DIGITIZING PRODUCTS: CREATING DEMONSTRATORS FOR FUTURE EDUCATION

Demonstrators' Peer-Review Analysis

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Project consortium

Dissemination level

Code	Access granted to
PU	Public

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About the DigiDemo project

Environmental challenges and digital transformation are two of the main drivers changing the world and the way business will be done in the future. Therefore, it is essential to enable future employees to address these drivers. The skills and competencies needed to develop digitalized products and awareness of the environmental challenges are therefore crucial for the European workforce and industry to continue being competitive in a future green economy and to maintain jobs across Europe.

The DigiDemo project addresses these challenges by developing demonstrators especially for higher education allowing to improve mainly mechanical engineering studies by integrating skills and competencies allowing them to understand, develop and commercialize connected products. The results will be publicly available and can be used by every institution interested in integrating this type of training in their cursus.

Content

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Abbreviations

ESTA	ESTA Belfort (France)
FHV	Fachhochschule Vorarlberg (Austria)
FIV	Fagskolen I Viken (Norway)
UCN	University College Nordjylland (Denmark)
UBB	Babes-Bolyai University (Romania)

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1 Introduction

The evaluation process of the demonstrators takes place on two distinguished levels: one provided by the students as a result of the use of demonstrators and a peer review through the project team, consisting of members from the different project partners. This document describes the results of the peer review of the demonstrators.

The peer review of the demonstrators is done based on a questionnaire developed as a part of the evaluation framework. It helps to identify the main characteristics of the demonstrators, as defined:

(1) potential to improve teaching,

(2) potential to improve sustainability awareness,

(3) potential to improve interdisciplinary skills,

(4) replicability, and

(5) meeting the requirements of the industry.

Mix teams of members from different partners analyze with the teams that planned and implemented the different demonstrators, rating the above-indicated criteria between very likely/excellent (1) and very unlikely/unacceptable (5).

2 Questionnaire & results overview

2.1 Questionnaire

The evaluation team scored the performances of the demonstrators following the path given through the five guiding questions and the associated score (1 - very likely; 5 – very unlikely):

1. Does the demonstrator have the **potential to improve teaching**?
   Response options: 1 to 5
2. Does the demonstrator have the **potential to improve sustainability awareness**?
   Response options: 1 to 5
3. Can the demonstrator **be replicated** (based on the provided documentation)?
   Response options: 1 to 5
4. Does the demonstrator **follow industry needs**?
   Response options: 1 = with industrial partner, 2 = without industrial partner
5. Does the demonstrator have the **potential to improve interdisciplinary** skills?
   Response options: 1 to 5

2.2 Overview

The ratings of the analyzed demonstrators were done during two transnational project meetings: in Norway for the first and second demonstrators, synthesized in Table 1, and in Romania, for the third and fourth demonstrators, synthesized in Table 2.

In the following, the evaluation results of the first and second demonstrators and, afterward, the third and fourth demonstrators are analyzed separately. The results across the two sets of demonstrators (1 and 2, and 3 and 4) are compared and briefly discussed as part of the analysis of the third and fourth demonstrators.

2.2.1 The results of the peer-review process of the first and second demonstrators

Below, in Table 1, is an overview of all the results for the first set of demonstrators (1 and 2) across all the partners.

Table 1: Overview of the peer-review process of the first and second demonstrators

Institutions	UBB		ESTA		UCN		FHV		FIV	
Demonstrator	CNC	Damage detection in beam	Connected Thermostatic Valve	Data transfer system	Chair telemetry transporder	Indoor air quality	Focus project	Elevator	Vessel Monitoring	Snow Depth Sensor
Questions										
Does the demonstrator have the **potential to improve teaching**?	2	2	2	1	1,5	1	1	1	1,5	2,5
Does the demonstrator have the **potential to improve sustainability awareness**?	3,5	3	2	3	4	2	3,5	3	1,5	1,5
Can the demonstrator be replicated (based on the provided documentation)?	3	2	3	2	1	2	4	3	1	1
Does the demonstrator **follow industry need**? (1 = with industrial partner, 2 = without industrial partner)	2	2	2	2	2	2	2	2	1	1
Does the demonstrator have the **potential to improve interdisciplinary skills**?	2	2	2	3,5	3,5	2	1	3	2,5	3,5
(1 - very likely; 5 - very unlikely)										

The potential for improving the teaching activity was rated 1 for 50% of the demonstrators, which is considered excellent (see Table 1). The other half was situated between 1 and 2,

considered very good (see Table 1). These results were expected as all the project members in the DigiDemo project are experienced lecturers, hence, have years of experience planning and developing educational material.

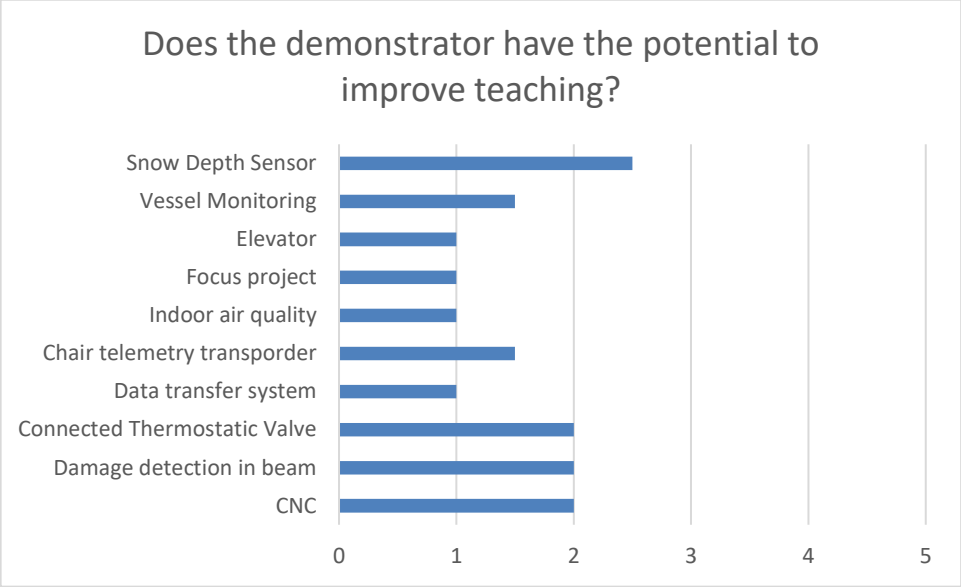

Figure 1: Overview of improving the teaching activity (first and second demonstrators)

