60th ILMENAU SCIENTIFIC COLLOQUIUM

COMPETENCE ORIENTED STUDY IN ENGINEERING EDUCATION - EXAMPLES FROM THE PACTICING PROGRAMME

practicING by BASIC

Competence oriented study in engineering education – examples from practicING programme

practicING projects → experiences from students → evaluation, summary

Sabine Fincke | Thomas Röckl | Lukas Daubner

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practicING projects

MOTIVATION

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from perspective supervising teachers

as early as possible

- involving interested students in engineering and scientific work
- give experiences in application of theoretical knowledge, and complex projects, provide individual learning paths
- encourage to engage with the fundamental skills in depth
- support networking and formation learning groups
- work on projects together with student teams >> very helpful in the development of experimental set-ups for use in teaching

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practicING projects

CHARACTERISTICS AND METHODOLOGY

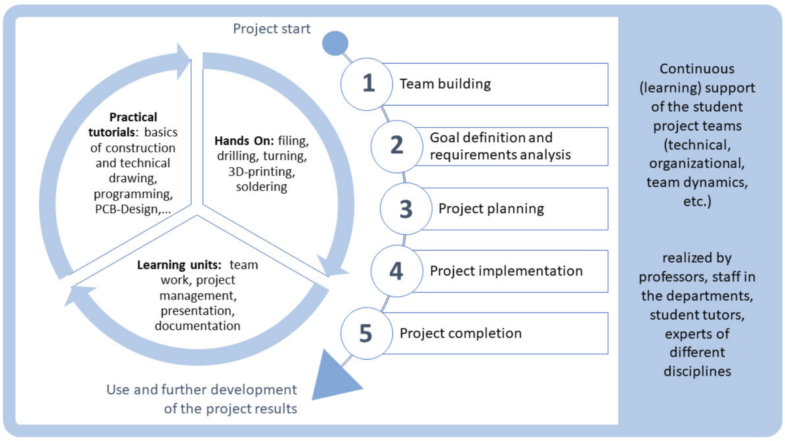

Figure 1: Implementation of a concrete practicING project from the project catalog

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experiences from students

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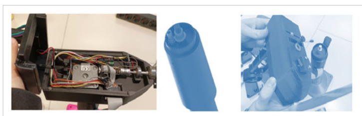
WIND TURBINE MODEL WITH DIGITAL TWIN

Thomas Röckl

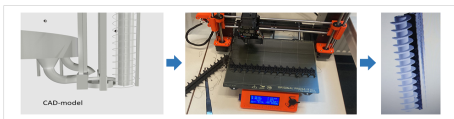


Department of Mechanical Engineering
„Product and System Development“

Univ.-Prof. Dr.-Ing. Stephan Husung

EXPERIMENTAL BALL DROP TEST ENVIRONMENT

Lukas Daubner



Department of Computer Science and Automation
„Systems and Software Engineering“

Dr.-Ing. Ralph Maschotta

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experiences from students

WIND TURBINE MODEL WITH DIGITAL TWIN

Objective of the project (11/22 – 04/23)

- Gathering additional efficiency information with sensors for *temperature, pressure, windspeed, heading, timestamp*
- Implementation of live-feed as digital twin
- Easy to disassemble/repair

Team: Yi Chun Hsu (MTR 4); Thomas Röckl (MTR 3); Clara Roßbach(MB 3);
Supervisor: Prof. Dr. Stephan Husung

Methodology in project processing

- Individual work packages
- Members could focus on strengths
- Meeting with supervisor every 2 weeks
  - Presentation of progress
  - Discussion of ideas & problems

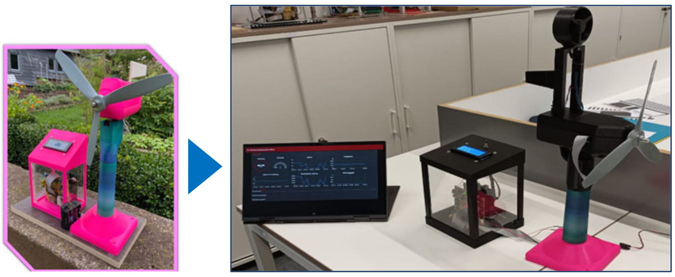


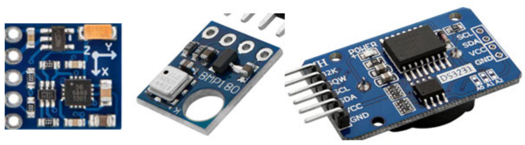
Figure 2: Wind Turbine model before and after our project

experiences from students

WIND TURBINE MODEL WITH DIGITAL TWIN

Implemented Solutions: Sensors

- Sensors in many parts "off the shelf" products
- Windspeed-sensor built from existing anemometer



