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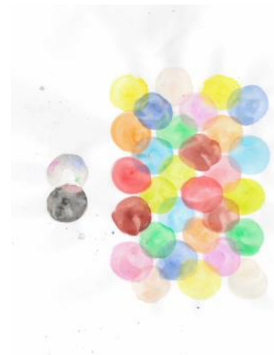

And then I made some pockets of change: Collage-making to think presents and futures of engineering education with

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What stories can we tell to help us rethink engineering education futures? How can we imagine what practices are possible? How can we transgress what hasn't served us, other critters, and the planet? These are questions that inspired us to develop a workshop in which we used collage-making to visualize narratives on current states and possible futures of engineering education. Grounded in Holland et al.'s (1998) theory of figured worlds and Lönngren and Berge's (2024) concept of emotional positioning, the workshop explored figured emotional worlds operating in and envisioned for engineering classrooms.

In this paper, we critically examine reflections of activities from during the workshop and its outcomes to ask the overarching question, how can engineers and engineering educators interact with the figured worlds of engineering to (re)imagine our work, our futures, and ourselves? To answer this question, we consider the workshop a case through which we 1) map out the context and progression of the activity, 2) share examples of collages and their stories, and 3) offer and explore multiple dimensions of critical reflection, thematically analyzing the collages and discussing their use in how they prompted us to imagine, tell, and transgress stories about current and possible futures of engineering education worlds.

INTRODUCTION

In the context of the 2024 Engineering, Social Justice and Peace (ESJP) conference that took place in Gothenburg, Sweden, participants provided and were provided with diverse perspectives and opportunities to (re)think engineering education with. The conference explicitly encouraged contributions beyond traditional abstracts for one-sided presentations on conducted empirical research. Its theme "Another university is possible" further invited everyone to explicitly think about what that "another" could mean. With the title being inspired by Isabelle Stengers' (2018) work, we accepted this visionary and transgressive invitation and developed a workshop in which co-creators[1] used collage-making as an art-based method to reflect on current conditions and possible futures for engineering education. This contribution continues that trajectory and thereby not only aims to communicate methodologies and reflections from the workshop, but also to offer a written example of how research can be conducted and communicated differently. With this said, we ground this work in Holland et al.'s (1998) concept of identity and agency in cultural figured worlds. This framework allows us to (re)imagine current and possible educational practices and prompts us to ask, how can engineers and engineering educators interact with the figured worlds of engineering to (re)imagine our work, our futures, and ourselves?

The need for (re)imagining is born out of engineering education's ongoing struggle to help students develop competencies that allow them to address the wicked problems of this 21st century (UNESCO, 2021). Many scholars argue that this struggle is deeply grounded in the reproduction of hegemonically white-Western-masculine practices, norms of rationality- and objectivity-driven thinking, and the method of goal-oriented problem-solving in which a specific, overly narrow subset of problems, practices, and solutions are prioritized and valued (e.g., Faulkner, 2001; Ottemo et al., 2020; Peters, 2017; Salminen-Karlsson, 2011). The resulting limitations in visions and understandings lead to "solutions" that generate sweeping new economic, environmental, and social problems, often on a global scale. Importantly, these hegemonic ways of doing engineering are being contested along multiple axes. Epistemological movements towards decolonization and sociopolitical awareness, for instance, demand that we acknowledge the situatedness of engineering education and practice (e.g., Cicek et al., 2023; Lachney et al., 2021; Ryoo et al., 2022) and deconstruct traditional dualisms, such as hegemonic nature-culture and emotion-reason divides (e.g., Chance et al., 2024; Paul, 2024). The acknowledgment of engineering and engineering education as situated and social practices is also strongly entangled with challenging the traditions

[1] We use the term "co-creators" for all conference participants who joined the workshop without being involved in its planning. This emphasizes that they not only passively participated in the workshop but actively shaped and co-created its activity. We actively distributed responsibilities across the room, acknowledging everyone to be part of each other's learning process and thereby transgress hierarchies between those who learn and those who teach in the classroom. Co-creators engaged in conversations and discussions during the workshop, as well as interacted with each other in the collage making. Furthermore, six of the co-creators shared their collages and reflections in this contribution and as well as in conversations during the analysis and have therefore co-authored this paper.

that tell stories about engineering that emphasize its practice as solely rational and objective (e.g., Gonsalves et al., 2019; Kotluk & Tormey, 2023; Lönngren et al., 2021a; Lönngren et al., 2021b).

In line with these movements as well as drawing further inspiration from work conducted in science education (Gonsalves et al., 2019; Günter et al., 2021), our workshop sought to reimagine the existing figured worlds of engineering through imaginative and transgressive play, as suggested by Holland et al. (1998) and through that play facilitate emotional and positional reflections. Holland and colleagues emphasize the ways that even as figured worlds embody the dominant stories a culture tells, play provides one avenue through which individuals living in that culture revise, rewrite, and improvise their own stories. This approach, we argue, can help us tell a different kind of story in engineering education, one that transgresses notions of objectivity and rationality and makes space for different subjectivities and, importantly, emotions. Research has only just begun to address the role of emotions in engineering education (e.g., Lönngren et al., 2024; Lönngren & Berge, 2024), including education specifically focusing on engineering ethics and social responsibility as one of many efforts to transgress dominant norms of objectivity- and rationality-driven engineering practice. To facilitate transgressive play, our workshop design explicitly drew on the emotional aspect of engineering, and in this paper, we critically reflect on the process and the outcomes.

To better understand the affordances and further avenues for development of this approach, we first situate the work and provide more detailed context. By sharing details about our ESJP conference workshop we hope to encourage further growth of this playful, material approach to pedagogical practice and research development. Explicitly sharing the workshop's methodology is, thus, one of the focal points in this contribution.

We then provide two layers of reflective analysis emerging from and with workshop co-creators and their collages to deepen the cognitive and emotional engagement with the collage making approach. For the first analytical layer, all twelve co-creators were invited to think and feel with the collage-making process. Six co-creators offered reflections for inclusion in this contribution. For the second analytical layer, the three workshop facilitators[2] engaged in a shared thematic analysis grounded in the concept of figured worlds of the first layer, in conversation with some of the co-authoring co-creators. In this analytical step, we focused on the process of learning with and from others in human-material entanglements and the affordances of collage-making as a play-based and play-full method (inspired by Nørgård et al., 2017) for engineering education learning. This allows us to put forward the second focal point of this work: the use of art-based methods in the process of reimagining engineering education.

[2] We use the term facilitators for the three co-authors who actively engaged in the preparation and facilitation of the workshop and who provided meta-reflections and participated in the writing of the paper (namely Katerina Pia Günter, Marie Paretti, and Johanna Lönngren).

CONTEXT

The conference

This workshop took place during the 2024 ESJP (Engineering, Social Justice, and Peace) conference, where the full conference theme was "*Another university is possible! Theories and practices of change related to engineering education in academic institutions.*" The broader ESJP network as well as the organizers of the 2024 conference explicitly invited conference contributions that disrupted and did not fit the mold of typical academic theoretical or empirical contributions (i.e., introduction-methods-results-discussion papers presented in a single-oral presentation). Instead, they encouraged contributors to submit creative works (including art-based approaches) that would engage participants in activities and co-creation with the goal of discussing "ideas across geographical and disciplinary borders" (ESJP Conference, 2024).

We followed this call by developing a workshop aimed at (re)thinking what another university and engineering education could look like and, even more so, feel like. Grounded in the ideas of figured worlds (Holland et al., 1998) and emotional positioning (Lönngren & Berge, 2024), we developed a play-full workshop in which session participants became co-creators who used magazines, scissors, glue, sticky notes, colored pens and markers, to create collages. These collages were material means to tell stories that a) represent the current state of engineering education and b) imagine its possible futures. This activity was inspired by another workshop co-created by Bas van den Berg, Nadia Kellam, and Helena Kovacs during the 2022 Emotions in Engineering Education Symposium (EEES, 2022). During their activity, collage-making was used as a tool to elicit and express emotions in engineering education and to reflect on the following question: "What emotions are possible in current engineering education and what emotions would you like to be possible in engineering education?" Our workshop is built on theirs, expanding the vision to encompass all the stories we have been telling and what stories we actually want and need to tell about the present and future in engineering education.

