Navigating complexity and embracing uncertainty: teaching participatory leadership in engineering education

Navigating Complexity and Embracing Uncertainty: Teaching Participatory Leadership in Engineering Education

Daniel Pargman[1], Elina Eriksson[1], Aksel Biørn-Hansen[1], Minna Laurell Thorslund[1], Arjun Rajendran Menon[1], Emilia Rekestad[2], Isabel Chender and Markus Schneider[4]

[1]Department of Media Technology and Interaction Design, KTH Royal Institute of Technology, Sweden

pargman@kth.se

[2]Emilia Rekestad Ecology and Health, Sweden

[4]Centre for Teaching and Learning, Karlstad University, Sweden

Abstract

Engineers are traditionally seen as problem-solvers, but global sustainability challenges are "complex" rather than just "complicated" and thus defy traditional engineering methods. When the complexity and uncertainty of the problems we face change, so must engineering education. In this paper, we describe the launch of a course that teaches participatory leadership at a technical university and we highlight the promises, challenges, tensions and lessons learned.

1 Introduction

Economics education teaches theories that were formulated hundreds of years ago, when human needs were modest and natural resources seemed infinite. The world has since changed, and many classical economic theories are now ill-fitted or even harmful to understanding and handling today's sustainability challenges (Daly 1977, Daly 1992). For centuries, engineering education has similarly taught students how to create cost-effective solutions to practical problems by applying scientific knowledge to build things (Shaw 1990).

Engineers are traditionally seen as problem-solvers, and engineering education teaches processes that include shaping and formulating problems in ways that allow them to be solved; analysing data and representing it through models, implementing and evaluating possible solutions etc. Engineering typically strives for control, certainty, and efficiency, and is well suited to addressing certain types of complicated problems. However, it does not engage with the broader challenges of navigating complexity and uncertainty, particularly in relation to so-called "wicked problems" (Rittel & Webber 1973). These include issues that resist simplification and involve ethical dilemmas, value judgements and social change. Engineering as a culture does not readily accommodate holding off problem-solving in favour of identifying and asking more meaningful questions (Easterbrook 2014).

The sustainability challenges faced by humanity in the 21st century are "complex" rather than merely "complicated", and checklists or blueprints aren't enough to solve them. In a world increasingly characterised by volatility, uncertainty and ambiguity, engineering must work with methods that are better suited for complex problems (Kurtz & Snowden 2003, Snowden & Boone 2007). This has far-reaching implications for engineering education and below we describe how we have introduced methods for working with complexity from "Art of Hosting" (also called "Participatory leadership") in a master-level engineering course called "Leading Complex Change Processes".

2 Art of Hosting

The complex and interconnected nature of wicked problems poses a challenge to engineers working with sustainability. Addressing such problems requires approaches that navigate complexity, embrace uncertainty and foster collaboration. "Art of Hosting and Harvesting Conversations that Matter" (henceforth AoH) is a participatory leadership approach that trains values and methodologies from the field of facilitation and participatory democracy (Quick & Sandfort 2014). Models that explore complexity, such as Cynefin (Kurtz & Snowden 2003), the Chaordic Path (Hock 2009), Two Loops of Systems Change (Wheatley & Frieze, 2006), and Living Systems Science (Meadows 2008) provide the context for interactive and reflective co-creation activities. AoH thus builds leadership capacities required for working with uncertainty and where multiple perspectives and fields of study are needed to probe, sense and respond to complexity and to understand, act on and accomplish shared goals.

AoH's core principles are articulated in its *fourfold practice* framework. Briefly stated, this practice includes 1) hosting oneself through inner work and self-reflection, 2) hosting others through facilitation and inclusion, 3) being hosted by receiving support and clear instructions and through active participation, and 4) participating in a community of practice that hosts conversations and learns together over time. AoH is an umbrella practice that includes a portfolio of co-creation methods for facilitating conversations and collective deliberation (Kaner 2014), including, but not limited, to Circle practice (Baldwin & Linnea 2010, see Figure 1), World café (Brown et al. 2005), Open Space Technology (Owen 2008), Appreciative Inquiry (Cooperrider, Stavros & Whitney 2008), Strategic Storytelling and Proaction café.

Figure 1: Circle Practice is one of the core forms of organising in Art of Hosting. It is a structured process of conversation that aims to foster equitable participation and deep listening.

