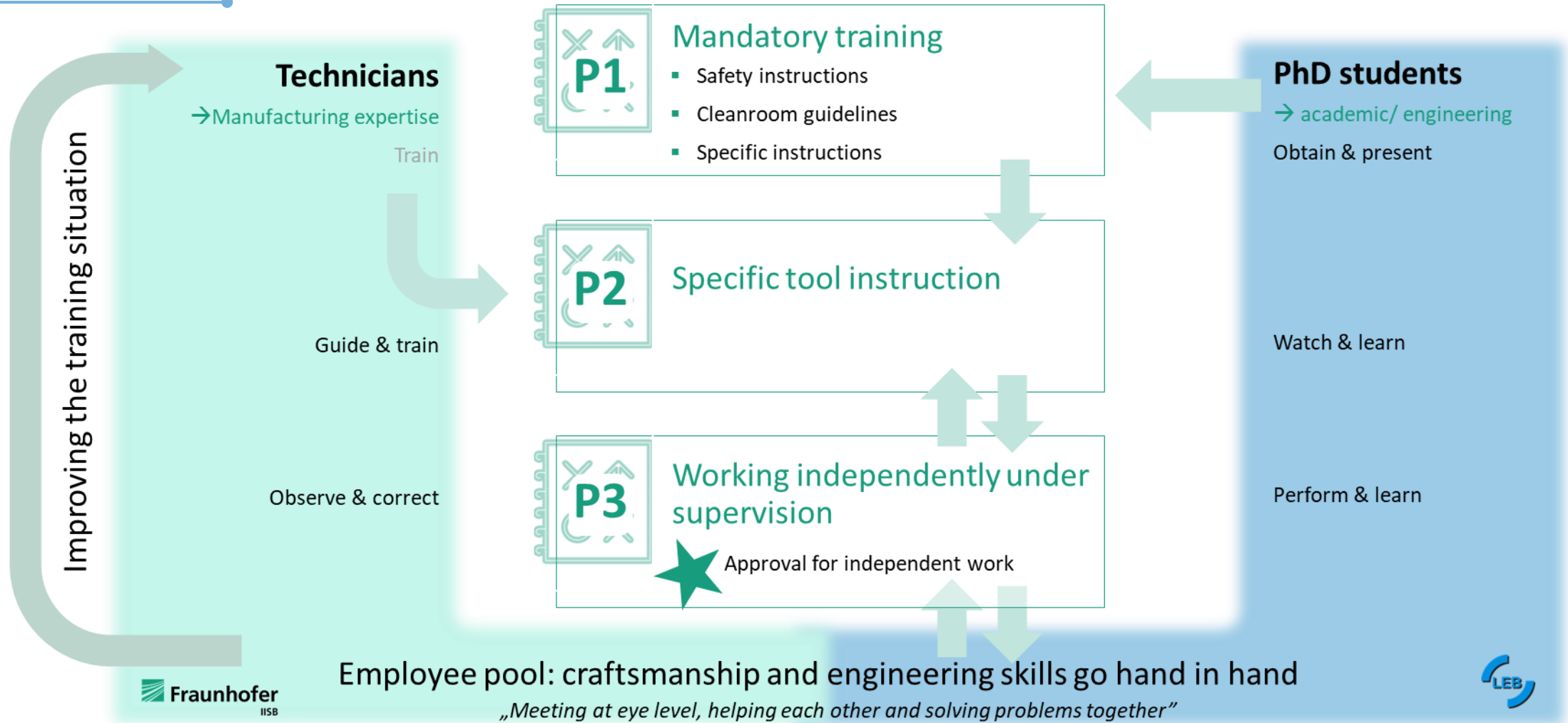


**μ -bauhaus
erlangen-nürnberg**

In-depth practical training ↔ Sound theoretical training

High perviousness of training paths in both directions

Implementation: The PhD candidate line at Fraunhofer IISB



V.

How to proceed to drive implementation forward?

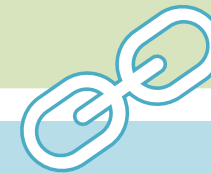
Needs-oriented increase of training capabilities

- Concept development for apprenticeship advancement in semiconductor technology
- Open vocational education towards the academic path
- Combined programs containing academic and vocational education
- Train the teachers
- Retraining programs for professionals

- Exchange and networking with other initiatives



- ✓ Blueprints
- ✓ Best-practice examples



What is needed to educate the shapers of the future?



THANK YOU!

 **Fraunhofer**
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Fraunhofer-Institut für integrierte
Systeme und Bauelemente-
technologie IISB

Dr. Sabrina Anger

Division Semiconductor Production Technology/Pi-Fab Management

Fraunhofer Institute for Integrated Systems
and Device Technology IISB
Schottkystraße 10, 91058 Erlangen, Germany
Phone +49 9131 761-317
sabrina.anger@iisb.fraunhofer.de



Federal Ministry
of Education
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This work is partly supported by the German project “Forschungsfabrik Mikroelektronik Deutschland - Modul Quanten- und neuromorphes Computing” (FMD-QNC). The project FMD QNC receives funding from the German Federal Ministry of Education and Research (BMBF) within the framework program “Mikroelektronik. Vertrauenswürdig und nachhaltig. Für Deutschland und Europa”. The information and results set out in this publication are those of the authors and do not necessarily reflect the opinion of the funding authority.

ICOS WORKSHOP – May 13-14th 2024, Athens



[icos-semiconductors.eu](https://www.icos-semiconductors.eu)

This project has received funding from the European Union’s Horizon Europe research and innovation programme under GA N° 101092562

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