The workshop

Like all 2024 ESJP workshops, ours was allotted 90 minutes and took place in a seminar room in which tables were arranged to accommodate four people each. On each table, multiple magazines (published by the Swedish Tourist Association, the Swedish Outdoor Association, the Swedish Association of University Teachers and Researchers, and the Swedish Association for Community Gardening) were provided, along with scissors, glue, and colored pens. Twelve co-creators attended the workshop, collaborating in four groups. Their backgrounds spanned engineering, engineering education, sustainability education, computer science, nursing and health, physics and astronomy, biology, and gender studies.

Theoretical underpinnings of the workshop

In the workshop, we actualized Holland et al.'s (1998) concept of agency and play in figured worlds and Lönngren and Berge's (2024) concept of emotional positioning in engineering education.

Methodologically, we used collage-making as an art-based approach for collaboratively negotiating, improvising, and re-imagining stories of engineering education.

Figured worlds

Imagine a classroom, a space in which roles (e.g., teacher, student), practices (e.g., lectures, assignments), and shared expectations (e.g., teaching, learning) are culturally defined. Without explicitly talking about it, people navigate and make sense of their roles within this space.

In their book *Identity and Agency in Cultural Worlds*, Holland and colleagues (1998) describe these kinds of spaces as "figured worlds," a concept we have used to frame both the design of our workshop and our subsequent critical reflection. Figured worlds are "socially and culturally constructed realms of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 52). In other words, figured worlds can be understood as shaped by histories and human and non-human inhabitants, while simultaneously shaping those histories and inhabitants over time.

Within figured worlds, individuals collectively understand, interpret, and navigate their roles, actions, and relationships. These worlds provide the backdrop or stage on which discourse (language and communication) and storytelling take place. Storytelling is hence crucial in framing what is considered normal, significant, or valuable within a particular context. Holland et al. (1998) map the ways in which individuals use stories to understand and communicate their place within figured worlds, negotiating and expressing identities, navigating social and cultural norms, and building and telling about shared understandings.

Importantly, figured worlds are not fixed entities, but subject to constant negotiation and improvisation. At the same time, change is often restricted by hierarchies of recognition and subsequent reproduction of normative ways of being and doing. The different social landscapes of figured worlds, such as classrooms and other university education contexts, are shaped by and shape "institutionalized 'structures' of power" (p. 57) and the ways in which those structures are (re)produced. Nevertheless, change can be created and actualized through fantasies and creative play, in which imaginations of new realities "take shape within and grant shape to the coproduction of activities, discourses, performances, and artifacts" (p. 51)—in play, imagination can disregard existing hierarchies and creatively challenge normative ways of being and doing.

Holland et al. (1998) thus position play as a critical aspect of both identity formation and, important for our work, agency within figured worlds. Play as an "opening out of thought within the activity" thus "allows for the emergence of new figured worlds, of refigured worlds that come eventually to reshape selves and lives in all seriousness" (ibid., p. 236). Such refiguration, in turn, allows people to explore alternative identities and challenge existing hierarchies within their figured worlds. Contrary to everyday language, where play is typically defined as a purely recreational activity, it is here understood as a key mechanism for identity formation and social positioning. In our workshop, collage-making served as the primary form of play that allowed participants to tangibly and visually disassemble and reassemble stories about engineering education, representing what is and improvising what might be.

Emotional positioning

The concept of emotional positioning (Lönngren & Berge, 2024), grounded in positioning theory (Davies & Harré, 1990), served as the second key framework guiding our design of the workshop and served as a sensitizing concept in our critical reflection. Positioning theory broadly focuses on social interaction and the distribution of power (people are assigned different rights and duties regarding what they can and should do) as people are positioned in specific social situations (Davies, 2023; Davies & Harré, 1990). Focusing on emotional positioning allowed us to intentionally highlight the role of emotions in how people involved in engineering education negotiate rights and duties. For example, people in engineering education can negotiate emotion norms (Hochschild, 1979), that is, who is allowed or expected to express which emotions in a figured world. Similarly, people can position someone as "angry," which can reduce the legitimacy of that person's demands for social justice (this phenomenon is often described as the "angry minority trope"). On the other hand, expressing anger can position another person as having acted wrongly and oneself as occupying a moral high ground. Consequently, drawing on emotional positioning allowed us to draw attention to how emotions are co-constructed and collectively performed in social interaction and how they matter for constituting different social realities in the figured worlds of engineering education. We specifically invited co-creators to explore how engineering education reproduces norms of rationality- and objectivity-driven thinking and to use emotional positioning to elicit imaginaries of possible futures for engineering education.

Progression of the workshop

Engaging and provoking with real life examples

The workshop encompassed two main activities: 1) an initial reflection on several provocative images, 2) a 45-minute work period for creating collages. After a quick introduction of ourselves and the workshop, we began with provocations (Figure 1) captured at different higher education institutions and in the academic literature.

Co-creators were first asked to think in silence about the following questions:

1) What thoughts and feelings come up when you look at these images?
2) What do they tell you about the culture(s) of engineering education, especially related to social justice and peace?

To ensure everyone could share, co-creators were then invited to discuss their reflections with the person sitting next to them and everyone was reminded to listen actively. We explicitly emphasized reflecting on what looking at the images felt like and what thoughts arose on seeing the images and the accompanying narratives (rather than talking about the images themselves), and then exploring what our responses could tell and teach us about the cultures of engineering education.

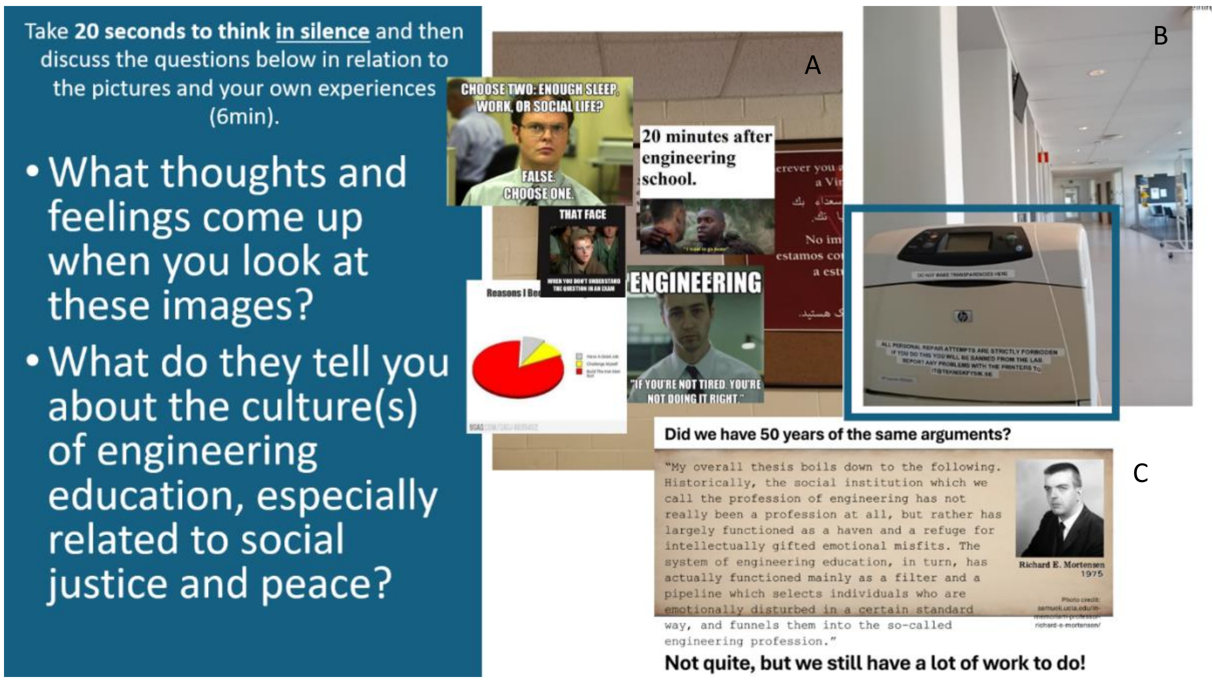


Figure 1. *Provocations presented in the introduction to the workshop. A and B were captured at the presenters' home institutions (A by Marie Paretti at Virginia Tech (memes originally hanging on the wall enlarged for readability in the presentation) and B by Katerina Pia Günter at Umeå university) and C was found in an academic publication from 1975 that Johanna Lönngren has used in previous presentations. A detailed description and the narratives that accompanied the provocations can be found in Appendix 1.*

Exploring with the self, the collages, and each other

We then invited co-creators to spend 45 minutes creating two collages using the provided magazines, their own drawings, and other available materials. We offered two prompts to guide the process: *Collage 1*: What does the current educational and emotional landscape of engineering look like? What does it make (im)possible? *Collage 2*: What does a possible future educational and emotional landscape of engineering look like?