In an AoH training, participants both experience and (are coached to) use co-creation methods to facilitate peer group interactions. This fosters an environment of peer learning and learning-by-doing that increases

engagement. By creating an environment of psychological safety (Edmonson 1999), trust and peer support, participants are able to step into collective sense making and learn by trial and by reflection. This approach aligns closely with a sustainability mindset as it encourages continuous exploration of complex, multifaceted problems.

We chose to introduce AoH in an engineering education context to train students to resist the temptation to quickly enter a problem-solving mode in search of quick fixes. In fact, shifting mindsets in engineering education is crucial for embracing uncertainty and complexity and for developing competencies such as self-awareness, systems thinking and critical thinking (Bianchi et al. 2022, UNESCO 2017). AoH encompasses concrete practical methods that equip engineers with frameworks, language and tools necessary for navigating complexity and uncertainty, boosting competencies such as personal development, teamwork and co-creation when tackling societal and technological issues (Woiwoide *et al.* 2021).

3 Local Setting, Positionality & Collected material

KTH Royal Institute of Technology addresses sustainability and global challenges broadly. As early as 2011, the president of KTH mandated that all five-year Master of Science programmes in Engineering include at least one 7.5 ECTS course solely dedicated to sustainability. In response, the first two authors developed such a course for the Media Technology Engineering programme, which has been offered annually since 2012 (Pargman & Eriksson 2013, Eriksson & Pargman 2014). KTH later decided to offer a master's programme in "Sustainable Digitalisation" which was launched in August 2024. The programme has two focus areas, "Digitalisation and sustainability" and "Leading in and through complexity", where the latter emphasises grappling with ontological uncertainty, complexity and wicked problems in it in this context we have chosen to introduce Art of Hosting in the course "Leading Complex Change Processes".

For transparency, we here mention the authors' own experiences of AoH. AoH trainings are usually given as 3-day residential courses. The first two authors, both experienced university teachers with more than 40 years of combined teaching experience, have each attended 2-3 trainings each, and have also served as co-trainers at one such training. The subsequent three authors are PhD students who have each attended 1 or 2 trainings. Since 2021, these five authors, all affiliated with KTH Royal Institute of Technology, have applied AoH practices in different constellations and in various contexts.

The remaining three authors have been part of designing and facilitating the course and bring further experiences of AoH from different contexts. Emilia Rekestad, an AoH steward, has over 15 years experience of participatory methods particularly in civil society and popular education contexts and with a focus on sustainability, holism and regeneration. Isabel Chender is an AoH steward with 15 years experience as a sustainability consultant and process designer. She has worked in alternative education since 2016 with international student groups in Brazil, Canada and Sweden. Markus Schneider, at the Centre for Teaching and Learning at Karlstad University, has practiced Art of Hosting since 2019. He has extensive experience of delivering AoH trainings and to foster co-creative leadership in higher education.

Planning for the course began 18 months before it was launched, during which we maintained a collaborative research diary. Additional material for this paper comes from a four-hour student debrief session held at the end of the course (which was offered September - October 2024),

4 Leading Complex Change Processes

The course "Leading Complex Change Processes" is designed to be a flagship introductory course that is compulsory in the new master's programme in Sustainable Digitalisation, but it also admits non-programme students. The course enrolled 18 students in its first iteration. The maximum number of students is constrained by the availability of flexible teaching spaces and by coaching capacity. When planning the course, we secured additional internal pedagogical funds, which allowed us to invite and remunerate experienced AoH stewards to co-design and co-facilitate the new course with us.

The course (7.5 ECTS credits) is taught for half the autumn term and at a 50% pace. While AoH courses are typically offered as 3-day intensive residential trainings, our course was given over a period of seven weeks, in two parts. The first part (3 weeks) was an AoH training adapted for a higher education context with six half-day sessions spread over the weeks. The second part (4 weeks) delved deeper into concepts and ideas that were presented during the first part, and more closely resembles traditional university courses. Each week, a new theme was introduced, with an introductory/inspirational lecture, course literature and a seminar. The seminars were organised and led by course participants, i.e. teams of students designed and led two-hour seminars (with coaching from teachers) based on the weekly themes and utilising AoH methodologies that were taught during the first part of the course. This type of student-led and student-active learning is rare within engineering education at our university. The course was exclusively examined through active participation and a final reflective essay. During the first part of the course and in preparation for the reflective essay, students were reminded and encouraged to capture their thought processes and feelings by journaling at least at the end of each week.