One of the main goals of professional training for future engineers is to improve sustainability awareness. This characteristic was rated between 1,5 and 2 for 40% of the demonstrators, which is considered very good (See Table 1). However, the remaining demonstrators were rated at the lower end, between 3 and 4, which is considered not good (See Table 1). These results could partly be explained by the project members' lack of insights into sustainability. However, as improved awareness of sustainability was one of the main drivers behind the project, it was decided to strengthen this part of the project. This was done by; (1) adding a paragraph to the framework for developing the demonstrators, explicitly addressing the sustainability aspect of the demonstrators, (2) making online lectures - Knowledge Bricks ('TechTalks' in the application) - focussing on sustainability (to inspire project members and people outside the project team), and (3) having inspirational talks targeting sustainability at two of the transnational meetings.

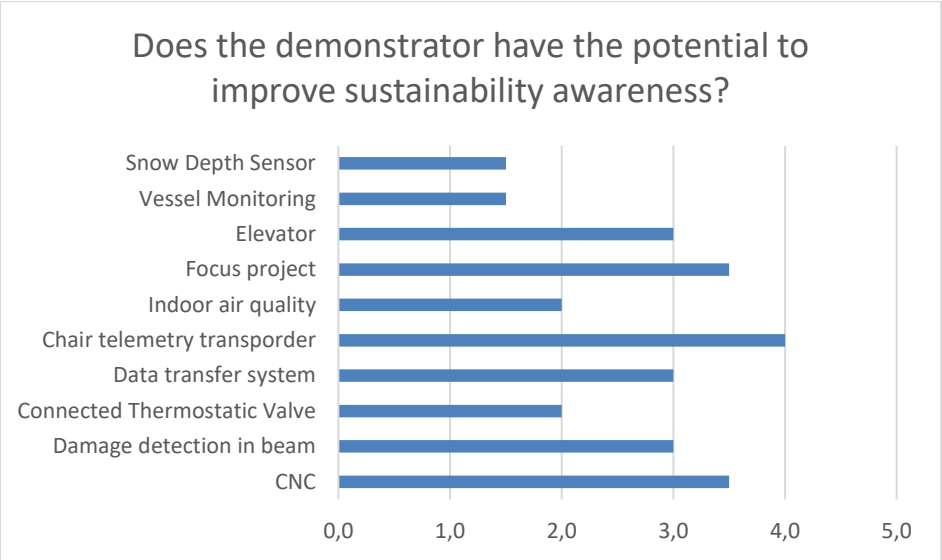

Figure 2: Overview of improving sustainability awareness (first and second demonstrators)

The replicability of the demonstrators, relative to several elements, e.g., costs and complexity, was rated between 1 and 2 for half of the demonstrators, which is considered very good (See Table 1). However, the other half of the demonstrators got a lower rating, between 3 and 4, which is not considered very good (See Table 1). However, there seems to be a built-in paradox between making highly valuable demonstrators targeting specific learning goals/situations at the individual partners while at the same time ensuring a high degree of replicability.

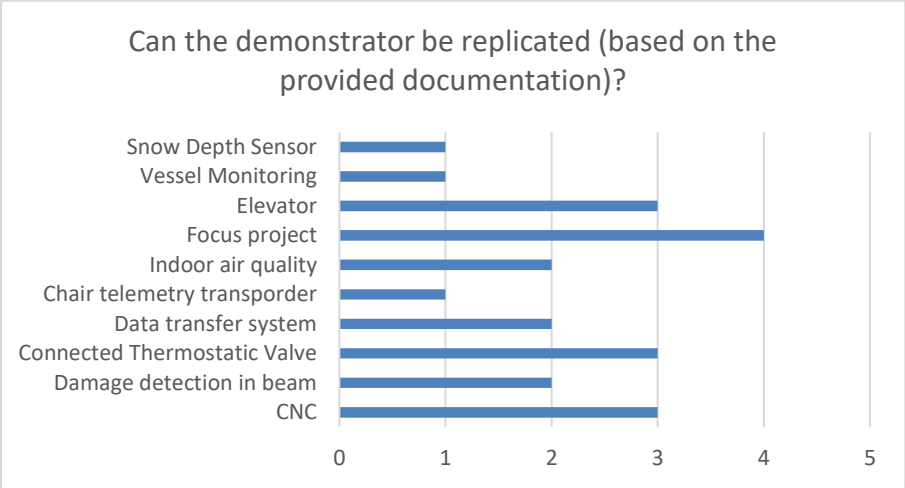

Figure 3: Overview of replicability (1st and 2nd demonstrator)

The link to the industry was rated between 1 and 2, which is regarded as excellent (See Table 1). Although most demonstrators were not implemented with a local industry partner, the demonstrators still contained a strong link and relevance to the industry. This can be explained by the many years of work experience in the industry among many project members. Hence, they have a deep insight into the industry context, including industry needs. Moreover, all the partner institutions collaborate closely with the local industry as part of the educational activities (one of the selection criteria in the project).