The co-creation period was active, with participants talking amongst themselves, and included a 5-minute check-in at the midpoint. Prompts asked participants to describe their process and what they'd found surprising thus far; following 15-20 seconds of reflection, co-creators debriefed with a neighbor and then returned to work, further guided by the question "How can your imagined future for Engineering education foreground and foster social justice and peace?" (aligned with the conference theme).

Importantly, we scaffolded the workshop not only in terms of content creation and reflection, but also emotionally. Before co-creators began work, we made explicit the personal nature of this critical reflection process and emphasized both that all ideas and emotions were welcome, but also we sought to create a safe space by assuring that co-creators should only share publicly what they felt comfortable bringing forward to the whole group. Sharing personal visions of the present and future certainly benefited the group but was neither required nor expected; the goal was first to inspire individuals, and only second to foster dialogue[3].

Toward that latter goal, the session ended with an invitation for any who wished to share their work, as well as an open discussion around three questions:

1) What differences between your two collages do you see as (a) most significant? (b) most attainable, and for whom?
2) In the exercise, (a) did you feel like you could think freely? (b) how did it feel to do this exercise?
3) What could be your own role in advancing some of the imagined changes to engineering education?

DATA COLLECTION

As a first step in extending the meaning-making process of the workshop to this contribution, we invited all participating co-creators to share their reflections about the process of collage-making about six weeks after the workshop, prompted with the following questions:

1. Looking back, what are reflections you remember having during your work with the collage at the workshop and which ones did you keep going back to after the workshop and until today?
2. How do you recall feeling when working with the collage and when reflecting on the current state and the possible futures of engineering education?
3. How do you think working with the available physical materials influenced your feelings and reflections? Do you recall any ways in which the material facilitated or limited what you could feel or think about?

These written reflections are the empirical basis from which we explore our overarching question: how can engineers and engineering educators interact with the figured worlds of engineering education to (re)imagine our work, our futures, and ourselves? In the following, we will map out the analytical process before sharing the collages and the collage reflections themselves.

[3] While a multitude of feminist methodologies inform both the development of the workshop as well as the collaboration on this publication, two ideas were the most prominent: a feminist ethics of care (Naylor, 2023) and to stay with the trouble (Haraway, 2016).

ANALYTICAL PROCESS

For the analysis of the collage reflections, we weave together thematic analysis (Braun & Clarke, 2006) as an analytical tool and figured worlds (Holland et al., 1998) as a guiding theoretical framework. Thematic analysis provides a structured approach to identifying patterns and meanings in qualitative data, while the figured worlds framework offers a lens for understanding how individual agency shapes and is shaped by the social and cultural contexts of engineering and engineering education. This intertwined approach captures both the patterns in the co-creators' experiences and the broader sociocultural structures that influence their engagement in meaning-making. In line with thematic analysis, the reflections were analyzed reiteratively in multiple steps that both drew on inductive and deductive semantic approaches (Braun & Clarke, 2006; Terry et al., 2017).

First, the three workshop facilitators immersed themselves in the data, individually getting familiar with the co-creators' collage reflections. Importantly, as Braun and Clark (2006) emphasize, our positionality—as both workshop facilitators and analysts, each with our own expertise—informed our analysis. That is, we explicitly drew on our knowledge of what we intended in the workshop as a space from which to consider what participants actually reported experiencing. In addition, our own expertise in emotional positioning, identity theory, figured worlds, feminist and socio-cultural critique, and both science and engineering education created the context in which we made meaning with and through these reflections. Beyond our academic expertise, however, our own backgrounds also informed the meanings we made; two of us were trained as engineers, one as a natural scientist; our graduate studies included English, gender studies, and engineering education; one of us worked as an engineer in industry; we have each occupied both insider and outsider positions in the larger culture of engineering education. Our differences enabled us to talk critically with one another to keep our meaning making rooted in the co-creators' collages and reflections, while at the same time enabling each of us to bring insights that may have been invisible to others. In our own ways we are, in Holland et al.'s (1998) language, improvising, and thus revisioning, the figured world of engineering through this process. Situated in our individual knowledges and backgrounds developing and facilitating the workshop and hence subjective (Haraway, 2013), this analysis step produced general codes such as *material affordances and challenges, (re)produced dualisms,* and *emerging emotions*.

Next, we initiated the patterning of the data. Here, we focused on orientations towards the research questions and towards the co-creators' narratives and meaning making. We invited all co-creators to reread their own and read each other's reflections and to discuss possible themes together in an online meeting. This step not only further integrated the co-creators in the process but also enriched the analysis and helped determine what themes were relevant (Terry et al., 2017). This step prompted conversations about stories and storytelling and made us think about a question inspired by Donna Haraway's (2016): what stories do we use to tell other stories with? The process yielded three candidate themes: *Collage making emotions, material uses and challenges,* and *creative play-based potentials*.

Third, the three facilitators revisited collages and reflections as well as the minutes from the online discussions deductively, grounding this step in the underlying theoretical framing of figured worlds. This grounding helped us treat the candidate themes as possibilities without unproductively reifying earlier discussions to create a thematic narrative (cf. Terry et al., 2017). We focused in particular on how the candidate themes both related to what is considered normal, significant, or valuable within the context of engineering education worlds and what transgressive worlds were figured within and through the play-full activity. This step resulted in a first written analysis that was reiteratively reworked by the facilitators to refine the themes before they were shared with the co-creators.

In a final analytical step, we invited the co-creators to read through and think with the written analysis and share their reflections in written form through comments in the manuscript or communications via email. This final analytical step helped us nuance the proposed thematic narratives and ensured that the co-creators had another opportunity to member check, further acknowledging the co-production and reflexive nature of this piece (Birt et al., 2016).

THINKING THROUGH AND WITH THE COLLAGES

In the following, we share the collages and the associated full reflections from six workshop co-creators. We consider these narratives whole units and argue, as does Catherine Kohler Riessman in *Narrative Methods for the Human Sciences* (2008), for the critical importance of retaining the integrity of original narratives in qualitative research. Her arguments focus on the authenticity, depth, and meaning that narratives convey, advocating for their preservation to respect the participants' voices and the richness of their experiences, which we aim to preserve through presenting the original collage descriptions. We therefore chose to show the full reflections as data instead of telling our own stories about the data supported by selected excerpts (Golden-Biddle & Locke, 2006). In this way, we seek to build on and extend previous examples of co-constructed texts in engineering education, including the collaborative inquiries about qualitative research methods by Walther and colleagues (2017) and Sochacka and colleagues (2018). Keeping these stories whole is, we argue, part of our own remaking of modes of knowledge production in engineering education, our own form of play to tell a different (kind of) story.

Co-creator one

A

B

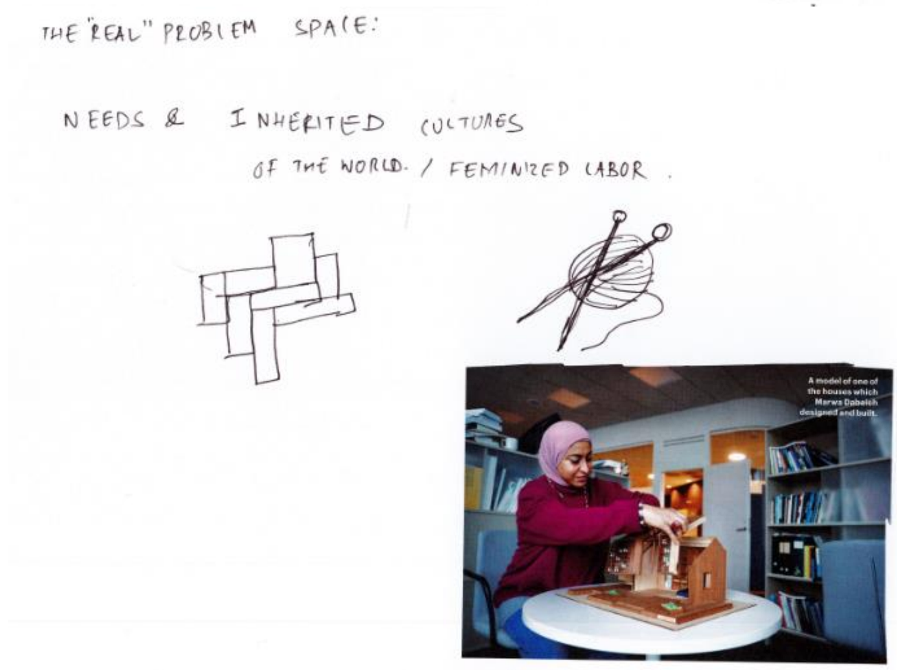


Figure 2. *Co-creator one's collages of (A) what engineering education looks like today and (B) what possible futures of engineering education could look like.*