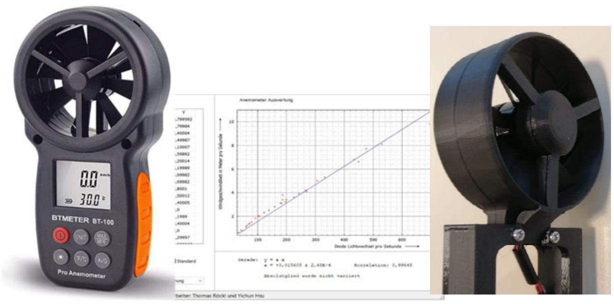


Figure 3: Windspeed-sensor build from existing anemometer

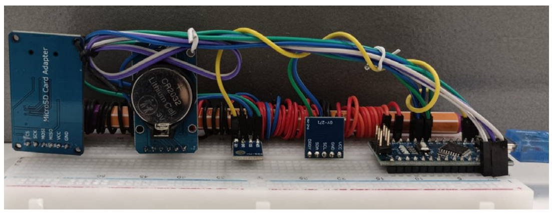


Figure 4: Test environment with sensors

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experiences from students

WIND TURBINE MODEL WITH DIGITAL TWIN

Implemented Solutions: Mechanics

- Overhaul of electronic boards enclosure
- New motorization by stepper motor and gear system
- Redesign engine pod

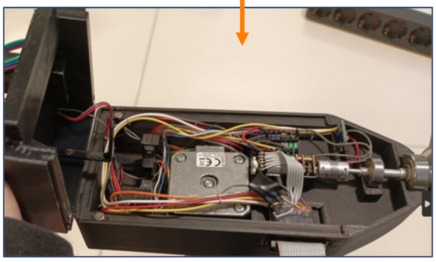

Figure 5: New engine pod

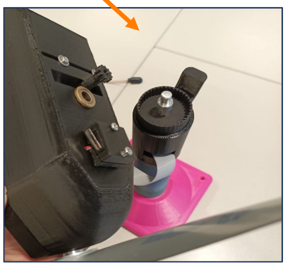

Figure 6: Motor and gear system

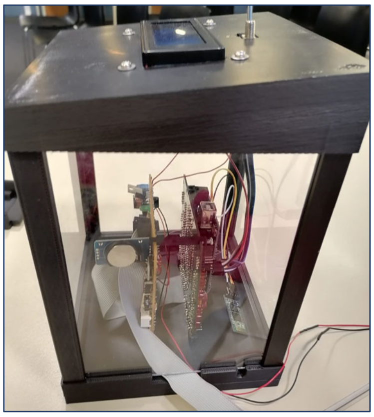

Figure 7: Electronic boards

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experiences from students

WIND TURBINE MODEL WITH DIGITAL TWIN

Implemented Solutions: Digital Twin

- Data collection on micro-SD-card
- Data transfer via Bluetooth connection
- Visualization in “node-red”

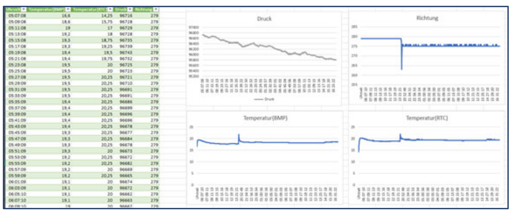

Figure 8: Data collection

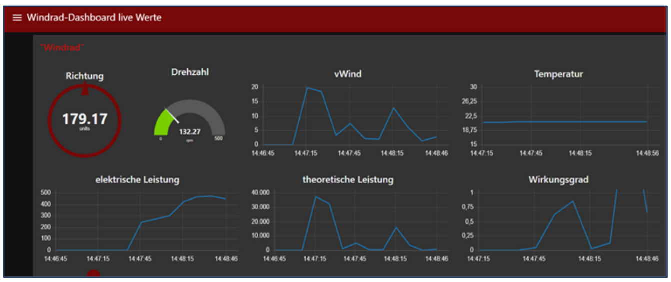

Figure 9: Data visualization in “node-red”