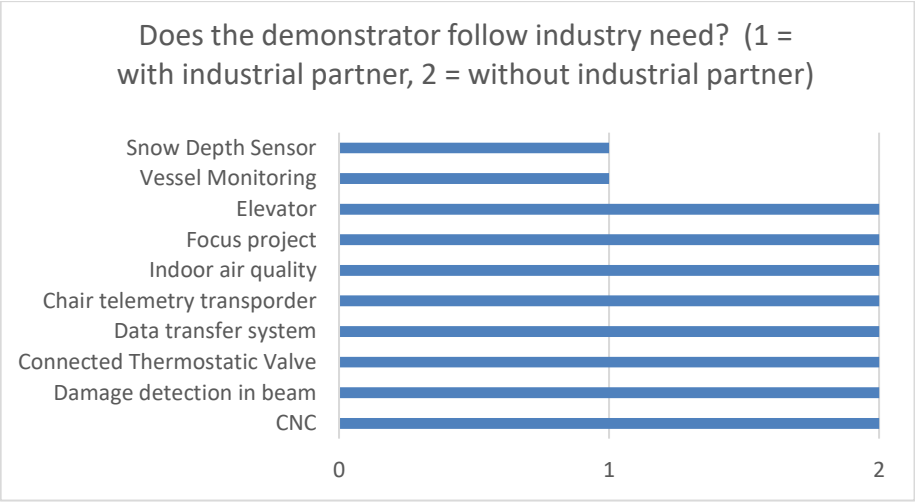

Figure 4: Overview of the implementation in partnership with industrial partners (first and second demonstrators)

The interdisciplinary skills were rated between 1 for 50% of the demonstrators and 2 for the other half. These results are regarded as excellent (See Table 1). The results were expected as all the project members in the DigiDemo project are experienced lecturers, hence, have years of experience planning and developing educational material. Moreover, one of the main purposes of the project was to strengthen the interdisciplinary aspects, hence a focal point in the project and the work done.

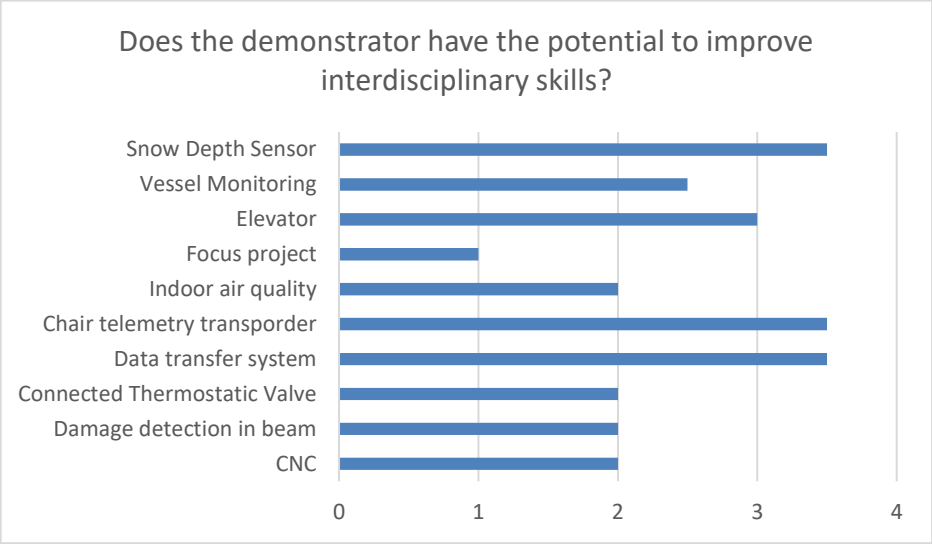

Figure 5: Overview of improving interdisciplinary skills (first and second demonstrators)

2.2.2 The results of the peer-review process of the third and fourth demonstrators

Below, in Table 2, is an overview of all the results for the second set of demonstrators (3 and 4) across all the partners.

Table 2: Overview of the peer-review process of the third and fourth demonstrators

Institutions	UBB		ESTA		UCN		FHV		FIV	
Demonstrator	Robotic	Solar tracker	Drilling machine	Smart lightning system	Mobile Platform	Pipe temperature sensor	Conveyor Belt	Liquid-Monitoring	PLC system	Accelero-meter
Questions										
Does the demonstrator have the **potential to improve teaching**?	2	1	2	2,5	1	1	1	2	1	1
Does the demonstrator have the **potential to improve sustainability awareness**?	3	1	4	2	3,5	1	3	1	3,5	3,5
Can the demonstrator be replicated (based on the provided documentation)?	4	2	1,5	2	4	1,5	2	1	1,5	1
Does the demonstrator **follow industry need**? (1 = with industrial partner, 2 = without industrial partner)	2	2	2	2	2	2	2	2	1	1
Does the demonstrator have the **potential to improve interdisciplinary skills**?	1	1	1	2	2	1	2,5	2	2,5	2,5
(1 - very likely; 5 - very unlikely)										

The potential for improving the teaching activity was again rated 1 for 60% of the demonstrators, which is considered excellent (see Table 2). The rest was situated between 1 and 2, considered very good (see Table 2). Hence, the high level of the first set of demonstrators was improved.

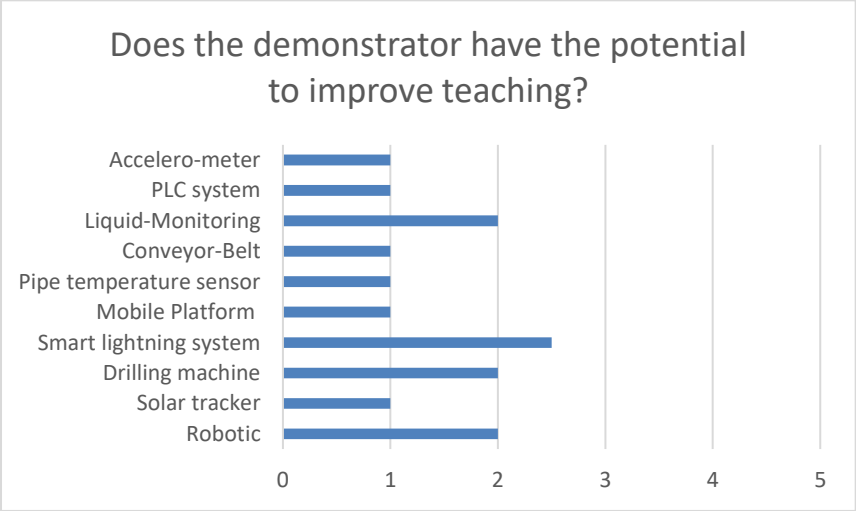

Figure 6.

Figure 6: Overview of improving the teaching activity (third and fourth demonstrators)

Sustainability awareness was rated between 1 and 2 for 40% of the demonstrators, which is considered very good (See Table 2). The remaining demonstrators were rated at the lower end, between 3 and 4, but with an improved rating (compared with the first set of demonstrators) considered good (See Table 1 and 2). Hence, the actions implemented after the first demonstrators seemed to have had a positive effect and increased focus on the area.