4.1 Practical Challenges

This is, to the best of our knowledge, the first time a full AoH training has been taught as part of a university-level course, although elements of AoH have been used at other universities, and extensively so at the University of Minnesota 10+ years ago (Lundquist *et al*. 2013). When we adapted the AoH training to this new context, we encountered various practical challenges and will here mention a few.

As higher education has become more controlled and more bureaucratic (Ahlbäck Öberg & Boberg 2024), there are many structures that university teachers need to adhere to (or navigate around). The first is the process of establishing a course, including defining the "intended learning outcomes" (ILOs). We wanted to stay true to the spirit of AoH, and sought to base ILOs on fundamental principles from AoH, i.e. the fourfold practice, including "hosting yourself". This was met with resistance from the university's quality assurance framework, which requires ILOs to be articulated with verbs that correspond to easily observable and gradable actions (e.g., "analyse", "create"). Attempts to reformulate this in terms of "self-leadership" or "leading oneself" were also rejected and the proposed ILO had to be removed. Throughout, we had to rephrase or reformulate concepts within AoH to fit local culture at our university. A core pedagogical choice was to not grade students from A-E, but instead use a pass/fail model. This was also met with resistance but was non-negotiable to us and we (fortunately) insisted and prevailed. We argued that the course's goal of encouraging students to engage with uncertainty, complexity and personal reflection would be undermined by a traditional A-E grading system that tends to nudge learners toward performative success and an (anxious) reproduction of "correct" responses, where we instead wanted to create the psychological safety necessary for students to dare to be vulnerable and experiment with new ways of thinking.

Considerable effort went into rethinking the course structure, as replicating a traditional three-day AoH training with full-day sessions was not feasible in a university setting. Instead, we designed six 4-hour sessions spread over three weeks. This led to practical issues, particularly in securing a flexible space large enough for Circle practice (see figure 1). While lecture halls for 100+ students are common at our university, few rooms can accommodate 50+ students sitting in a circle. We also used the same room throughout all six sessions, but could not leave any materials between sessions and we therefore had to transport supplies back and forth and repeatedly mount and remove visual aids and results from earlier sessions from the walls.

5 Results

Below, we report on the results of giving the course in terms of 1) students' experiences, 2) tensions (which are more difficult to solve compared to the practical challenges above) and 3) lessons learned.

5.1 Students' Experiences

As teachers, we were concerned that the course's unconventional methods could be questioned and seen as "unserious" by the students, or that we would be asking too much from students who are very shy or uncomfortable with speaking in front of others. We were thus a bit uncertain about how for example circle practice (figure 1 above) and the general "fuzziness" of participatory leadership would be perceived and received by engineering students. Notably, many of the master's students enrolled in the course had recently moved to Sweden and came from educational cultures where the student-teacher relationship is (from a Swedish perspective) more hierarchical, distant and sometimes excessively respectful. This worry turned out to be unfounded as there was buy-in from *all* students already during the first week of the course.

A four-hour debrief session with the AoH team and the students was arranged when the course concluded. At that point, some of the authors had not met the students for a month and noted they seemed more open and to more readily shared their thoughts and experiences. Students were invited to write post-it notes about what they appreciated about the course and what could be improved. There were significantly more notes about the former, but more importantly, the notes were often quite substantial in terms of content, while comments about what could be improved often were brief or logistical (e.g. "*The literature could have been handed out earlier*"). Two examples of what students appreciated were:

"Complexity and systems theory in relation to sustainability. Finally a course that tackles those topics along with inner transition!"

"Explore the importance of asking the right questions. Not only "solving" things without a second thought.

5.2 Tensions

Besides practical challenges (above), we also encountered several "tensions" that are more difficult to solve, and will mention three of them here. If practical challenges can be framed as problems to be solved, the tensions can instead be framed as issues that are "unsolvable", that can be handled better or worse and that we will have to continue to live with.

