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Navigare Necesse Est: Defining Purpose and Adaptability in ASEE and TELPhE

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Navigare Necesse Est: Defining Purpose and Adaptability in ASEE and TELPhE

In recent months, ASEE has engaged its membership in discussions aimed at revitalizing the organization and redefining its purpose. This strategic planning initiative seeks to ensure ASEE's continued relevance for a future where teaching in increasingly impacted by technology. A parallel debate has been taking place within the Technological and Engineering Literacy / Philosophy of Engineering (TELPhE) division, serving as a microcosm of the broader dialogue within ASEE about its role and direction.

Currently, ASEE demands little of its divisions other than the production of a quota of papers for the annual conference, which grants them limited visibility. TELPhE, like other divisions however, is a community of volunteers. Activities beyond the annual conference rely on members' voluntary efforts. Such dependence on volunteerism mandates that: 1) built-in procedures are used to maintain continuity as individuals transition in and out of roles, and 2) that volunteers find value in their activities to ensure sustained engagement.

Another similarity between ASEE and TELPhE is highlighted by Rosalind Williams' observation of the fragmentation of knowledge in engineering. Similar to Adam Smith's and Friedrich Hayek's ideas on the division of labor/knowledge, ASEE's divisions have proliferated based on emerging topics and individual interests. This fragmented structure has led to significant overlap between divisions, complicating the organization's coherence. For example TELPhE, which was originally focused on technological literacy, received a remit in philosophy, which intersects with other divisions' areas, such as ethics and liberal education.

The fundamental questions facing ASEE and its divisions are: is its primary function to hold an annual conference and publish journals? If so, is this enough to sustain and grow membership? Or is ASEE's purpose to promote research in engineering education that will have a broader societal impact? These considerations also apply to TELPhE, which must determine if it is merely an internal discussion forum or if it should actively promote technological citizenship and engage in public discourse.

For both ASEE and TELPhE, the challenge lies in adapting to technological changes and evolving societal needs. As organizations grapple with these shifts, it becomes clear that adaptability—not mere strength—is key to survival and future growth. This paper explores through analysis of historical data the lessons learned from these ongoing discussions and their implications for ASEE's strategic planning.

Introduction

Over the past several months, the American Society for Engineering Education (ASEE) has been immersed in a strategic planning process aimed at clarifying its mission and ensuring its ongoing relevance. Much of this effort centers on how technology is transforming the way we teach, learn, and conduct research in engineering—and on whether ASEE, along with its many divisions, can respond nimbly to these trends. The TELPhE (Technological and Engineering

Literacy / Philosophy of Engineering) Division is a microcosm of these debates, struggling with questions about its own identity and purpose in ways that reflect ASEE's broader organizational challenges. The tension between breadth and focus is heightened by ASEE's organizational structure, in which volunteer-led divisions solicit papers for the annual conference. While this requirement encourages activity, it can also lead to a diffusion of effort and a lack of cohesive vision—a phenomenon that TELPhE is currently experiencing firsthand.

In particular, TELPhE has a mandate that touches on technological literacy, philosophy of engineering, ethics, and liberal education, placing it at the intersection of disciplines often dispersed in different corners of engineering education. A less charitable interpretation is that TELPhE is concerned with issues that are seen as peripheral to technical engineering education. From this perspective the mission of TELPhE could be seen as pushing such issues more to the center [1].

Addressing these issues requires us to step back and examine the broader question of why engineering education exists, what it should be doing for society, and how organizations such as ASEE can better structure themselves to achieve impact. This paper draws from recent discussions within TELPhE and ASEE at large, as well as historical data on the evolution of engineering societies [2], [3], [4] to observe that volunteer-led, division-based organizations can either thrive or stagnate when confronting the rapid shifts of the modern world. Ultimately, the question is not how strong TELPhE (and by connection ASEE) is in its current form, but whether it can adapt to changing times—whether it possesses the self-correcting mechanisms necessary to shape the future of engineering education for broad societal benefit and what such benefit actually is.

