IREB Roundtable Summary Report: Educating Sustainability in Software Engineering Research and Practice

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The IREB Roundtable on "Educating Sustainability in Software Engineering Research and Practice" was broadcast live on 11 March 2025. Educating sustainability is crucial to equip students and practitioners with a sustainable mindset, a shared understanding of sustainability, and knowledge of the concepts and tools available to them. The roundtable discussion was well attended by an audience that asked insightful questions.

Watch the recording on YouTube: https://youtube.com/live/elyUxVrCI5A?feature=share

1 Who are our expert panelists?

We are proud that we had four authoritative persons on the topic of education and sustainability taking part in the roundtable discussion:

- **Patricia Lago**, professor at VU Amsterdam in the Netherlands. Her Software and Sustainability (S2) group offers two master programs on sustainability and has translated knowledge to trainings for industry. Her expertise is in software architecture, design decision making, sustainability qualities, and embedding sustainability in the design and evolution of systems. She among other things developed the SAF Toolkit.

- **Jari Porras** is a professor at Lahti University in Finland. His university recognized early that sustainability is key in all of research and education, and offers a master's program for sustainable development. He helped develop the Finnish climate and environmental strategy for the ICT sector, and is part of the Software Engineers for Green Deal (SE4GD) program to educate software engineers with a sustainability mindset.

- **Thorsten Jonas** is a sustainability activist based in Germany, who has founded the Sustainable UX (SUX) Network, a non-profit global community providing among other things a database of design resources, events, podcasts and the SUX Academy with courses and classes to help designers integrate sustainability in their products and design processes. He also co-authored the W3C Sustainable Web Design Guidelines.

- **Michael Wahler** is a senior lecturer at the Zurich University of Applied Sciences (ZHAW) in Switzerland. His department realized that sustainability plays an important role in educating and training the future generation of software engineers. They currently provide two elective modules for sustainability, with practical applications with industry, and are extending it to make sure every student gets a basic knowledge of sustainability.

2 What is sustainability?

According to the participants, sustainability is software engineering considers the benefits from using software, which is considered in dimensions such as:

1. **Technological:** Role of the technology, design decisions
2. **Ecological:** Impact on the environment, energy consumption, carbon footprint
3. **Economic:** Cost and time investment, return on investment, affordability
4. **Social:** Targeting users, actual use of the technology
5. **Individual:** Personal considerations, human-computer interaction
6. **Time:** Preserving benefits over a certain amount of time
7. **Context:** Embracing constant change.

The first five dimensions are commonly accepted in software engineering, but Patricia remarked that the latter two are often underestimated. Jari noted that projects tend to

focus on the environmental aspect, and product owners often think on the environmental and technical levels. However, the individual aspect is also important: not only the "footprint", but also the "handprint" of digital solutions. Michael also supported that the social and individual aspects need to be considered more, while Torsten explained that the focus on carbon impact is likely because it is the easiest to measure, and that from a design perspective, the context or ecosystem of the digital product or service is important, with a focus on the user, but in line with the business perspective.

3 How can the business demand for sustainability be raised?

Thorsten remarked that many people have not yet understood that sustainability is already a business case, and that it must be a priority. An important narrative is to compare it to the current challenges meeting accessibility regulations; a similar thing will happen with digital sustainability in a few years. Impacts must be made transparent and visible: showing an organization whose website attracts millions of visitors how many tons of CO2 it requires is an eye-opener.

Patricia highlighted the importance of learning to become better. Instead of just reporting on numbers, knowing exactly what the actions are that led to these numbers helps to change practices and build skills. Company management must make sustainability a top priority to shape company culture to operationalize and measure it, they should lead by example, motivate people and identify missing competences.

4 How can sustainability be integrated into teaching curricula?

Michael noted that students often come with preconceptions of sustainability; some are eager about the topic, others think of greenwashing. Patricia noted that there are two types of approaches that can help build an interesting program to convey knowledge, soft skills and competences to students:

- **Central integration:** dedicated courses on sustainability aspects such as measuring the energy footprint of software or managing resources of cloud computing.
- **Cross-cutting courses:** Enriching courses on traditional software engineering competences like project management or architectural design with applications to industry cases.

Michael talked about how in cross-cutting courses, they were able to create a spark. In courses on fields of software engineering, such as requirements engineering, architecture or design, they taught what sustainability means. Based on this, the students started owning the topic and address sustainability aspects in their project even when it is not asked of them.

Jari clarified that this demonstrates having a sustainability mindset in action. He mentioned GreenComp, a European sustainability competence framework, and his own Sustainability

Mindset Framework. Among other things, this mindset involves understanding the limitations of the planet, creating visions, making a change, knowing how to act, and being aware of the tools. It is important for those in all phases of software engineering, from requirements engineering to implementation, to have the same mindset.

5 What about the mindset in industry?

Thorsten explained that many practitioners already come to him with a mindset, but they do not feel empowered to have an impact. The large constructs help get an understanding, but it is the awareness of the little changes one can make, or the adjustments to the existing tools, processes and methodologies, that help achieve quick wins and can often be made without management buy-in.