One of the key reflections I had during the workshop was to consider the “problem space” of what is considered an “authentic engineering problem” in dominant modes of engineering. I thought that the idea of analyzing the imagery and representation of engineering in the world out there was really interesting because it helps us critically evaluate the social construction of “authenticity” (in our case engineering) and how that is a double-edged sword, because it a) devalues the richer space of engineering and problem-solving that does exist and abound around us but in the dominant world (that is, the world of people with power, not the majority world or historically marginalized peoples in the first world) these spaces are not considered as important, valuable and “real” and b) it all but ensures that material and well-compensated human resources are not put to use to solve the engineering problems of “the majority and marginalized worlds” in the same way as problems of the first world. When I sifted through the magazines, I was looking at any imagery related to engineering, its practice and education, and was looking at both the products and the spaces of engineering and how “first-worldly” these representations were or not. As I found some images that countered this construction, I thought about how difficult it is for such countering work to happen in engineering education. Many engineering students might come from “majority world” or historically marginalized contexts but largely work on “first-world” problems. However, there were some images in the magazine that challenged this norm thereby attempting to shift this valuation and hopefully shift engineering education. The feeling I largely had was vacillating between hope and pessimism. I think the materials themselves influenced my feelings and what I ended up focusing on. I was looking at European magazines that had some “diverse representation.” Magazines from Asia, Africa or Latin America, or even Western/European cooking/knitting magazines might have facilitated something else.

Co-creator two

A

B

Figure 3. *Co-creator two's collages of (A) their perception of what engineering education looks like today and (B) what they envision as possible futures of engineering education.*

During the collage-making workshop, I found myself initially struggling to come up with any ideas. I spent several minutes just flipping through the provided magazines to try and get some ideas. The magazines tended to be either outdoor magazines or academic magazines, which felt a bit limiting initially since I spent a lot of time thinking of potential analogies for what I wanted to express with the given materials. I decided to create a two-part collage. In the "Now" part of my collage [focusing on the current engineering education landscape], I focused on things in engineering education that I wanted to change. The main ideas that I found myself thinking about included: (1) how many classes are still lecture-based, (2) how many engineers are still white men, and (3) how many engineering programs have strict program requirements that limit students' pathways to graduation. I also included a section on what I called the "recipe for success", which includes: following the path to graduation, getting approval for your technical work (and nothing else), and earning money in your career. Thinking about this as I worked on the collage made me generally feel quite sad and discouraged about the state of engineering education as it is now. When I was working on the "Future" part of my collage [focusing on possible future landscapes of engineering education], this is where I found the provided materials to be helpful because it gave me a way to be more creative about expressing what I wanted engineering education to be. I also started to feel a lot more hopeful and energized thinking about how I could create the changes that I would like to see in engineering education. For this part, I included photos of people out in a field creating something, interacting with art as an engineer, valuing others' opinions even if they are not white men, and generally trying to support others rather than competing to earn approval. A lot of what I included in this portion of the collage were things I had already been thinking about and am still thinking about in terms of how I want to teach my classes in the future. I would love to expand upon practices such as experiential learning even more by finding ways to bring students out of the classroom into spaces that are more conducive to experiential learning. This way students don't need an internship or research fellowship to access these experiences. I also made sure to specifically include an image about including art in engineering. During this part of the collage-making, I remember thinking about my first conference where I learned that people do engineering research on origami, the art of paper folding that I grew up doing. I remember being somewhat upset that I did not know studying origami was an option as an engineer. By including arts in engineering education, I want to help future students avoid having this experience. Overall, I found the collage-making process to be quite cathartic because it gave me a way to put what I found discouraging into words and pictures, and then what I found encouraging into a physical form.

Co-creator three

A

B

Figure 4. *Co-creator three's collages of (A) what engineering education looks like today and (B) what possible futures of engineering education could look like.*

The reflections I made during the workshop were very much influenced not only by the general mood and ideas represented at the conference but also by current trends in engineering education, e.g. in CDIO (Conceiving — Designing — Implementing — Operating), in promoting a more holistic role for engineers. It is also influenced by my working on Bildung and engineering from the perspective of Bildung being a process where you are able to connect your field to society and politics, and as such become an engaged citizen (also) on the basis of your professional skills and knowledge.

As such I wanted to stress moving away from a traditional (tradition represented by the julbock) role of engineers being (only) concentrated on numbers, production, equations, industry economy and management, towards a future role of engineers taking into account the whole of influence engineering has on both humans participating in creating, but also using or being used (?) by technology, and not least nature and the impact on the non-human environment.

When working with the collage I felt a bit conflicted, as the result was perhaps not traditional in the sense described above, but relatively mainstream within the trends I initially mentioned. Had I merely exchanged one dominant discourse of engineering with another? How free was my thinking really? On the other hand, the possibility of working a bit more creatively was invigorating.

The physical materials created an opportunity to get ideas from e.g. flipping through a magazine and instantly connecting an image to something. It could at the same time be limiting in the sense that you had something you wanted to express, but could not find an appropriate illustration, but for me, I merely made a couple of small drawings in addition, so it was not really limiting.

In retrospect, perhaps it is the elements I put into drawing I am most pleased with. The traditional "engineering arrogance" (everybody else are idiots) vs. an IT department that actually thinks about the users of their solutions. Then again, this might be because they are pet peeves I have had for years.

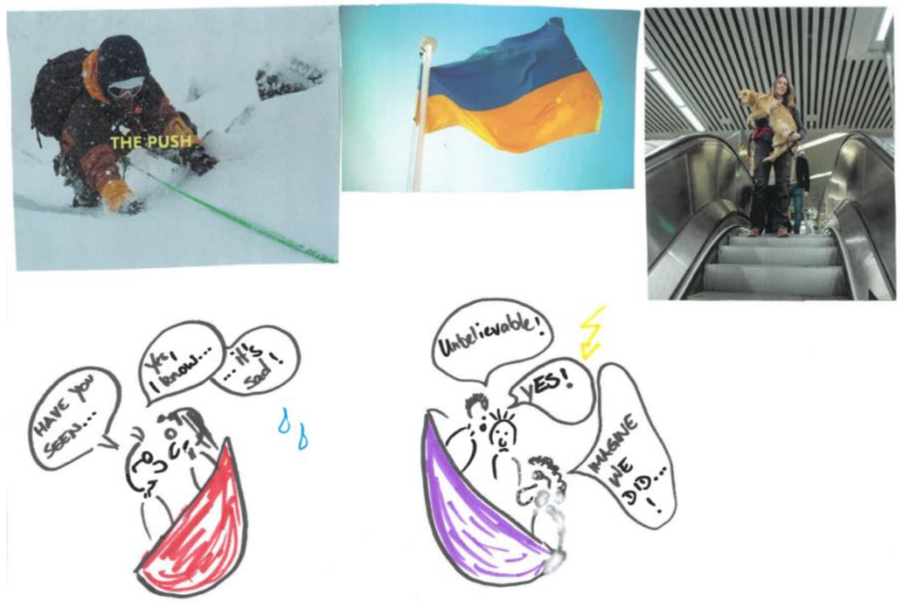
Co-creator four

Co-creator four did not share their collages but provided the following reflections on the collage making process.