Before delving into the broader structural and philosophical questions, it is important to situate the authors. One of the authors is an ASEE lifetime achievement award winner, another is a Fellow, and the third has been active in the TELPhE division for many years. We come from different disciplines, different countries, and each author has a unique set of experiences. The youngest author has thirty years of experience in engineering education, the oldest over sixty. Over our careers we have served on committees, participated in strategic planning, and used technology to reshape our classrooms; in hindsight much of this work seems to be a complete waste of time. We come to these debates not just as scholars, but as people whose careers have been devoted to the advancement of engineering education, and who are at points in our careers where being retrospective comes naturally. This is both a privilege and a limitation, as our deep involvement can make it harder to see beyond established norms or challenge the organizational status quo; we are seeking to expand our scope.

At this time we are, to be frank about it, a little afraid. This fear, which remains nameless and unformed, stems from changes which seem to be wrought by technology making the world what the US military identifies as VUCA – volatile, uncertain, complex, and ambiguous. As climate change is a catalyst and accelerator for other crises, a VUCA world make both engineering and education more difficult. This fear has led us to the conclusion that it is necessary to engage broadly to redefine TELPhE's purpose in a time of accelerating change. Whether that involves rethinking how volunteer divisions are structured within ASEE, or critically reassessing the mission of higher education itself, depends on both internal organizational imperatives and external societal pressures. The biggest challenge—and opportunity—emerges from the collision

of these pressures, which collectively demand that we reevaluate the role of engineering education in shaping the world to come.

Beyond the "Iron Triangle"

Most discussions about reforming higher education start by tacit acceptance of the so-called "iron triangle" of an individual's contributions to teaching, research, and service. We academics spend considerable time arguing about how best to balance these three components that can border on the ridiculous. For example, on one of our campuses we had a well-attended (and quite serious) seminar by a former university president called "*Are we teacher-scholars or scholar-teachers?*". Yet this focus on individual success and acceptance of the status quo seems of questionable value when technological, demographic, and societal shifts are redefining the very foundation of education itself. What should teaching, research, and service look like in an era marked by climate change, rapid automation, and global health, political, and economic crises? Never-the-less the structures and norms captured in the iron triangle increasingly define what it means to be an academic today.

Increasingly, institutions of higher learning are becoming more like businesses [5], [6]; pressured to demonstrate return on investment. New digital platforms and artificial intelligence tools are expanding educational access but also exacerbating inequities. Research is similarly shaped by data-driven evaluations that can discourage interdisciplinary, long-shot, or long-term projects. For engineering education in particular, questioning the "iron triangle" that constrains academic careers intersects with questions of how to prepare students for living on a planet beset with urgent environmental and social challenges. Engineering is widely understood to be application-oriented, but educators must still ask: application toward what end? Does the engineering profession primarily serve industry, or does it have a moral and civic responsibility to protect the public good? The process through which we answer these questions (if we choose to do so) has the potential to shape engineering education profoundly. Because businesses are notoriously risk-adverse and short-sighted, these ongoing shifts in institutional cultures will eventually impact upon what engineering education can be.

When organizations fail to address far-reaching questions, the consequences can be dire [7]. This is illustrated starkly by the experience one author had while writing this paper – watching on TV an old friend's house burn in a wildfire, an image that symbolizes the often-predictable but never-the-less devastating consequences of inaction. These disasters—whether they manifest as climate emergencies, public health crises, or social unrest—are not only random events but also the product of long-term systemic failures; not the least of which is education. We are educators and therefore in part responsible. These crises are not separable, they are interlinked. This connectedness unfortunately means that change is not easy. Education is a system, and fixing one part of a system does not fix the whole system; in fact it can make it worse [8]. For these reasons many see such fundamental transformation as nearly impossible—yet the stakes are simply too high to ignore.