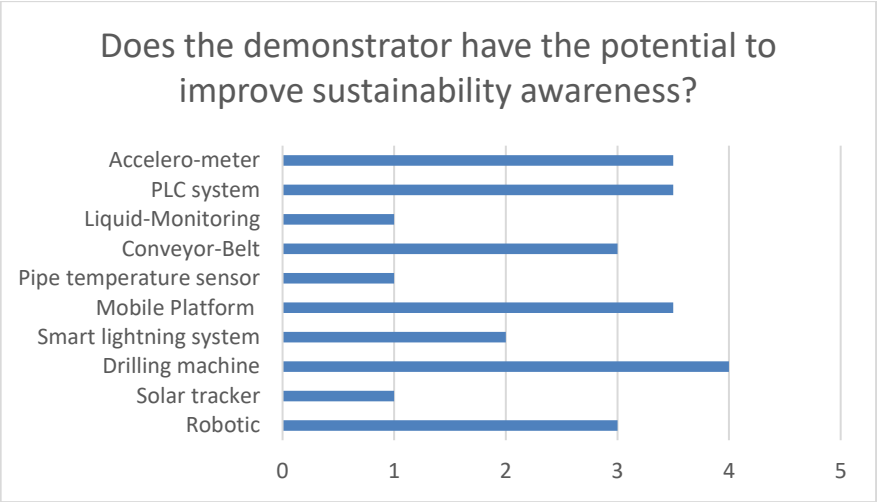

Figure 7: Overview of improving sustainability awareness (third and four demonstrators)

The replicability of the demonstrators, relative to several elements, e.g., costs and complexity, was rated between 1 and 2 for 80% of the demonstrators, which is considered very good (See Table 1). Hence, this aspect has been improved for the second set (third and fourth demonstrators).

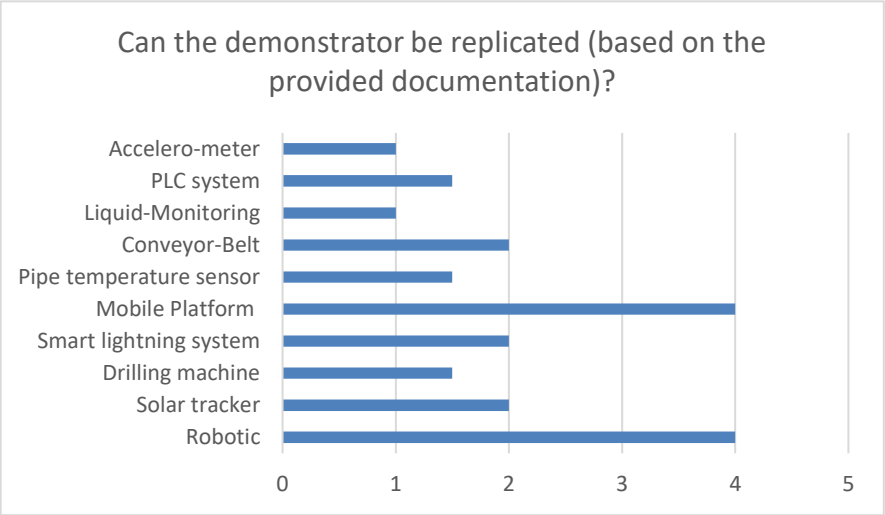

Figure 8: Overview of replicability (third and fourth demonstrator)

The link to the industry was rated between 1 and 2, which is regarded as excellent (See Table 2). This result reflects the evaluation of the first set of demonstrators (first and second).

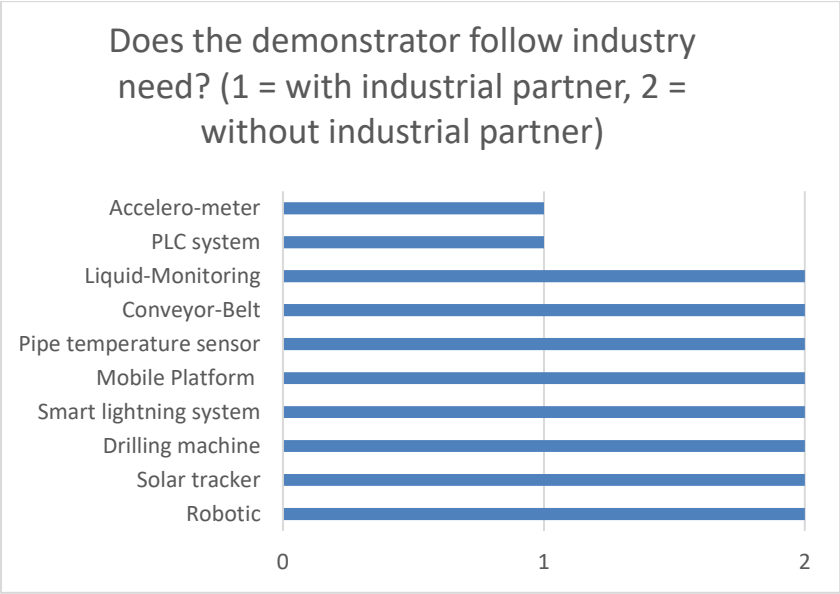

Figure 9: Overview of the implementation in partnership with industrial partners (third and fourt demonstrators)

The interdisciplinary skills were rated between 1 for 40% of the demonstrators and 2 for the other half. These results are regarded as excellent (See Table 2). These results are slightly lower than those obtained for the first set of demonstrators but still acceptable.