Michael also noted that it helps make practitioners think less about sustainability as goal that is difficult to achieve if they are aware that they often already adopted sustainable practices, such as how Agile with Scrum positively impacts the social dimension of sustainability, or how optimizing software testing helps save energy, positively impacting environmental sustainability. This makes it easier to take further steps in sustainability.

6 What are success factors for teaching sustainability successfully?

The discussion so far showed that in students, the fire needs to be kindled to create the right mindset, while practitioners need to be equipped to have influence, awareness, and knowledge. So, what experiences did the panelists have to best achieve this?

Patricia saw the best effects when a project puts theory into practice; one that helps a company, one that resonates with the students, or even both. Students will come with creative solutions that are inspiring to all. Jari saw this in action in the capstone courses; it educates not just the students, but also the companies, and gives them a positive experience with sustainability; a win-win.

7 What tools, solutions, and best practices are available? (Audience question)

Several initiatives are building practices, some with and others without measures. This shows that there are resources and structures to help; practitioners do not need to start empty-handed, and students taught in sustainability will be able to bring in this knowledge. Panelists recommended:

- The Green Software Foundation
- The Dutch National Coalition for Sustainable Digitalization (NCDD)
- The W3C Web Sustainability Guidelines (WSG) for a standardized protocol; currently a community draft

- The SUX Network
- The Digital Sustainability Center
- The Sustainability Awareness Framework (SusAF), for requirements engineering and awareness creation
- The SAF Toolkit, for software architectural design and quality assurance
- The IREB Special Interest Group on Sustainability (SIGsus)
- The dedicated track on Software Engineering in Society at the International Conference on Software Engineering (ICSE)
- The ICT for Sustainability (ICT4S) community with an interdisciplinary audience and open access publications
- The Green Web Foundation, whose JavaScript library is the standard for measuring carbon impacts on the Web, with guidelines on how to integrate it into applications

Thorsten noted that many of these are joint efforts where experts come together and create solutions for sustainability. One of the challenges is to bring even more people together to achieve more. But collaborations are happening on all levels. Patricia added that several of the organizations and resources mentioned are more geared towards research or are provided by research for use by practitioners. She highlights the importance for industry to share good practices.

8 What are best practices to promote sustainability? (Audience question)

- Share of archives and catalogs of practices is crucial to drive knowledge onwards. Patricia has made all quality assessment tools and standards for architectural design from her professional trainings open source.
- Begin by asking: What could be five quick wins that make my product more sustainable? Things that could be changed easily, such as disabling videos on websites, Thorsten recommends.
- Measuring before and after is important. That seems obvious, but it is important to learn how to measure the impact of the five dimensions, thereby establishing the real impact of these low-hanging fruits. This was recommended by Patricia.

9 How can sustainability be considered more as a business case? (Audience question)

Jari noted that when the Finnish government published a strategy on sustainability, there was a lot of industry interest at first, but this subsided in one or two years because companies didn't see quick wins. This has been a big topic in the public debate in Finland. The key to being successful is if you can manage to sell sustainability improvements to management in terms of cost savings, such as cloud costs. Moreover, some sectors did not see the return on investment, such as producers of software solutions. This was resolved by talking to the procurers, who were keen to compare offers by including environmental

sustainability criteria, which in turn encouraged software producers to explicitly consider the impact on sustainability. This shows that there are business cases, but it depends on how to sell it internally, and how to control pressure from outside.

Patricia looks at the future: Companies who either are aware of the impact on the business survival or see that sustainability is coming, like the narrative mentioned by Jonas before, are the ones adopting sustainable practices. It also helps not to look at the negative side ("the biggest contributors to pollution") but to phrase it positively ("a front-runner in making changes"), and using that as a unique business model to give a good example and encourage others to invest time and money in this cause.

10 What is your personal recommendation to the audience to promote sustainability?

Michael suggests that we do not just think about the business case of sustainability for companies, but also define the business case for students. They must manage the resources of time and mental capacity to get good grades and finish their studies. So, what warrants that you include additional material on sustainability topics in your curriculum that you ask the students to invest their resources in? It is important to demonstrate that students see this as an investment in the future, even if the immediate benefit is not apparent. It helps to do this by extending concepts that are already being taught (such as loose coupling and high cohesion in programming) to improve maintainability.

Thorsten recommends to just start with whatever you want to start with, which is better than to not start at all. Everybody can be the small rock that brings the whole mountain to slide. This is why we try to equip people with what they can do, narratives, tools and methodologies, as well as confidence, hope, and the right mindset. Join the people with the same mindset to make an impact!

Patricia sees that the strategy that resonates most with students when embedding sustainability in a program is to promote active thinking about the competences. In a portfolio course, the student answers reflective questions at the end of every period: what did I learn in this course, what does it mean for the digital transition and sustainability? This helps to translate sustainability to their own context and identify what is the most relevant. Every student and practitioner can then inject the change and start the conversation within existing and new organizations.

Jari concluded with the wise and motivating words: If you want to move, you need to take the first step. Just start to do something in the right direction. It can be just a small step and doesn't have to be a big leap. And then just keep continuously doing that, step after step.