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experiences from students

WIND TURBINE MODEL WITH DIGITAL TWIN

Summary

➢ **Achievements**
- Optimized data gathering and visualization
- Better accessibility
- Optimized construction

➢ **Individual learnings**
- Practical experience in 3D printing, programming...
- Working in a team with
  - Defining work packages
  - Individual responsibility
  - Regular exchange of ideas

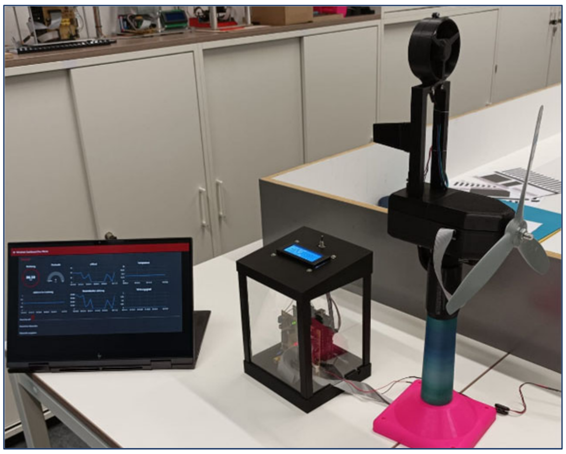

Figure 10: Final wind turbine model with digital twin

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experiences from students

EXPERIMENTAL BALL DROP TEST

Objective of the project

- Build new experiment setup
- Allow easier modification

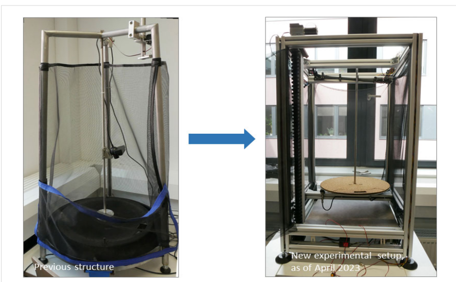

Figure 11: Experiment setup "Ball drop test environment"

Aims of the project

- The following major and critical components were identified:
  - Base structure and framework,
  - Construction of the turntable and drive thereof,
  - The ball transports,
  - The catching mechanism for the balls,
  - The electrical system,
  - The release mechanism and the ball drop mechanism,
  - Separation of the balls after release,
  - The modularization of the overall setup.

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experiences from students

EXPERIMENTAL BALL DROP TEST

Methodology in project processing

- Five students from courses in computer engineering and mechanical engineering
- Estimated two years until use in teaching
- Processed only first subproject within practicING

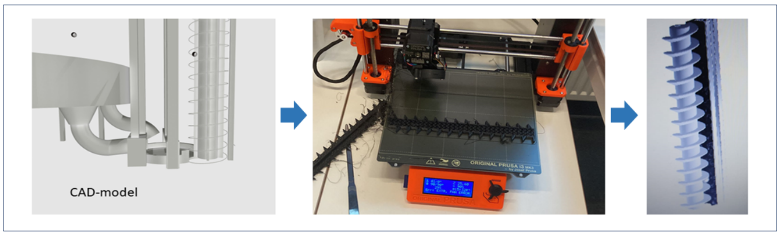

Figure 12: Creation of prototypes for the vertical transport of the balls

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EXPERIMENTAL BALL DROP TEST

Ball movement solutions

- Archimedian screw
- Horizontal movement
- Magnetic realease mechanism

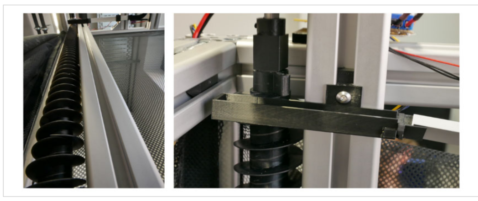

Figure 13: Archimedian screw

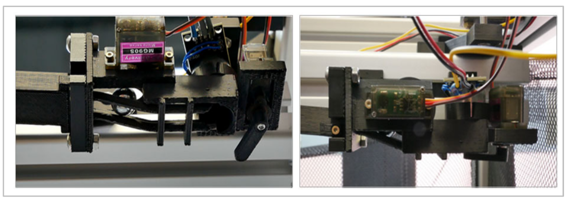

Figure 14: Magnetic release mechanism

Figure 15: Horizontal movement

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experiences from students

EXPERIMENTAL BALL DROP TEST

- “Off the shelf” electronics components with few own developments
- Cork for sound dampening
- Two sensors for position and speed observation