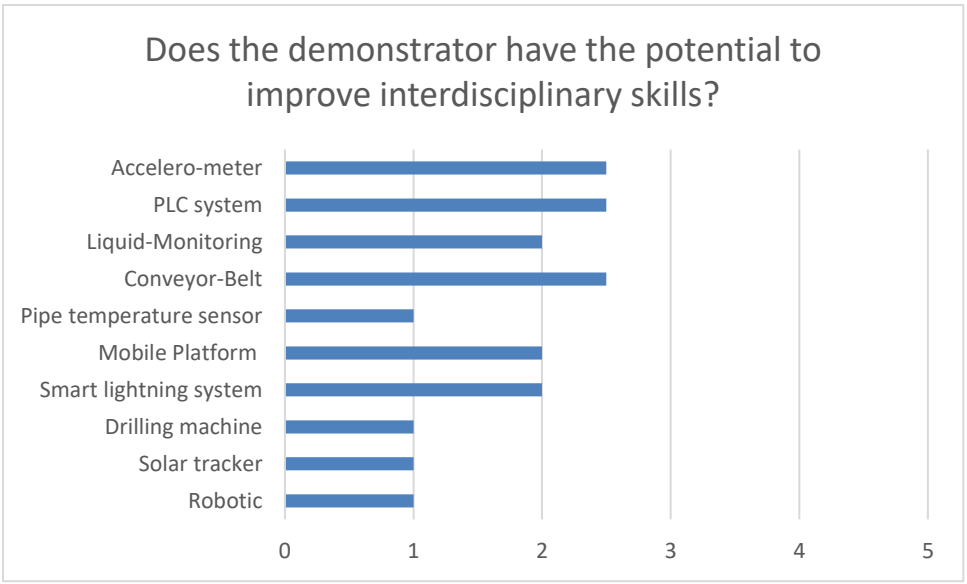

Figure 10: Overview of improving interdisciplinary skills (third and fourth demonstrators)

3 Summary

Overall, the evaluation demonstrated positive results across all the characteristics of the demonstrators: teaching, sustainability awareness, interdisciplinary skills, replicability, and industry relevance. This outcome was expected since the evaluation criteria aligned with the framework used for developing the demonstrators. Therefore, the peer review evaluation serves as an internal quality assurance measure, ensuring the overall quality of the demonstrators.

Additionally, the evaluation results indicated a slight improvement in two key areas, namely sustainability awareness and interdisciplinary skills, between the first set of demonstrators (the first and second) and the second set of demonstrators (the third and fourth). This suggests that the project team acquired a greater understanding and knowledge in these two crucial aspects as they progressed from the initial to the subsequent set of demonstrators.

Apart from evaluating the demonstrators, the process also yielded valuable insights and input regarding their content, including the underlying logic. This foundation not only facilitated the improvement of the teaching material developed within the project but also benefitted the project members in general, enhancing their overall knowledge and expertise.

Annex A: Peer-review *Connected Thermostatic Valve* / ESTA

Name of demonstrator: Connected Thermostatic Valve

Responsible Institution: ESTA

Date of evaluation: 09/02/2022

Name of participants: Torben Holm, Robert Amann, Daniel Schlegel, Zoltan Josef Korka, Gilbert-Rainer Gillich

Review of the characteristics of the demonstrator

1. Does the demonstrator have the **potential to improve teaching**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: In itself, it cannot improve teaching. It needs to collect the experience of the design process (for example all the bad ways chosen by the students). After that, we have to select some specific points to build short courses.

2. Does the demonstrator have the **potential to improve sustainability awareness**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: the aim of the demonstrator is to reduce the heat and power consumption, that is a sustainability objective. But the design in itself is not integrated enough to reduce material and components consumption; much of the components is oversized and much of the material is misused. Asking the students to propose enhanced solutions could make a link with sustainability.

3. Can the demonstrator **be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments: There are many parts that should be 3D printed, and the assembly will only work if these parts have a given dimension. So, there are preliminary tests to lead, in order to evaluate the precision of the printer and to correct the size, with specific dimensions. One of these parts should be tapped. The budget is about 50 Euros for one valve.

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments: The demonstrator already has equivalent commercial versions, this shows its relevance, even if it is not developed with an industrial.

5. Does the demonstrator have the **potential to improve interdisciplinary** skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: The demonstrator uses all the information – action chain, from IoT to mechanical effectors. The level of knowledge required for most aspects to show or to teach is quite low, so it can be used to teach skills to people from other disciplines

Annex B: Peer-review *Data transfer system* / ESTA

Name of demonstrator: Data transfer system

Responsible Institution: ESTA

Date of evaluation: 09/02/2022

Name of participants: Horatiu Pilsan, Steffen Rahbek Vutborg, Cristian Paul Chioncel, Helene Karin Mallasvik, Thomas Rohr, Tommy Edvardsen Hvidsten

Review of the characteristics of the demonstrator

Project description:

Gather data and transfer them to a management system

1. Does the demonstrator have the **potential to improve teaching?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments**:** Combines practical and theoretical training, well integrated in teaching

2. Does the demonstrator have the **potential to improve sustainability awareness?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments**:** integrated in an application to steer environmental control

3. Can the **demonstrator be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments**:** Documents missing

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments**:** In-house application

5. Does the demonstrator have the **potential to improve interdisciplinary skills**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** **4** 5

   Comments**:** electronic and IT skills, but mechanical skills not necessary in this step

Annex C: Peer-review *Chair Telemetry Transponder* / UCN

Name of demonstrator/number: Chair Telemetry Transponder

Responsible Institution: UCN

Date of evaluation: 09/02/2022

Name of participants: Horatiu Pilsan, Steffen Rahbek Vutborg, Cristian, Helene Karin Mallasvik, Thomas Rohr, Tommy Edvardsen Hvidsten

Review of the characteristics of the demonstrator

Project description: Gather data and transfer them to a management system

1. Does the demonstrator have the **potential to improve teaching?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments**:** Used as a use case to understand through an application. Objective: groups of two students, limited demonstrator skills. Taught to technical IT students

2. Does the demonstrator have the **potential to improve sustainability awareness?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 **4** 5

   Comments**:** Primary objective is on functional aspects not on sustainability or environmental awareness. Thus, sustainability awareness depends on the application case.