TELPhE and ASEE: Collective Action

TELPhE, as a division within ASEE, offers a microcosm of how noble aspirations can become diluted. Originally focused on issues of technological literacy, then later the philosophy of

engineering, TELPhE's scope has expanded over time, partly due to the proliferation of interests within the division and ASEE [9]. It now overlaps with areas covered by other divisions—ethics, liberal education, and social justice—potentially enriching cross-disciplinary collaborations but also creating confusion and duplication of effort. Some members of TELPhE acknowledge contributing to this problem; we have been having internal discussions that by trying to serve everyone, the division risks losing its core identity. Volunteers are spread thin, juggling multiple responsibilities beyond their ASEE involvement. Without a clear, shared direction, the division can devolve into either a mere intellectual forum for a small group or, conversely, a catch-all that addresses too many issues superficially.

The predicament is reminiscent of Adam Smith's and Friedrich Hayek's insights into the division of labor and knowledge—concepts that shaped industrial and economic thinking but also set the stage for fragmentation in professional organizations. ASEE's growth into multiple divisions, each with overlapping yet distinct interests, reflects the same tension: Are these subdivisions a sign of necessary specialization, or do they fragment our collective ability to address truly pressing problems? TELPhE's experience suggests that specialization can inadvertently hamper collaboration, creating silos at the exact moment we need collaborative synergy. If the divisions of ASEE choose to stay within narrow confines (e.g., focusing only on producing papers for annual conferences), they risk becoming irrelevant in the face of urgent societal challenges.

One of the most pressing questions for TELPhE—and for ASEE we believe—centers on how to mobilize collective action. Big problems require broad coalitions; no single division, or even ASEE itself, can tackle issues like climate change adaptation or the ethical governance of emerging technologies alone. We remain small fish in very big ponds. Yet while the current structure enables policy statements to be produced [10], it provides few ways of building coalitions. Individual volunteers, often motivated by personal passion, spearhead initiatives, but these efforts frequently lack continuity when leadership changes. As a result, promising efforts fizzle out. If ASEE and its divisions truly want to have a societal impact, and this is the choice we are advocating for, institutional frameworks that allow for consistent, collective pursuit of major priorities need to be created. This is not a trivial matter. Many organizations, both inside and outside academia, have discovered that consensus-building requires intentional design: establishing committees or task forces with real authority, allocating resources for long-term projects, and holding participants accountable for sustained engagement. For TELPhE, building consensus involves first defining a workable scope—recognizing that "we can't drink the ocean," as the saying goes—and then collaborating with other divisions to address areas of overlap in a coordinated, rather than redundant, way.

We do not believe, however, that a simple reorganization can address the need for collective action without first revisiting the fundamental purposes of education. Is education primarily a means to an end—job readiness, technological advancement, economic competitiveness—or is it also an end in itself, just as students are persons in themselves, that fosters democratic citizenship, moral responsibility, and critical thinking [11]? Historically universities have played multiple roles: guardians of knowledge, engines of innovation, and crucibles for civic development. Over time, however, pressures for revenue and prestige have layered on various peripheral functions, from big-time athletics to real estate development. These expansions can distract from the core mission of preparing people to live in, and shape, the world of tomorrow.

Engineering education similarly grapples with a dual identity - fostering technical capabilities while instilling ethical and societal values to use technology wisely and humanely. Education is about "future-proofing" young people, not just to survive and thrive in future society, but to actually *become* that society [12], [13].

In many ways, engineering education is akin to optics—an "enabling science" [14] that affects all other fields of scientific and technological inquiry. Just as optics underpins everything from telecommunications to medical imaging, education underlies the development of almost every aspect of society. As some scholars have noted [15], education has long time constants. The changes we implement today may not yield visible results for years, or even decades, down the line. This delayed feedback loop can breed complacency, as organizations that fail to see immediate benefits may question the value of putting resources towards an uncertain future. But watching Los Angeles burn as this paper is being written is a reminder of the consequences of complacency in the face of slow but inexorable change. By thinking about how we can expand our scope to span curricula, governance, and public engagement our division has the potential to shape people who will define the next half-century.