I found the exercise a little difficult since I haven't been through an engineering education, and it seemed that everyone else had. Thus, my reflections stemmed more from working with engineering teachers and students in a professional capacity rather than my own experiences of the education. What I noticed was that in my impressions of the current situation, I had a rather more positive interpretation than those around me who chose pictures of a white male dominated environment with one way communication—almost military like—with low tolerance and a focus on machines/technology rather than people and nature. While there are elements there that I certainly recognized, I also wanted to highlight the dialogic nature of the discipline with a lot of group work and co-creativity. I also wanted to show the changing nature of the discipline where I experience initiatives in interesting directions as concerns diversity, inclusion, ethics and representation. My future perspective (or was it our dream scenario?) was to continue these trends further with more awareness of nature, of people and the interaction between these groups.

Co-creator five

A



B

Figure 5. *Co-creator five's collages of (A) what engineering education looks like today and (B) what possible futures of engineering education could look like.*

The first collage shows “pockets of change”, i.e. groups of people who care about our world, see that there are huge problems that should be addressed. One of the pockets shows two persons talking about what they see is going on, which may e.g. be an observation of structural discrimination, and share a view that it is sad. The other pocket shows a person who seems angry, shouting “Unbelievable!”. The other person confirms this emotion, while the third person takes this further talking about what they could be doing in response to this (“Imagine we did…!”). While some speech bubbles show the conversations, they leave open what the issues discussed are about. I did this purposefully, because I think we have so many interconnected, deep issues. I am thinking of our times that sometimes are described as “poly-” or “meta-crises”.

Above the “pockets of change”, three images convey my perception of the status quo—ongoing dynamics that seem to hinder broader transformation. These forces limit change emerging from the “pockets of change”. For example, the Swedish flag represents nationalism, reflecting an increase in right-wing or anti-democratic governments primarily focused on national interests. For example, nationalism restricts the pursuit of equitable climate change mitigation. Countries already experiencing severe climate impacts, typically poorer and with limited power, contribute the least to the problem yet face the greatest risks. Meanwhile, wealthier nations often prioritize preserving their consumption-driven lifestyles and power positions, rooted in modern-colonial legacies, rather than addressing the harmful impacts of their choices on vulnerable countries (Stein et al. 2023). The image on top, to the right, shows someone carrying their dog on an escalator, in what seems like a modern building made of smooth, grey, metal material produced by our celebrated engineers. I was thinking of our relationship with nature and how it has deteriorated. We still have our dog but are moving a lot in spaces that seem quite separated from the living world. The image in the top-left shows a person fighting their way up in a snowy landscape. I was thinking of it as representing the coldness in our environments, which ask us to “push” and “fight”. We are protected not to fall, we have the equipment, but it is still cold and stormy, and we are alone.

The second collage collects some impressions of what I see in a more desirable future. I see community and togetherness and being with that which is important, e.g. food (image to the bottom right). I also see us being together and relating to other living species, like dogs (image to the top right) and all living things. We also value, protect, and care about natural landscapes, mountains, water etc. We have found ways to relate and deeply connect to nature (image to the right, in the middle). The big image to the left shows a group of people being and moving together, all sharing a direction (a viable, livable future for all). Some people might explore their own paths, but they still are connected to each other and the world through care.

A few words about myself: I am working as an “educational developer” for sustainability at a technical university in Sweden. I teach staff at our university (mostly engineers or natural scientists) and develop this teaching. I also do research. I have a background in computing, which is positioned in mathematics, engineering, and natural science. As such, my thoughts are about engineering, but I also have a strong wish for inter- and transdisciplinary thinking, which is why, perhaps, my reflections on the current educational and emotional landscapes of engineering may appear as not being about engineering.

Co-creator six

A

B

C

Figure 6. *Co-creator six's collages of (A) what engineering education looks like today and (B) what possible futures of engineering education could look like. Both collages were joined to form a slide with two sides (C).*

My collage represented two slides, like the ones you'd find in a playground. They were joined at the top, with one common staircase to get there. Each of the steps had the Swedish word "jobbigt" ["tough" or "troublesome" in English] written because going through an engineering degree was presented to me, and I experienced it to be, hard and unpleasant. As an educator, I think students still share these emotions and beliefs. I really want to change this: things can be complex and yet intriguing, fun, without unnecessary discomfort or barriers.

The staircase also represented the feeling of "making it to the top" when becoming an engineer. This competitive aspect was reflected in one of the slides, with representations of "teams" where the leader is a privileged person taking most if not all of the credit (and finding representations of privilege in magazines is anything but hard). This is an example of what this slide represented: current engineering education and all the times we say, "let it slide". I was frustrated and angry, while it was also cathartic, to graphically represent concepts such as "exploration" being really acts of colonization. I felt shame coming from a colonizing country and being too aware of all the unpacking I still need to do, of all the harm I'm (un)knowingly part of. Shame that I shared that presentation of engineering as obscure labyrinths that only "true engineers" can solve. It was hard to realize that many of these attitudes were not only in my past, but I still have to work a lot on them, as they come afloat when I least expect them. It also motivated me to continue being part of social justice and peace networks, to help me with this personal learning and work.

The other side was inspired by the slide being one of my kids' favorite things to do on the playground: the feeling of excitement and joy, controlled risk, and inner exploration. Co-creating a world where we work together, fueled by love and kinship understood in broad ways, where care is shared and valued by all. When I see my children play, they remind me of how this kind of world can be possible. I had a similar experience exploring my queer identity, enjoying discovering new things about me and others, becoming more comfortable with things not being very defined or constrained in a binary, and reflecting on how my identity fit in my life and in engineering education. These memories were partly triggered by the material provided: lots of nature, rainbows, smiling children. To me, these materials transmitted and created a feeling of freedom paired with the responsibility of taking care of other (non) human beings and the planet. I felt hope. Because if there was anything I couldn't find around me, I could always draw what I was able to imagine.

META-REFLECTION ON THE WRITTEN REFLECTIONS

Guided by the principles of thematic analysis, our collaborative meta reflections yielded three themes: *Catharsis, frustration, hope as a salient emotional constellation; Materiality as enabling or limiting the making of collage stories;* and *Potential futures of this activity as a way forward*.

Catharsis, frustration, and the spark of hope

In reading the emotional responses of co-creators, we came to see the ways in which the collage-making process offered a form of emotional catharsis, enabling co-creators to confront the stories told about shortcomings of engineering education while envisioning potential futures. Co-creator six, for example, described feeling both frustrated and liberated when addressing themes of colonization, inequality, and exclusion in engineering. The exercise allowed them to "graphically represent concepts such as 'exploration' being acts of colonization," acknowledging the discomfort of these realizations while finding a release in creatively addressing them. Allowing co-creators to work predominantly in images thus perhaps helped open space for emotional experiences and expressions that are often excluded from traditional modes of academic thought and engagement centered not just on words, but on written text. Catharsis has been described as one of the powerful effects of storytelling (e.g., Aleong et al., 2017; Banks-Wallace, 1998; Molthan-Hill et al., 2020; Rose, 2017). While not a traditional Western mode of academic knowledge production, storytelling is a tool deeply rooted in indigenous and feminist practices (e.g., Fearon, 2024). In fact, Holland et al.'s work on gender and culture in Nepal emphasized the role of women's narrative play in opening up new ways of, for instance, understanding gendered roles and identities (Holland et al., 1998).

This cathartic process often shifted to feelings of hope when co-creators focused on future possibilities. When crafting the "future" section of their collages, one co-creator noted, "I started to feel a lot more hopeful and energized thinking about how I could create the changes I would like to see in engineering education." Another expressed a sense of joy, envisioning "a feeling of freedom paired with the responsibility of taking care of other (non) human beings and the planet." These reflections demonstrate that confronting existing issues while imagining alternatives can yield an empowered, hopeful outlook on the future of engineering education.

Importantly, we distinguish here different kinds of hope emergent in our co-creators' reflections. While a certain techno-optimism often characterizes engineering work and education and rather reinforces technological solutions for sustainable development (Knutsson, 2018), we here find a hope that does not build on technology as the only solution. Transgressing a technology-centered hope, which risks obscuring the deeper ethical and political entanglements of technology, necessitates a more critical approach to both hope and technology. Drawing from Zembylas' (2015, 2023) concepts of the pedagogies of discomfort and pedagogies of dread, this activity allowed us to engage with the unsettling realities of technological implications, transgressing a certain techno-optimistic perspective, fostering both discomfort and critical reflection, while at the same time struggles with not providing artifacts with which that techno-centrism could be expressed. As seen in sustainability education, acknowledging eco-anxieties and discomforts can be a productive space for reimagining futures beyond mere optimism (Eriksson et al., 2022). This collage-making exercise, by visually representing acts like exploration through colonialism and dominances of whiteness and masculinities, exemplified how grappling with discomfort can generate transformative learning moments. As we will further discuss, the materialities of the activity played a crucial role in shaping the collage-making experience. While the material itself evoked the brightness of nature, it paradoxically enabled engagement with the world's pain and darkness, highlighting the tensions between comfort and discomfort in confronting complex issues.