3. Can the **demonstrator be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments**:** Graphs & code are provided, off-the-shelf components

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments**:** General use case in industry without direct industrial customer

5. Does the demonstrator have the **potential to improve interdisciplinary skills**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely): 3-4

   1 2 **3** **4** 5

   Comments**:** Mainly focusing on IoT in the current state, potential to include interdisciplinary aspects in the future

Annex D: Peer-review *Indoor air quality monitor* / UCN

Name of demonstrator/number: Indoor air quality monitor

Responsible Institution: UCN

Date of evaluation: 9. 2. 2022

Name of participants: Daniel Schlegel, Torben Holm, Robert Amann, Zoltan Josef Korka, Rainer-Gilbert Gillich

Review of the characteristics of the demonstrator

1. Does the demonstrator have the **potential to improve teaching**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments:
   - hands-on with a physical device can increase motivation in learning how to integrate electronics and mechanics.
   - Students can understand and relate to the problem

2. Does the demonstrator have the **potential to improve sustainability** awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments. Following points can improve sustainability awareness:
   - Awareness of how air quality influence life quality.
   - Awareness of not using more energy than needed to have the correct air quality.

3. Can the **demonstrator be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: Some understanding of sensors is required.

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments: The demonstrator is not developed in cooperation with an industry partner, but it can be made into a marketable product.

5. Does the demonstrator have the **potential to improve interdisciplinary skills**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: Main focus is on electronics, but the same electronics can be connected to various mechanical solutions.

Annex E: Peer-review *Elevator* / FHV

Name of demonstrator/number: Elevator

Responsible Institution: FHV

Date of evaluation: 9.02.2022

Name of participants: Daniel Schlegel, Torben Holm, Robert Amann, Zoltan Josef Korka, Gilbert-Rainer Gillich

Review of the characteristics of the demonstrator

1. Does the demonstrator have the **potential to improve teaching**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: hands-on with a physical device can increase motivation in learning how to implement and how test programs for logic controllers.

2. Does the demonstrator have the **potential to improve sustainability awareness**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments. The following points can improve sustainability awareness:
   - Foster awareness about energy consumption by publishing energy information to the cloud and visualizing it.
   - Increase the lifetime of the system by supervision of operation according to the specification (monitoring of weight of load).
   - Construction details which save resources: using 1 switch for all floors instead of 4 switches (in each station one switch)

3. Can the **demonstrator be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments: CAD drawings and schematics of electronics and a list of material is available, but no detailed information about assembly; knowledge in the field of electronics and mechanical construction is necessary.
   It is not necessary to use the exact same system: Any other mechanical construction and controller can be used (linear axis, motor controller, PLC). A technician with an automation background can easily set up a similar system by himself.

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2** 3 4 5

   Comments: The demonstrator is not developed in cooperation with an industry partner, but the learning goals which can be reached are strongly connected to industry needs/skills (e.g., PLC programming, visualization)

5. Does the demonstrator have the potential to **improve interdisciplinary skills**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

Comments: Good starting point for mechanical engineers to get into programming.

Annex F: Peer-review *xyz axis system* / FHV

Name of demonstrator/number: xyz axis system

Responsible Institution: FHV

Date of evaluation: 09/02/2022

Name of participants: Horatiu Pilsan, Steffen Rahbek Vutborg, Cristian Paul Chioncel, Helene Karin Mallasvik, Thomas Rohr, Tommy Edvardsen Hvidsten

Review of the characteristics of the demonstrator

Project description: Add a functional z-Axis to an existing xy-Axis system including programming to build a functional pock-up system. Groups of 5 students, with individual work in cooperation. Students decide on the repartition of the different parts. Overall, the feedback was very positive. Having a presentation to the customer one week prior to the final deadline. Coaching on Teamwork by a colleague. Course = lectures & application. The overall cost of about 7k€ for each demonstrator xy-Axis system

1. Does the demonstrator have the **potential to improve teaching?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments**:** Seeing something moving is a great motivation for students. Many different elements need to work together.

2. Does the demonstrator have the **potential to improve sustainability awareness?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** **4** 5

   Comments**:** Has the potential to improve sustainability awareness (energy consumption, reparability, end-of-life….) Tentative to introduce sustainability awareness through the search for solutions. Tentative failed.

3. Can the **demonstrator be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 **4** 5

   Comments**:** Difficult to be replicated: high costs, many proprietary solutions integrated into the demonstrator needing adaptations, course of 18 ECTS in one term (including lectures and project work)

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments**:** Relevant case for industry

5. Does the demonstrator have the **potential to improve interdisciplinary skills**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments**:** Interdisciplinary and intercultural cooperation resulted in different outcomes depending on the students

Annex G: Peer-review *CNC Machine* / UBB

Name of demonstrator/number: CNC Machine

Responsible Institution: UBB

Date of evaluation: 09/02/2022

Name of participants: Horatiu Pilsan, Steffen Rahbek Vutborg, Cristian Paul Chioncel, Helene Karin Mallasvik, Thomas Rohr, Tommy Edvardsen Hvidsten

Review of the characteristics of the demonstrator

1. Does the demonstrator have the **potential to improve teaching?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments**:** Students developed the demonstrator in groups, not yet generally introduced into teaching

2. Does the demonstrator have the **potential to improve sustainability awareness?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** **4** 5

   Comments**:** Use of different heads with one machine, use of recycled materials for demonstrator parts to reduce environmental impact

3. Can the **demonstrator be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments**:** The design of pieces exist and can be reused, with overall costs of about 2k€, replicability reasonably possible

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments**:** Common industrial use, interest by a company using CNC machines

5. Does the demonstrator have the **potential to improve interdisciplinary skills**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments**:** Potential is there, but not yet used in teaching

Annex H: Peer-review *Structural Health Monitoring* / UBB

Name of demonstrator/number: SHM

Responsible Institution: UBB

Date of evaluation: 09/02/2022

Name of participants: Daniel Schlegel, Torben Holm, Robert Amann, Zoltan Josef Korka, Gilbert-Rainer Gillich

Review of the characteristics of the demonstrator

1. Does the demonstrator have the **potential to improve teaching?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: Students developed the demonstrator in groups, not yet generally introduced to teaching

2. Does the demonstrator have the **potential to improve sustainability awareness?** Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments: The demonstrator was mainly built with materials/components that already existed in the laboratories. At the same time, the method offers the possibility, based on the carried-out tests, that the health of different materials can be identified, and the duration of exploitation extended.

3. Can the **demonstrator be replicated** (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: The provided description offers a good possibility of being replicated, the used components being not expensive, easy to find, and used on a large scale.