1. "Hosting" in the AoH context refers to the participatory skill of creating, holding, and protecting a safe and generative space for dialogue. One tension is that this "soft" skill deals with forms of knowledge that students are neither familiar with nor necessarily comfortable engaging in. While

we worried (too much) about this in advance, we still imagine this could be a challenge to some students (as well as to us as teachers). It raises the question of "what exactly are we teaching in this course?". Participatory leadership differs from the types of knowledge that engineering is traditionally associated with, e.g. "immutable principles", "hard facts" and learning how to create "*cost-effective solutions to practical problems by applying scientific knowledge to building things in the service of mankind*" (Shaw 1990, p. 15).

2. Another tension exists between "voluntary" and "compulsory". A core principle of AoH is that it is voluntary; whoever signs up are the right people and participants are encouraged to "host themselves," including stepping away if a particular exercise does not resonate. While students have applied to the course (or to a master's programme where the course is compulsory), they likely did not understand what the course would actually entail. Opting out after a course begins is difficult, and withdrawing from a master's programme even more so. We accept the possibility that the training may not be a good fit for some students, putting them in a difficult position.
3. The third tension is that an AoH training is labour-intensive. Regular AoH trainings can be costly to attend, which pays for the costs of multiple trainers. While we had additional pedagogical funds to draw on, the course budget will eventually have to adhere to "regular" rules for funding university courses with X credits and Y number of participants. It might thus become difficult to staff and teach the course while maintaining a high or sufficient level of quality.

5.3 Lessons Learned

Compared to the intensity of a standard three-day AoH training, our course progressed at a more leisurely pace, which may help students better absorb what is being taught. On the other hand, this meant that both teachers and participants were distracted by other commitments throughout the training (other tasks, other courses etc). The changed dynamics of the training brings both advantages and disadvantages. We were aware of this in advance, but could not predict how it would play out. There were thus many smaller insights we can build on for future course iterations, as well as some greater ones.

One problem we foresaw was the hassle of repeatedly moving in and out of a classroom, instead of "owning" a room for the full duration of the training. Compared to a standard three-day training, more time has to be allocated to summarise and repeat outcomes from previous sessions and practicalities such as mounting and removing materials from walls take time, and the materials need to be carefully stored and transported.

A major insight was that, in contrast to a standard three-day training, we had the luxury of immersing ourselves into various topics during the second part of the course. Each remaining week treated a theme that was related to the topic of the course, "Leading Complex Change Processes", i.e. 1) Regenerative Leadership, 2) Expanding Engineering Methods, 3) Futures Literacy and 4) Complexity and Uncertainty. Since the pace was slow compared to a standard AoH training, the seven-week-long course allowed both for more depth and for more time to think and reflect on the experience.

6 Conclusion

The engineering course "Leading Complex Change Processes" embeds a comprehensive Art of Hosting training within a masters-level course. While methods from AoH have previously been used in higher

education, integrating a full training and subsequently having students co-design and facilitate their own learning experiences represents a novel pedagogical approach.

Organisational and logistical constraints meant that the standard three-day residential AoH training was divided into six half-day sessions over three weeks, something that significantly influenced learning dynamics. The spaced-out sessions and the fact that the whole course was seven weeks long meant there were opportunities for continuous reflection and for students to directly apply their newly acquired skills by co-creating and facilitating seminars during the second part of the course. The lack of immersion and the presence of potential distractions, on the other hand, risk diluting the intensity and impact compared to standard AoH trainings.

One of the external hosts noted large changes in student behavior during the course, e.g. students embodying AoH principles such as "listening with attention and speaking with intention", indicating significant development beyond mere methodological competence. Furthermore, an important outcome was the rapid formation of strong social bonds among students who were new to the master's programme.

Establishing the course as part of an ongoing master's programme provides the course with crucial stability and continuity as well as a degree of protection against the vicissitudes of (for example) new managers or quickly shifting university policies. Furthermore, the stability may, over time, help mitigate resource implications of the labour-intensive AoH structure, for example, by potentially building up an internal hosting capacity at the university.

While there were many challenges, the course itself was highly appreciated by the students, and we believe there are clear benefits to opening up engineering education to methods that prepare students to take on truly complex problems. Methods from AoH help build important skills for leading groups, navigating complexity, embracing uncertainty and focusing on asking better questions — all essential qualities for engineers who can act as agents of change for a better future.