The Perspective of Information Networks

In his recent book, *Nexus* [16], historian Yuval Noah Harari analyzes how information networks influence organizational structures and governance models, whether democratic or autocratic. Though Harari's work does not specifically address engineering education, the insight it offers—that the flow of information shapes power dynamics—applies directly to ASEE and its divisions. One of Harari's central arguments is that the sheer volume of information in contemporary society can be both liberating and paralyzing. On one hand, we have unprecedented access to knowledge and tools that can accelerate learning and collaboration. On the other hand, information overload can obscure priorities, fragment attention, and fuel polarization. If education is about equipping students to navigate this reality, then the structure of education-adjacent organizations should reflect a commitment to transparency, deliberation, and robust debate. Harari introduces three simple models of the role of information, reproduced in Figure 1, below. The 'naive' view sees information as leading to truth, so more information results in more truth, wisdom, and power. Harari believes this view is misguided because of the pernicious effects of misinformation. The 'populist' view sees information as power. This view is damaging for society since truth is ignored in the quest for power and order, and as a result misinformation creates intersubjective realities that are often harmful for human thriving. Harari argues, aligning with Bruner [17], a more accurate view is that 'information' consists of both stories and data, and it is important to distinguish between information's role in finding truth and its role in creating order. Order is necessary, but need not be benign or beneficial since maintaining order can be achieved through misinformation which can be as powerful as truth.

Harari points out that both truth and order are central to democracies and other beneficial governance structures, while order is more important for autocracies, which are threatened by truth. Truth is maintained by strong self-correcting mechanisms within a society or organization: rewarding finding error, transparency, admitting mistakes, and similar actions. Harari's models of information inform ASEE and TELPhE by pointing out that if our work is to have a beneficial impact we must actively cultivate a self-correcting ethos and focus on both truth and order. This leads to the question of whether our current process for setting

division priorities encourages the breadth of dialogue and debate needed for self-correction or whether we are more focused on the bureaucracy (literally 'governance of drawers') of the publications needed for promotion and advancement; i.e. creating order. In this model the challenge is to figure out how divisions can better cooperate in sharing information to create a more self-correcting organization. The alternative is an organization locked into a top-down model where volunteers dutifully fulfill quotas without ever reconsidering the broader raison d'être.

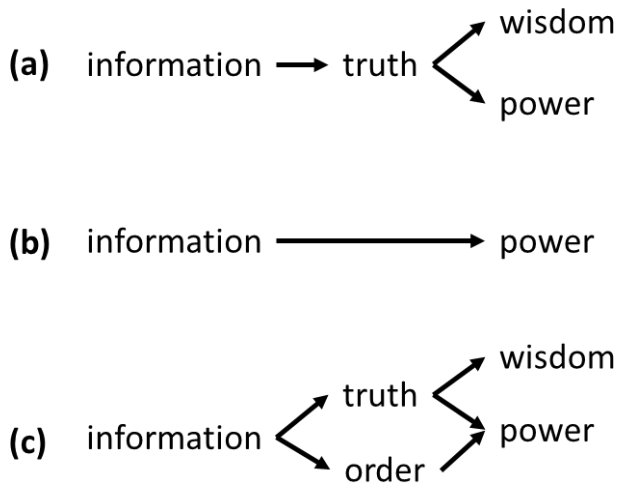

Figure 1: Three models of information from Harari [16]**: (a) 'naive' view of information that sees more information as beneficial, (b) 'populist' view of information that focuses on acquisition of power, (c) 'historical' view of information where truth and order are balanced in service of society.**