4. Does the demonstrator **follow industry need**? Answers on a scale of 1 to 2 (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments**:** Of interest to companies that produce materials and assure maintenance as well.

5. Does the demonstrator have the **potential to improve interdisciplinary skills**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: The demonstrator follows the identification of mechanical properties, and appealing diagnostic methods that involve electronic, data acquisition, and informatics knowledge.

Annex I: Peer-review Peer-review Vessel Monitoring *Sensor* / FIV

Name of demonstrator/number: Vessel Monitoring demonstrator

Responsible Institution: Fagskolen i Viken

Date of evaluation: 09/02/2022

Name of participants: Daniel Schlegel, Torben Holm, Robert Amann, Zoltan Josef Korka, Gilbert-Rainer Gillich

Review of the characteristics of the demonstrator

1. Does the demonstrator have the **potential to improve teaching**? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1,5 2 3 4 5

   Comments: The demonstrator is planned for use by first-year students in the electrical study programs.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1,5 2 3 4 5

   Comments: The task is understandable for the students, and the product/service will save many trips to check the status of boats.

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: the demonstrator is built from a few basic modules which are readily available.

4. Does the demonstrator follow industry needs? Answers on a scale of 1 to 5 (1 = with industrial partner, 2 = without industrial partner)

   1 2

   Comments: the concept is available as a product/service from a company called Sensar Marine in Bergen, Norway.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2.5** 3 4 5

   Comments: the controller and sensors are the central parts of the demonstrator; the mechanic design must take weather impact and maritime environment into consideration.

Annex J: Peer-review Peer-review *Snow Depth Sensor* / FIV

Name of demonstrator: Snow Depth Sensor

Responsible Institution: Fagskolen i Viken

Date of evaluation: 01.02.2002

Name of participants:

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2,5** 3 4 5

   Comments: The plan is to use the demonstrators for continuous education training. The plan is to produce portable kits for IoT demonstrations and C# training.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1,5 2 3 4 5

   Comments: Given good tasks inducing student reflection on sustainability, for example, how many trips to check the snow depth on the cottage are saved due to the device, the demonstrator has quite good potential for improving sustainability awareness.

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: the basic concept has low complexity and may easily be replicated.

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

   1 2

   Comments: a company (Nysny AS - http://nysny.no) is currently marketing the device.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2.5 **3.5** 4 5

   Comments: the electronics is the core part of the demonstrator, but the mechanic design must take wind and snow removal into consideration, so the interdisciplinarity is important but not a core part of the demonstrator version 1.0

Annex K: Peer-review *Drilling machine* / ESTA

Name of demonstrator/number: #3 Drilling machine

Responsible Institution: ESTA

Date of evaluation: 01/02/2023 (Reşita)

Name of participants: Horatiu Pilsan, Steffen Rahbek Vutborg , Daniel Schlegel, Thomas Röhr, Cristian Paul Chioncel, Dejan Ardelean

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments:
   - Improves understanding of measuring displacements and the interaction between mechanics and data visualization, focusing on programming.
   - Potential to collect data.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 **4** 5

   Comments:Technology/methodology to upgrade/retrofit old machines (should be addressed in the teaching part)

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments:
   - Just one part to be designed and produced to mount the sensor to a belt.
   - Rest: standard elements

6. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments:
   - Huge industrial need due to many existing "old" machines", but no direct industry request
   - Potential to do quality control when data transfer is added.

4. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: Combination between mechanical, data acquisition, (easy) programming

Annex L: Peer-review *Smart lighting system* / ESTA

Name of demonstrator/number: Smart lighting system

Responsible Institution: ESTA

Date of evaluation: 1st February 2023

Name of participants: Tommy, Torben, Sylvain, Korka Zoltan, Esben

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 **2** **3** 4 5

Comments:
- Simple (adapted to the level of students)
- Possibility to add more components (upgrade)

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 **2** 3 4 5

Comments:
- Different levels of ST:
  - (1) temperature regulation (sun),
  - (2) components choice,
  - ST programming

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 **2** 3 4 5

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

1 **2**

Comments: The application could concern the industry

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 **2** 3 4 5

Comments:
(1) Programming

(2) electronic

Annex M: Peer-review *Conveyor-Bel* / FHV

Name of demonstrator/number: Conveyor-Belt/Demonstrator 3

Responsible Institution: FHV

Date of evaluation: 01.02.2023

Name of participants: Christian Chiocel, Steffen Rahbek Vutborg, Thomas Röhr, Daniel Schlegel, Dean Ardelean, Horatiu O. Pilsan

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: It has been implemented for teaching use in a large course project.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments: Energy constraints shall be added and addressed to improve sustainability.

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: The availability of MATLAB is of advantage. PCB is documented but has to be produced.

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments: Does follow the needs, but not a direct company need.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: Interdisciplinary skills are needed to understand and program, but it is focusing on software.

Annex N: Peer-review Liquid-Monitoring / FHV

Name of demonstrator/number: Liquid-Monitoring/Demonstrator 4

Responsible Institution: FHV

Date of evaluation: 01.02.2023

Name of participants: Christian Paul Chioncel, Steffen Rahbek Vutborg, Thomas Röhr, Daniel Schlegel, Dean Ardelean, Horatiu O. Pilsan

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: Can be used, it has potential. Needs to be confirmed. Handling of sensitive personal data is needed. Usable in both engineering and nursing programs.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: Different types of sustainability than engineers usually think of (STG #3): Health care. It has a high impact.

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: Off-the-shelf components. Easy to configure and implement.

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments: Need for the FHV research center. Can be used for updating similar equipment in operation.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: Mechanics, electronics, and programming included.

Annex O: Peer-review *PLC system* / FiV

Name of demonstrator/number: FiV#3 PLC system

Responsible Institution: Fagskolen I Viken

Date of evaluation: 01.02.2023

Name of participants: Zoltan, Torben, Esben, Sylvain, Helene, Tommy

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Very specific for teaching purposes

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 – very likely; 5 – very unlikely)

1 2 **3** **4** 5

Comments: Depends on the application

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 – very likely; 5 – very unlikely)

1 **2** 3 4 5

Comments: Easy to replicate

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

1 2

Comments: High potential

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 **2** **3** 4 5

Comments:

- Depends on the application.