At the same time, the reflections underscore, however, how varied experiences and perspectives of engineering worlds shape divergent narratives about engineering education. While the dominant idea of the present is commonly understood as rather depressing, frustrating, and hopeless as it recognizes the ways that engineering education often emphasizes not only unconsidered techno-optimism but also exclusivity and hierarchy, co-creator four, who had not undergone formal engineering education, had a more optimistic view of the field, highlighting practices involving group work and co-creativity. This contrast highlights how external or indirect experiences of engineering education can diverge significantly from firsthand perspectives, shaping different narratives about its practices and values. That is, even as we all reflect on the same cultural world, our perspectives and therefore our emotional responses may differ. Play here thus also becomes a way for us to see each other differently and opens up space for reflections on how enculturations into engineering worlds shape and induce shifts in perspectives.

Generally, these emotional trajectories and differences elicited by the play of the collages prompt us to ask what constraining stories we have been (re)telling about engineering education. Many of the academics at the conference were engineering educators working actively for change, operating from within and drawing on research that emphasizes the restrictive hegemonies of engineering and engineering education. Those are the same stories we drew on in our framing of the images and text in Figure 1 to open the workshop. But our own reflections as co-creators' also served as a reminder that we may be telling ourselves only part of the engineering story, which is also visible in co-creator four's perspective of someone who is not directly in engineering or engineering education. They see engineering education in a more positive light than the other co-creators, highlighting the affordances of a certain distance to the normative discourse. Even if the depressing and inequitable appears to be the most dominant, loudest part, we are here encouraged to also remember to look for the places where the narrative runs in other, hopeful, directions, reimagining worlds of engineering education.

As this theme draws on complex emotions, we may want to explore ways in which engineering education is and can be emotionally positioned as spaces full of hope, empathy, and care for people and planet rather than apathy or (only) passion for technology.

Materialities: Enabling and limiting collage storytelling

Reflections on affordances and challenges of the use of magazines as materialities for collage making prompted further reflections about materialized visual stories and storytelling. Building on Marilyn Strathern's work and the idea that "it matters what ideas we think ideas with" Haraway posits, "it matters what stories make worlds and what worlds make stories" (2016, p. 12). These ideas provided important inspiration for the second theme, focusing on how the material mattered when making the collages and imagining—figuring—present and possible future worlds of engineering education.

In and through the process of reflecting and discussing collectively, we came to understand that the magazines and their illustrations provided physical artifacts which afforded or limited building the figured worlds co-creators wanted to build. That is, even as we wanted to use artifacts that would allow for playful improvisation, those artifacts were themselves part of what Holland et al. (1998) frame as the historical figured world(s) that came before the workshop. As raw materials the illustrations were (re)purposed to (re)shape their own stories about present and possible future engineering education. Hence, the (un)availability of certain imagery and, with that, certain materialized stories, fundamentally shaped the process of collage-making in terms of what thoughts were thought, what stories were developed, and what improvisations co-creators engaged in to create stories for which they could not find the physical raw material among the texts and images provided. This constraint is in line with Haraway's (2016) challenge to consider the power of stories in not only constructing other stories, but in constructing imagery of the figured worlds we inhabit. Many co-creators highlighted the ways in which the materials used in the collages—primarily Scandinavian nature magazines with limited diversity of representation in terms of both people and ideas—both enabled and constrained the stories depicted in the collages. For instance, co-creator three noted that while the materials provided "an opportunity to get ideas," they also felt limiting due to a lack of images that fully represented the range of stories they wished to tell. As co-creator two observed, "the magazines tended to be either outdoor magazines or academic magazines, which felt a bit limiting since I spent a lot of time thinking of potential analogies for what I wanted to express with the given materials."

This challenge and tension led co-creators to draw additional elements or create counter-narratives, improvising with additional materials such as pens and markers, transgressing the materials' limitations by adding a third dimension to the 2D-space, and using improvisations as springboards to challenge dominant narratives. This dynamic suggests that materials served not only as resources but also as catalysts for re-imagining the boundaries of the "story-able" within engineering education and prompted thoughts about what is part of the dominant narrative that is not visualizable with the given material. Improvisation, which Holland et al. (1998) describe as spontaneous and adaptive ways in which individuals navigate, reinterpret, and reshape their identities and roles within social and cultural contexts, became an essential tool for co-creators who wished to convey stories otherwise absent in the physical materials.

Notably, however, even though additional creative materials were available in the main room of the conference, just downstairs from where we were working, none of the workshop co-creators gathered or used these other materials; they engaged only with the materials provided within the confined space of the workshop; there was, perhaps, an operative part of the academic figured world that constructed and constrained "conference workshop behavior" in terms of both available time and appropriate practice. Thus, the materials and the setting unintentionally narrowed the scope of what stories could emerge. Had the workshop been held downstairs in the main room, where a more expansive set of art materials were available, the collages could have emerged differently. Similarly, had we worked outdoors, co-creators could have had access to a more open emotional space (the workshop room was quite small) and natural as well as additional human-created materials through which to tell stories. As Holland et al. (1998) explain, improvisation of new stories through play occurs in part because we all move through multiple figured worlds and occupy different positions in different worlds; agency operates as we bring pieces from one world into another to tell the story differently. In some ways, our workshop offered elements from other figured worlds, but in other ways, we perhaps thought too narrowly or were constrained in our own ways by existing social and material relations. This process of meta-reflection itself opens new possibilities for thinking not just about what stories we tell, but how we tell them, what we draw on to tell them, and where we stand when we tell them.

We also noted how the materials could influence emotional positioning of engineers, engineering students, and co-creators themselves. For example, co-creator one noted that "the materials themselves influenced [their] feelings." As we discussed this comment in the online meta-reflection, we realized that the outdoor magazines were full of images showing people who were positioned as caring for and thriving in nature. On the other hand, one co-creator had also found an image of a rifle (in Sweden, outdoor stories are often entangled with hunting stories) made it possible to position engineering education today as violent, impersonal, and inflicting suffering.

One co-creator used photographs to emotionally position engineering students today as "serious" and working engineers as experiencing "no joy". The same co-creator's collage for the future, on the other hand, included a photograph of a smiling person. Another co-creator literally positioned people who experienced and expressed emotions (care about the world, sadness and anger about current situation, excitement about possible actions for change) in isolated "pockets," thus indirectly positioning the rest of engineering education as uncaring, emotionally disengaged, and "cold." A third co-creator used a picture of a wooden sign saying "Kärleksstigen" (in English: the path of love) in their collage for the future, clearly positioning the future as characterized by a strong, positive emotion (love), while the journey of engineering education was illustrated through a staircase as a "tough" struggle to the top. This co-creator also offered a more nuanced emotional positioning for future engineering education: "things can be complex and yet intriguing, fun, without unnecessary discomfort or barriers." This positioning is much in line with contemporary research on science and engineering education as inherently emotional, but not unnecessarily discomforting (e.g., Lönngren et al., 2024).

Finally, the physical materials allowed co-creators to not only develop an increased self-awareness through the use of the material, but also to emotionally position themselves in ways that could strengthen their agency to work for positive change in figured worlds of engineering education.

For example, co-creator six positioned themselves as ashamed as they reflected how they had used images "to graphically represent concepts such as 'exploration' being really acts of colonization." This self-positioning as feeling ashamed reminded them of "all the unpacking [they] still need to do, of all the harm [they're] (un)knowingly part of" and of the hard personal and professional work they want to do to keep working for social justice and peace.

To foster inclusivity and social justice, engineering education must re-evaluate the dominant narratives in figured worlds of engineering education that often prioritize competition, hierarchy, and technological detachment over care, collaboration, creativity, and ecological sensitivity. As these meta-reflections reveal, building a resilient, socially responsive engineering practice will require confronting and transforming the "stories that make worlds" within engineering education.