A healthy democracy relies on checks and balances as well as an informed and engaged citizenry. As we consider TELPhE's (and also ASEE's) strategic planning efforts, a few fundamental questions stand out: 1) is the primary function of divisions to support an annual conference and publish articles? 2) Is the divisions' purpose to promote research in engineering education for broader societal impact? 3) For TELPhE specifically, are we an internal forum for discussion, or should we actively promote technological citizenship and engage in public discourse? If the latter, what concrete steps can the division take to move beyond annual conference sessions and formal publications? These questions are neither rhetorical nor easily answered. Nonetheless, posing them is essential if the organization wants to move beyond superficial reforms and meaningfully adapt to a world that increasingly demands integrated, ethical, and visionary approaches to education. No significant change can happen without building structures that allow for self-correction. These might include: review processes that encourage divisions to share how their papers contribute to the division's (and ASEE's) broader mission; regular forums to bring multiple divisions together to discuss overlapping interests; developing metrics for assessing external impacts such as contributions to policy, industry practices, or community well-being. Without these self-correcting mechanisms, both ASEE and TELPhE risk becoming complacent, focusing on routine tasks (conference planning, member recruitment) while missing the chance to shape the evolution of engineering education in meaningful ways.

Morality and the Common Good in Engineering Education

Although rarely mentioned, there is a 500-pound gorilla in the room that impinges on all these discussions – the underlying question of what is the role of morality and the common good in engineering education. Engineering, particularly design, is inherently about creating new technologies—tools, systems, processes—that shape how we live. It is not enough for students to master the technical aspects of design; they must also grapple with the moral dilemmas that arise when technology intersects with society. One question that arises is whether engineering ethics as currently taught impacts students' moral choices in design (courses). Another is the extent to which we as a society own the negative consequences and impacts of the technologies we create. Engineers design systems that are used by corporations or governments, often for good, but sometimes for ends that are harmful if not outright nefarious. How should educators instill in their students a sense of responsibility for downstream effects? If not the engineers, who will? Many contemporary issues—such as data privacy, social media's influence on democracy, and AI-driven surveillance—underline the difficulty of controlling technology once it's widely deployed.

Related to questions about the common good is the broader issue of technology ownership and accountability. Since engineers design and implement many of society's most powerful tools, it is logical for them to play a central role in assessing, mitigating, and rectifying harmful consequences. But is this realistic in a system governed largely by what some call "extractive capitalism," in which corporate interests may overshadow the public good? Some years ago, Goldman [18] argued that engineers are so beholden to such capitalist structures, they have abrogated control of their future, and thus cannot take responsibility to prioritize societal well-being over corporate objectives. As with all organizations ASEE seeks to build strong ties to corporations because, as the bank robber Willie Sutton is erroneously attributed as saying, "that is where the money is." How can we utilize these relationships and the areas where ASEE and industry has common interests to address these difficult questions?

Organizational Change

In her commentary on knowledge fragmentation [19], Rosalind Williams identified the tendency of engineering societies to focus on narrowly defined projects that produce measurable outcomes (like conference papers) while neglecting bigger-picture thinking. Indeed, many academics seeking tenure or promotion find themselves incentivized to publish in specialized journals, often missing opportunities to collaborate on interdisciplinary efforts that might be more impactful. TELPhE members recount experiences where bold, interdisciplinary panels—such as one addressing terrorism and crowd safety—generated large audiences eager for frank discussions that transcended standard technical boundaries. These events hint at a latent hunger within engineering education for addressing real-world complexity. Yet the organizational structures and reward systems mostly remain geared toward more conventional outputs.