Figure 16: Electrical components (left) and top and bottom of the rotary disc (middle and right)

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experiences from students

EXPERIMENTAL BALL DROP TEST

Summary

- **Experiment setup**
  - More reliable setup
  - Less audible distraction for neighbouring rooms
- **Personal benefits**
  - Gained skills in presentation
  - Improved working in bigger groups
  - Learned using CAD and circuit design

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MOTIVATION FOR PARTICIPATING

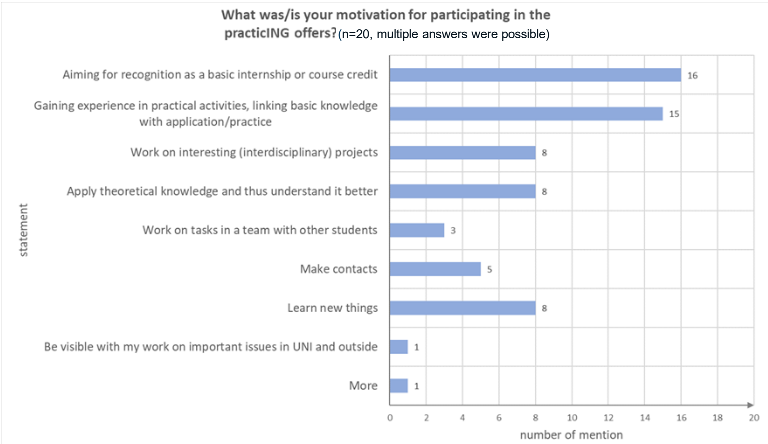

Figure 17: Motivation for participation in the practicING offers

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evaluation

PARTICULARY EXCITING

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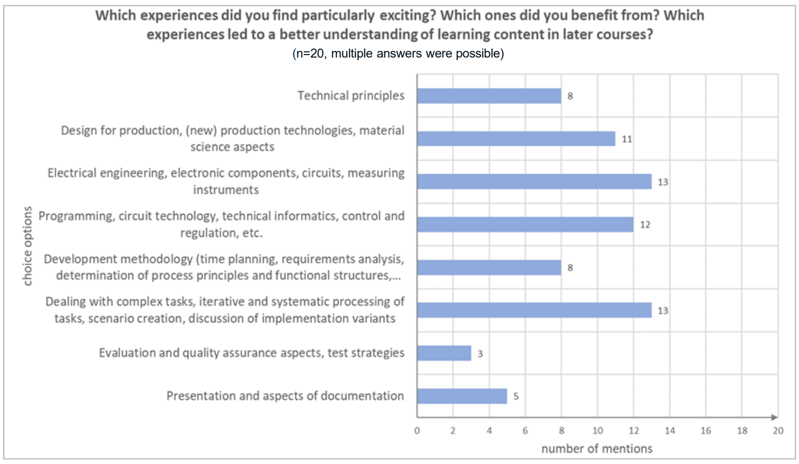

Figure 18: Responses regarding particularly useful experiences

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evaluation

WHAT WAS THE BEST THING?

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- Insight into different areas (programming, coordination of people, electrical engineering, interaction of components, 3D printing, work in the specialized areas, professional writing....),
- I really liked the practical work or the practical reference | The workshops and additional offers were particularly successful| Essential skills for engineers are tackled right at the beginning: CAD, manual work (soldering, turning, milling, filing, drilling, etc.), programming (microcontroller),
- Getting a good feeling for what it means to be an engineer and what requirements you should be able to handle,

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evaluation

WHAT WAS THE BEST THING?

practicING by BASIC

- Receiving constructive criticism from people with special expertise (e.g. in the creation of operating instructions),
- The opportunity to go into workshops and manufacture the components yourself, gaining experience around 3D printing,
- Good practical supplement to theoretical basics from the early semesters,
- Start right away with your own design work as part of the practical project: Learning by doing,
- Direct close cooperation also with professors

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summary

EXPERIENCES SO FAR

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- The students can use the practicING offers to develop specific engineering competencies. Individual learning paths are supported.

- Important conditions for success are:
  - available time slots for common project work and supplementary learning opportunities
  - individually oriented supervision of students and project teams by staff and supportive student tutors

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„Have the courage to do things differently.“ (R. Messner)

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