Potentials of the collage-making design

The emotional arcs of our co-creators and the opportunities created by shifting from words and texts to images highlights the potential not only of play as described by Holland et al. (1998), but also of speculative thinking, as Isabelle Stengers (2018) describes it, as a means of envisioning "another" engineering education. Working against the constraints of the provided materials, some co-creators embraced anarchy by going beyond the available images to create their own drawings, write new elements, and transform the two-dimensional paper into three dimensional structures. This act of "thinking-with" the material, as Stengers puts it, allowed co-creators to "relay" ideas through materials, collaboratively expanding the boundaries of what engineering and engineering education practices could become. So, what are the possible futures of the collage-making activity? How can we take what we learned and envisioned in this space and move forward to not only imagine another university but enact one?

In addition to rethinking how the material resources we provided shaped participants' play, this final theme focuses on how the larger practices and design of the workshop operated to constrain and/or enable improvisations of a new future. We could observe both topic emotions (related to the content of learning), as well as epistemic (related to learning processes), achievement (related to success or failure), and social emotions (related to social interaction, e.g., Pekrun & Linnenbrink, 2012) in the process of collage-making.

First, even as our reflections highlight the expansive emotional opportunities of the collage-making process, our reflections on the role of materiality in the workshop reminded us to re-examine the stories we are telling ourselves about engineering; our framing and choices constructed a situation in which we made space for retelling how terrible engineering is today, but they also constrained the range of available stories. For example, what would have happened if we had provided engineering magazines? In many ways, the absence of such images pushed different kinds of thinking because the existing materials did not provide many representations of the "technical" (apart from, for example, technical equipment for outdoor activities), instead emphasizing the "natural." But the absence of technical imagery may also have limited co-creators' opportunities to find hope in the technology-focused present. Similarly, what if the magazines had not provided a source of hope through their connection to nature? Or, as asked earlier, what if we had worked in a different space (indoors or outdoors), with different art materials? What could the activity have become if we had provided a different set of magazines to all co-creators or if we had provided different groups in the same room with different magazines? Or if we had provided other types of printed media such as newspapers with information on past and current affairs? Would that have impacted the playfulness of the activity? What could have happened if the group had been even more diverse in terms of identities and disciplines? What stories could have emerged if we had intentionally selected magazines at a bookstore rather than using materials that we as facilitators happened to have available and that were closely connected to how we tended to narrate our personal stories? These questions can challenge us all to continue exploring new spaces for ever more expansive ways of telling stories about the present and the future of engineering education.

Second, in this cathartic process, we noted that our framing of the collage-making activity was rather dichotomous, focusing on engineering education today (implicitly: something that should be changed) versus what it could become in the future. This framing implied that (only) "new" ways of doing are needed, an idea that was also made explicit in the conference theme, and it did not invite reflecting about what is there to keep. It was only because one co-creator did not share the experience of having gone through engineering education that this limitation became visible. Hence, we wonder what would have happened if we had started with a different framing, for example explicitly challenging the dominant discourse about engineering education but also encouraging people to think about positive elements we wish to preserve, build on, or strengthen. Thus, not just the materiality of the workshop, but also its discursive framing, can be further developed to explore increasingly productive and intentional ways in which we can use stories to co-construct our futures.

Finally, building on the question of what to keep, we see how the collaborative structure of the workshop helped the co-creators tell new stories. For example, we could see how telling and listening to each other's stories could allow co-creators to disrupt taken-for-granted narratives in constructive ways. We could also see how co-creators' diverse identities and perspectives helped to identify differences between stories and therefore making those differences available for discussion. Thus, it was not just the process of making one's own collage, but also that of looking at and hearing about others' collages, that allowed new stories—and new variations on old stories—to emerge. In the same way, the meta-reflective processes we engaged in as we read about and discussed co-creators' experiences allowed us to continually renegotiate and expand the stories we tell, both in this contribution and in future discussions, on how we can create spaces for co-creating desirable futures, through critical conversations, playful imagination, mutual care, and concrete action for change.

CONCLUSION

This collaborative contribution has shown how the material, social, and relational elements all contribute to the narratives we create, produce, and reproduce. Through reflecting on the workshop methodology as well as analyzing the co-creators' reflections, we could visualize and problematize how playful art-based methods can help us reimagine worlds of engineering education. By staying cognitively and emotionally engaged with different troubles we face today and having methodologies that make that staying and its transgressions through imaginations and speculative thinking possible, can we collectively figure, envision, and work toward a more inclusive and resilient future in which engineering education values diverse experiences, social responsibility, and the co-creation of knowledge. Again, the idea of stories and storytelling became central in the reflections in this piece and made us think about Donna Haraway's (2016, p. 12) claim, "it matters what stories we tell to tell other stories with." The questions of what stories we tell and what stories we *need to* tell will accompany future efforts to transgress engineering education practices that no longer serve the planet, other critters, and ourselves to make it possible to co-create further pockets of change.

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POSITIONING STATEMENTS

Katerina Pia Günter (she/they) identifies as a queer woman who is strongly influenced by moving across geographies and communities (born in Germany with ties to Greece, making kin in and with lesbian and queer two- and four-legged communities in the US, living in Sweden). Being the first in her family to afford a Ph.D. degree with an academic background in biology, gender studies, and science education, They value transdisciplinary and transnational norm critical epistemologies and collaborations across communities. Particularly inspired by the work of Sara Ahmed, Donna Haraway, Robin Wall Kimmerer and bell hooks, Katerina not only finds herself in the realm of intersectional feminist science education but also transgresses fields of knowledge production towards Science and Technology Studies. Central to these transgressions is an interest in how to reimagine community building in educational spaces and what higher education could look like, as well as queering practices and retying human-non-human entanglements, guided by thoughts and worlds of restorative and regenerative critical and feminist pedagogies.

Virginia Grande (they/them) is a non-binary queer immigrant in Sweden with Spanish roots, which, as with other aspects of their identities, leads to a frequent background feeling of not fully belonging to the expectation, often presented as a forced choice between binaries that they do not make sense of. With temporary academic contracts, a background in computer science and a PhD in computing education, they experience academia as an unstable rigid space that needs, even if it resists, change. Being part of research communities in STEM education that dare to think and feel differently has been infectious, inspiring Virginia to use their privilege to, for instance, organize three editions of HCEE (Humanization of Computing and Engineering Education) to further strengthen ties between academics working for futures that elevate emotions and care.

Samantha Hoang (she/her) is a cis-gendered Asian American woman whose parents immigrated to the United States from Vietnam following the Vietnam War. She is the first person in her family to earn a Ph.D degree and pursue a job in higher education. Samantha earned her bachelor's degree in general engineering and a master's degree and Ph.D. in mechanical engineering. During the pursuit of her graduate degrees, she became disillusioned with the current structure and environment and academy due to the competitive nature of the academy and how it seemed to not care about her personal values. As a result, she is transitioning away from traditional mechanical engineering research to conduct research in engineering education where she is interested in research how to improve the student experience both in and out of the classroom. As a new faculty member, she is focused on expanding her experiences and challenging herself with new perspectives while navigating the promotion and tenure process.

Ronny Kjelsberg (he/him) is a cis-gendered white Norwegian male. Having grown up on a small mountain farm at the time run by his grandparents, he has a mother who had taken kindergarten teacher education and was as such not a first-generation student when entering university. The topic of theoretical physics was however far removed from the shorter, more professional educations more common in the surroundings he grew up in. After studying he got a job teaching physics at an engineering college but also engaged himself in politics and labor union work, the combination of which created a particular interest in working class students in engineering programs, and how engineering intersects itself into society. After a merger in 2016 he is now working at the Department of Physics at NTNU, where he is currently also deputy head of department for education.

Darakhshan Mir (she/her) is read as South Asian, but grew up in the valley of Kashmir under Indian occupation at the cusp of Central and South Asian cultures. She is currently an Associate Professor of Computer Science at Bucknell University in Pennsylvania, USA. She ended up studying Computer Science & Engineering in the Northeastern state of Assam in India (~3000 km from her hometown) after high school because of a box she had checked on a form on an engineering colleges entrance examination, having very little idea of what it was. She had barely used a computer and accessed the Web up until then (Internet access in Kashmir was heavily restricted by the Indian state, and unavailable to the larger public until about 2003) and had never programmed before. She arrived at college two months later than everyone else (due to delays in getting her high school graduation certificate) and sat in her first "Introduction to Programming in C" course which was halfway through the semester faced with a Unix prompt that she had no vocabulary or context to interact with. This experience fundamentally shaped her approach to learning and still informs her pedagogy. Her scholarly and pedagogical interests are centered around efforts to transform the discipline of computing, the knowledge and technologies we create, and therefore the world, to be more equitable and less unjust. Over the last few years, her scholarly efforts have focused on a transdisciplinary project with colleagues and several undergraduate students at Bucknell that investigates the ideologies encoded in algorithmic decision-making in the criminal legal system to understand their impacts on incarcerated people. Through her pedagogical and community-building efforts, she aims to challenge entrenched notions of meritocracy in Higher Education in general and STEM in particular.