This mismatch creates a sense of frustration for those who believe that engineering education can—and should—tackle existential questions relating to the common good. If ASEE aims to stay relevant, it must reexamine how it rewards, funds, and promotes initiatives that go beyond narrowly defined research topics to engage the broader public good. Any such recalibration of engineering education will not be easy, it requires institutional will. Programs that place ethics at

the core are often at odds with a marketplace-driven approach that prioritizes technical competencies. However, no change is possible unless organizations like ASEE advocate for a more ethically integrated curriculum and invests in shifting broader academic norms. How do we begin to shift gears? A few preliminary ideas have emerged from discussions within TELPhE around Heywood's 2021 whitepaper *Future Directions for Technological and Engineering Literacy*. We envision several concrete steps, beyond those discussed previously, that ASEE could take to start the process for organizational change:

1) Establish a cross-divisional task force on how to achieve societal impact. This task force could identify key issues like sustainability, ethics, and technological governance that cut across multiple divisions. Part of this process would be to develop a theory of change [20] centered on engineering education. Charged with making actionable recommendations, the task force would be empowered to propose changes to ASEE's strategic plan and organizational policies and be given time and space at sequential annual meetings.
2) Create deliberate spaces for deep and sustained dialogue at ASEE conferences. Many members express a desire for extended conversations that go beyond the usual 15-minute conference presentation. ASEE could pilot special symposia, multi-day retreats, or structured online forums. These spaces would encourage participants to grapple with the "big questions," unhurried by rigid session formats. An example is the recent "Mindset Report" [21]. The National Academies might serve as a model.
3) Reallocate resources and rethink the role of papers. The current focus on conference papers might inadvertently perpetuate fragmented, quantity-over-quality approaches. ASEE leadership could explore alternative metrics—e.g., evaluating divisions on how effectively they organize interdisciplinary workshops or facilitate community outreach. Supporting more journals for publication could also be considered. Some of these efforts are already underway in some divisions. We acknowledge that the opportunity to present an ASEE conference paper is important for many members, but having more publication venues would reduce some of this need.
4) Institute ongoing evaluation and iteration of the organization and its processes. Building on the concept of self-correcting mechanisms and commit to regularly scheduled review of its practices.
5) Engage in more public discourse. Take a public stand on significant engineering-related issues such as equitable AI policies or sustainable infrastructure. Offering policy briefs, editorial contributions, and position statements can help create a more influential voice in the broader societal dialogue about technology and education.
6) Look at the practices other professional societies use to have influence—in academic, industrial, and policy realms—as well as generate revenue. For example, supporting standards is an important and impactful activity for technical professional societies. What would standards in engineering education look like and how would they impinge upon and differ from accreditation?

Taken together, these steps represent a more intentional—and arguably more courageous—approach to professional engagement. Rather than confining activity to conferences and journals, they position ASEE and its divisions as thought leaders that influence not just the field of engineering education, but the future of technology and society at large. We note that ASEE is the right place for change to start since it engages individuals who are engaged with engineering

education at some level – either in the classroom or at higher administrative or policy levels. While many engineering educators are not members of ASEE, and may not prioritize scholarship or professional development in engineering education, the starting point of change is always with those who do engage on an issue.

Conclusion

In a *New York Times* editorial from January 12, 2025 [22], Ezra Klein posits that society has passed through a "phase change," entering a realm in which our traditional institutions, including higher education, are no longer fit for purpose . While some might dismiss calls for radical change as alarmist, the real-world signals—from catastrophic wildfires to deepening social inequalities—suggest that we ignore these transformations at our peril. For those of us in ASEE and the TELPhE Division, the challenge is clear: will we adapt, or will we remain tied to structures that no longer serve us? The conversation is not about discarding the annual conference or ceasing publication in reputable journals; those activities remain valuable. Rather, it is about fundamentally reevaluating the role of engineering education so it can address bigger questions of morality, societal responsibility, and beneficial technological futures.

If we continue to watch houses burn—literally or metaphorically—while staying within the confines of our established processes, we risk losing our professional credibility, our sense of mission, and, ultimately, our collective ability to shape a livable future. Yet there is reason for hope: the very volunteer energy that powers ASEE's divisions can also power the transformations we need, provided it is harnessed with clear vision and organizational support.