References

Ahlbäck Öberg, S., & Boberg, J. (2024). *Ökad kontroll och ökad byråkratisering: En kartläggning av statens styrning av universitet och högskolor* [Increased control and increased bureaucratization: A survey of state governance of universities and colleges]. Report from Sveriges universitets- och högskoleförbund [Swedish Association for Higher Education Institutions]. Available online at: https://suhf.se/app/uploads/2024/04/Okad-kontroll-och-okad-byrakratisering-Ahlback-Oberg-Boberg-mars-2024-REV-1.pdf

Baldwin, C., & Linnea, A. (2010). *The circle way: A leader in every chair*. Berrett-Koehler Publishers.

Bianchi, G., Pisiotis, U., Cabrera, M. (2022). *GreenComp – The European sustainability competence framework*. Bacigalupo, M., Punie, Y. (editors), EUR 30955 EN, Publications Office of the European Union, Luxembourg. https://repositorio-aberto.up.pt/bitstream/10216/139375/2/527960.pdf

Brown, J. (2010). *The world café: Shaping our futures through conversations that matter*. Berrett-Koehler Publishers.

Cooperrider, D. L., Stavros, J. M., & Whitney, D. (2008). *The appreciative inquiry handbook: For leaders of change*. Berrett-Koehler Publishers.

Daly, H. E. (1977). *Steady-State Economics*. W.H. Freeman, San Francisco

Daly, H. E. (1992). From empty-world economics to full-world economics: Recognizing an historical turning point in economic development. *Population, technology and lifestyle*, 23-37.

Easterbrook, S. (2014). From computational thinking to systems thinking: A conceptual toolkit for sustainability computing. In *ICT for Sustainability 2014* (ICT4S'14) (pp. 235-244). Atlantis Press.

Edmondson, A. (1999). Psychological safety and learning behavior in work teams. *Administrative science quarterly*, *44*(2), 350–383. https://doi.org/10.2307/2666999

Eriksson, E., & Pargman, D. (2014, August). ICT4S reaching out: Making sustainability relevant in higher education. In *ICT for Sustainability 2014* (ICT4S'14) (pp. 40-47). Atlantis Press.

Hock, D. (2009). *One from many: Visa and the rise of chaordic organization*. Berrett-Koehler Publishers.

Kaner, S. (2014). *Facilitator's guide to participatory decision-making*. John Wiley & Sons.

Kurtz, C. F., & Snowden, D. J. (2003). The new dynamics of strategy: Sense-making in a complex and complicated world. *IBM systems journal*, 42(3), 462-483.

Lundquist, L., Sandfort, J., Lopez, C., Sotela Odor, M., Seashore, K., Mein, J., & Lowe, M. (2013). *Cultivating Change in the Academy: Practicing the Art of Hosting Conversations that Matter within the University of Minnesota*. Available at: https://conservancy.umn.edu/items/ba50416f-4ef3-4fc4-b8d8-8b0f806c1ed3

Meadows, D. H. (2008). *Thinking in systems: A primer*. Chelsea green publishing.

Owen, H. (2008). *Open space technology: A user's guide*. Berrett-Koehler Publishers.

Pargman, D., & Eriksson, E. (2013). "It's not fair!" - making students engage in sustainability. Proceedings of the *6th International Conference on Engineering Education for Sustainable Development* (EESD'13).

Quick, K., & Sandfort, J. (2014). Learning to facilitate deliberation: practicing the art of hosting. *Critical Policy Studies*, 8(3), 300-322.

Rittel, H. W., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy sciences*, 4(2), 155-169.

Shaw, M. (1990). Prospects for an engineering discipline of software. *IEEE Software*, 7(6), 15-24.

Snowden, D. J., & Boone, M. E. (2007). A leader's framework for decision making. *Harvard business review*, *85*(11), 68.

UNESCO (2017). *Education for Sustainable Development Goals - Learning Objectives*, United Nations Educational, Scientific and Cultural Organization (UNESCO), France, ISBN 978-92-3-100209-0, https://doi.org/10.54675/CGBA9153

Wheatley M. & Frieze, D. (2006). *Using Emergence to Take Social Innovation to Scale*. The Berkana Institute. https://berkana.org/wp-content/uploads/2020/04/Emergence-Booklet-English.pdf.

Woiwode, C., Schäpke, N., Bina, O., Veciana, S., Kunze, I., Parodi, O., Schweizer-Ries, P & Wamsler, C. (2021). Inner transformation to sustainability as a deep leverage point: fostering new avenues for change through dialogue and reflection. *Sustainability* Science, 16, 841-858.