- Not much mechanical as is, but it is possible to implement.

Annex P: Peer-review *Accelerometer* / FiV

Name of demonstrator/number: FiV#4 Accelerometer

Responsible Institution: Fagskolen i Viken

Date of evaluation: 01.02.2023

Name of participants: Zoltan, Torben, Esben, Sylvain, Helene, Tommy

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Very specific for teaching purposes

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 – very likely; 5 – very unlikely)

1 2 **3** **4** 5

Comments: Depends on the application

Accelerometers, which are devices that measure acceleration or changes in motion, can contribute to improving sustainability in several ways:

- Energy-efficient transportation: Accelerometers play a crucial role in optimizing fuel consumption and reducing emissions in vehicles. By measuring changes in acceleration, they enable the implementation of advanced driver assistance systems (ADAS) and eco-driving techniques. ADAS uses accelerometer data to provide feedback to drivers, encouraging smoother acceleration, braking, and cornering, which in turn reduces fuel consumption and greenhouse gas emissions.
- Smart buildings: Accelerometers can be employed in smart buildings to optimize energy usage. For example, they can be integrated into heating, ventilation, and air conditioning (HVAC) systems to monitor occupancy patterns and adjust energy consumption accordingly. By detecting the presence or absence of occupants in specific areas, HVAC systems can focus on providing conditioned air only where needed, resulting in energy savings.
- Renewable energy systems: Accelerometers can aid in enhancing the efficiency and safety of renewable energy systems. In wind turbines, they can monitor vibrations and movement, ensuring the turbines are operating optimally and detecting any anomalies or potential failures. By promptly identifying issues, maintenance can be performed proactively, reducing downtime and maximizing energy production.

- Sustainable manufacturing: Accelerometers are valuable tools for optimizing manufacturing processes and minimizing waste. By monitoring and analyzing vibrations during production, they can help identify inefficiencies, such as misalignments or excessive vibrations that lead to excessive energy consumption or product defects. This data can then be used to fine-tune machinery settings, reducing energy consumption, and enhancing overall sustainability.
- Wearable devices: Accelerometers are commonly found in wearable devices, such as fitness trackers and smartwatches. These devices can promote sustainable behaviors by encouraging physical activity, thereby reducing reliance on sedentary modes of transportation, and promoting healthier lifestyles.

Overall, accelerometers contribute to sustainability by enabling energy efficiency, optimizing resource usage, enhancing renewable energy systems, and promoting sustainable behaviors in various domains.

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 – very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Easy to replicate

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

1 2

Comments:

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 **2** **3** 4 5

Comments: Depends on the application

Annex Q: Peer-review *Robotic* / UBB

Name of demonstrator/number: Robotic/Demonstrator 3

Responsible Institution: UBB

Date of evaluation: 01.02.2023

Name of participants: Korka Zoltan, Tommy Edvardsen Hvidsten, Helene Karin Mallasvik, Esben Skov Laursen, Sylvain SAGOT

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: It has been implemented for teaching use.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** 4 5

   Comments: Highlights the possibility of updating classic equipment with modern measuring and control features.

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 **4** 5

   Comments: Considering its particularity – the constraint of an adaptation for specific equipment in the Engineering Faculty laboratory, replicability is limited.

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments: Does follow the needs, but not a direct company need.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: Interdisciplinary skills are needed to understand the behavior of the whole.

Annex R: Peer-review *Solar Tracker* / UBB

Name of demonstrator/number: Solar Tracker/Demonstrator 4

Responsible Institution: UBB

Date of evaluation: 01.02.2023

Name of participants: Christian Chiocel, Steffen Rahbek Vutborg, Thomas Röhr, Daniel Schlegel, Dean Ardelean, Horatiu O. Pilsan

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: It has been implemented for teaching use in a large course project.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Focused to obtain maximum energy yield from renewable sources (PV).

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 **2** 3 4 5

Comments: Some components that have to be done are not ready to purchase.

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

1 **2**

Comments: Does follow the needs, but not a direct company need.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Interdisciplinary skills are needed to understand the behavior of the whole.

Annex S: Peer-review *Mobile Platform* / UCN

Name of demonstrator/number: Mobile Platform - #3

Responsible Institution: University College Nordjylland

Date of evaluation: 01/02/2023

Name of participants: Christian Paul Chioncel, Thomas, Daniel, Horatiu Pilsan, Steffen & Dean (student at Resita).

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 4 5

   Comments: Many levels of complexity of tasks in different disciplines

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 **3** **4** 5

   Comments: the implicit potential that can be addressed in teaching

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 2 3 **4** 5

   Comments: The kit is not available anymore but can be bought in parts. A lift must be built. The cost of components is high.

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

   1 **2**

   Comments: Industrial need is increasing, and similar commercial products are on the market.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

   1 **2** 3 4 5

   Comments: For navigation alone, the discipline is mostly focused on programming, but an understanding of the mechanical system is needed.
   If a lift is used mechanical understanding is even more needed.

Annex T: Peer-review *Pipe temperature sensor* / UCN

Name of demonstrator/number: Pipe temperature sensor / 4

Responsible Institution: UCN

Date of evaluation: 01-feb-2023

Name of participants: Sylvain, Helene', Tommy, Esben, Bluc

Review of the characteristics of the demonstrator

1. Does the demonstrator have the potential to improve teaching? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Easy to understand the purpose. Projects can be simple or complex by choice.
Mechanical can be simple or sophisticated, in relation to thermodynamics.

2. Does the demonstrator have the potential to improve sustainability awareness? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: High possibility to improve the saving of fresh water

3. Can the demonstrator be replicated (based on the provided documentation)? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Can be adapted to the level of students

4. Does the demonstrator follow industry need? (1 = with industrial partner, 2 = without industrial partner)

1 **2**

Comments: Saving water is also important in industry. Producing and selling the unit can also be an industrial purpose.

5. Does the demonstrator have the potential to improve interdisciplinary skills? Answers on a scale of 1 to 5 (1 - very likely; 5 – very unlikely)

1 2 3 4 5

Comments: Can train electronics, communication, databases, and mechanical subjects.