Anne-Kathrin Peters (she/they) identifies as a cis-gendered woman and also feels comfortable with the pronoun they/them, moving along a more fluid spectrum of gender. She grew up in Berlin, Germany and moved to Uppsala, Sweden, 14, years ago, a shift that became part of a broader journey of self-understanding. A central part of this journey has been questioning the fields of knowledge and practice she is a part of, how they shape her and how she might influence them. She studied computer science and, struggling to make sense of this field and her role within it, also turned to education. She later worked as a school teacher with the subjects mathematics and computer science, yet her questions about the role of computer science and technology in society led her to research norms, values and power relations in education, especially in technical and STEM education. Today, she works at a technical university, doing research, educational development, and teaching to contribute to educational and societal transformation towards equality and sustainability. She likes to see herself as an "undisciplined academic" with a strong desire to do something meaningful in these perilous times.

Marie Paretti (she/her) is a cis-gendered White woman whose grandparents immigrated to the U.S. from Europe at the beginning of the 20th century. While she is technically a first-generation college student because neither of her parents attended college, both her parents have siblings who graduated from very prestigious U.S. universities, which afforded her a high degree of motivation for and comfort with attending a university and pursuing graduate degrees. She is both an insider and an outsider in engineering, with a bachelor's degree in chemical engineering and a master's degree and a Ph.D. in English. She thus moves back and forth freely across technical and social science/humanities domains, equally at home in and troubled by (and troubling) multiple fields. As a professor in Engineering Education at Virginia Tech, she has the freedom to spend much of her time studying the present state of engineering education and imagining different futures. As the co-founder of a journal in the field, she has also both helped reify some academic publishing expectations and challenged others; much of her life, as with her contributions to this paper, walks among multiple figured worlds in ways that are always both/and.

Johanna Lönngren (she/her) is a cis-gendered White woman with a strong international and interdisciplinary identity, often accompanied by an experience of almost being part of the norm, but still not quite fitting in. Geographically and culturally, Johanna has equally strong ties to Germany and Sweden, and she has been influenced by living, studying, working, and travelling in many other countries. Disciplinarily, Johanna has studied/worked with organic gardening, engineering, ethics and sustainability, classical music, traditional boat building, and engineering education research. Today, Johanna is privileged to hold a permanent position at Umeå University in which she has agency to choose which academic communities and practices she engages in. International communities of engaged scholars, such as the emotions in engineering education network, provide inspiration, empowerment, and care. These communities also provide spaces for collectively grieving over looming crises and inadequate responses as well as sharing and building hope that we still can work for a better future, through a combination of research, pedagogical development, community building, advocacy, negotiating, resourcing, and norm breaking.

APPENDIX

Provocations

During the introductory presentation to the workshop, we used three pictures and stories taken from our respective contexts and in one case previously used as a provocation. In the following, we describe the content of the pictures used and the tension and provocation we hoped to provide with them. All provocations were shown on the same slide together with two questions that the co-creators participating in the workshop got to reflect on and discuss in small groups.

Marie's provocation

Figure A1. *The first provocation was a picture taken by Marie Paretti in a corridor at Virginia Tech in the USA, showing a welcoming sign in multiple languages next to memes about engineering education.*

The first provocation was a picture taken by Marie Paretti in a corridor at Virginia Tech. The picture shows a sign that welcomes students in a variety of languages (among others Arabic and Spanish) sitting on a wall in the main corridor of the engineering building at [University in the USA]. To its left, there is a whiteboard on which students taped different memes related to engineering education. In order to make the memes readable, they were enlarged for this visualization. The memes convey ideas about engineering and engineering education to be difficult and hard, being done well to lead to not getting enough sleep and social interaction, yet also to be about being challenged and a certain nerdiness (building the iron man suit).

The whiteboard displays norms of hardship with a potential to being associated with meritocratic and exclusionary ideas about the survival of the hardest/fittest and consequential exclusion of some from and in the practice, stand in strong contrast to the welcoming board. This contrast we used as the first provocation in the introduction to the workshop.

Katerina's provocation

Figure A2. *Picture of a printer in the student corridor with multiple labels on it that say: "Do not make transparencies here" and "All personal repair attempts are strictly forbidden. If you do this, you will be banned from the lab. Report any problem with the printers to [university email]".*

The second provocation is a photograph taken at Umeå university, in a corridor in which both engineering, physics, computing and mathematics students have access to computer rooms, learning spaces with desks and screens, a kitchen to warm up their lunches, and the student representatives' room. The photograph shows a printer which was labeled with instructions to not attempt any repairs in case of malfunctioning. While this only is an assumption, the label might indicate that previous attempts were made (maybe even unsuccessfully).

While the learning spaces are inviting and provide students with a variety of resources on a trust basis (they have access to these spaces 24/7 with their campus card), the labeling on the printer explicitly denies any explorative and hands-on repair attempt which, Katerina argues, could be part of an engineering identity and habitus. A tension emerges between invitations for collaborative and creative learning and an explicit denial of possibilities to apply knowledge and competencies.

Johanna's provocation

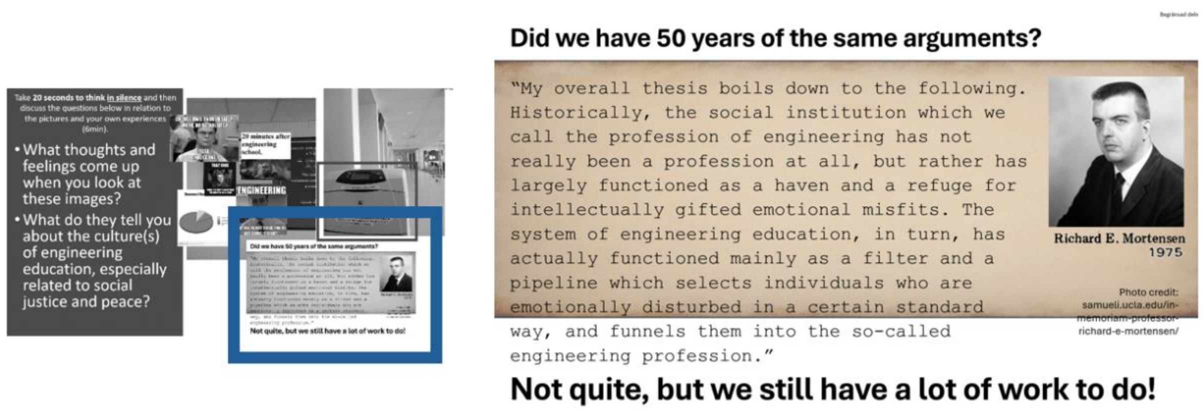

Figure A3. *Picture of a slide reproducing a quote from an article published in Communications Society in 1975.*

The third provocation shows a PowerPoint slide Johanna Lönngren that has used in multiple lectures and workshops about emotions in engineering education. The slide reproduced a quote from an article published in *Communications Society* in 1975. In the article, Richard Mortensen describes engineers as "intellectually gifted emotional misfits" and engineering education as "a filter and a pipeline which selects individuals who are emotionally disturbed." Next to the quote, the slide shows a black-and-white portrait of the author, taken from a memorial note published online.

Johanna encountered the quote during her work with a systematic review of the literature on emotions in engineering education, and she vividly remembers the shock and disbelief she experienced at the time. In some sense, the quote "only" reproduces common stereotypes of engineers, so it should not trigger so strong emotions. However, the quote creates such an absurd and blatantly insulting image of engineers that makes it impossible, according to Johanna, to not react and question the underlying narrative. The quote also shows that narratives about engineers and engineering education have changed over the past 50 years, but that this change has primarily influenced *how*—not *what*—stories are told about engineers.