In the end, engineering education is about preparing young people for the world that will be, and perhaps more importantly, helping to shape that world for the better. These young people are not just residents of that world, they *are* the future world. By engaging in substantive conversations about ethics, policy, and collaboration—by building self-correcting and inclusive structures—ASEE and TELPhE can become catalysts for the kind of change that today feels daunting but will seem, in retrospect, absolutely necessary. The first step is to recognize the gravity of the moment, then come together to chart a path forward. It will not be easy, but it may well be our only responsible choice.

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Citations

[1] C. Hilgarth and J. Heywood, "oving Technological and Engineering Literacy into Mainstream Conversation: The 2021 Whitepaper 'Future Directions for Technological and Engineering Literacy and the Philosophy of Engineering' Revisited," presented at the ASEE Annual Conference and Exhibition, Baltimore, MD, 2023. doi: 10.18260/1-2--43944.

[2] C. Seron and S. S. Silbey, “The dialectic between expert knowledge and professional discretion: Accreditation, social control and the limits of instrumental logic,” *Eng. Stud.*, vol. 1, no. 2, pp. 101–127, Jul. 2009, doi: 10.1080/19378620902902351.
[3] A. Akera, “Setting the Standards for Engineering Education: A History [Scanning Our Past],” *Proc. IEEE*, vol. 105, no. 9, pp. 1834–1843, Sep. 2017, doi: 10.1109/JPROC.2017.2729406.
[4] R. A. Cheville, “A Century of Defining Engineering Education,” in *2014 ASEE Annual Conference & Exposition*, Indianapolis, 2014.
[5] S. Slaughter and G. Rhoades, *Academic capitalism and the new economy: markets, state, and higher education*. Baltimore: Johns Hopkins University Press, 2004.
[6] R. Brown, “Higher education and the market,” *Perspect. Policy Pract. High. Educ.*, vol. 12, no. 3, pp. 78–83, Jul. 2008, doi: 10.1080/13603100802181125.
[7] P. Senge, *The Fifth Discipline: The Art & Practice of The Learning Organization*. New York: Doubleday, 2006.
[8] D. H. Meadows, *Thinking in Systems: A Primer*. White River, Vermont: Chelsea Green Publishing, 2008.
[9] C. Hilgarth, “‘Where do we go from here?’ A Discussion Regarding Technological Literacy / Philosophy of Engineering,” presented at the ASEE Annual Conference & Exposition, Tampa, FL, 2019. doi: 10.18260/1-2--31927.
[10] “ASEE Public Policy Statements.” Accessed: Apr. 28, 2025. [Online]. Available: https://www.asee.org/about-us/what-we-do/ASEE-Public-Policy-Statements
[11] R. A. Cheville, *Becoming a Human Engineer: A Philosophical Inquiry into Engineering Education as Means or Ends*. Cambridge: Ethics International Press, 2022. Accessed: Nov. 08, 2021. [Online]. Available: https://ethicspress.com/products/becoming-a-human-engineer-a-philosophical-inquiry-into-engineering-education-as-means-or-ends
[12] R. A. Cheville, *Becoming a Human Engineer: A Philosophical Inquiry into Engineering Education as Means or Ends?* 2021.
[13] J. Macmurray, *Freedom in the Modern World*. London: Faber & Faber, 1932.
[14] Committee on Optical Science and Engineering, *Harnessing light: Optical science and engineering in the 21st century*. Washington, D. C.: National Academy Press, 1998.
[15] E. A. Hanushek and L. Woessmann, “The Role of Cognitive Skills in Economic Development,” *J. Econ. Lit.*, vol. 46, no. 3, pp. 607–668, Aug. 2008, doi: 10.1257/jel.46.3.607.
[16] Y. N. Harari, *Nexus: a brief history of information networks from the Stone Age to AI*, First edition. New York: Random House, 2024.
[17] J. Bruner, *Actual Minds, Possible Worlds*. Cambridge, MA: Harvard University Press, 1987.
[18] S. L. Goldman, “The Social Captivity of Engineering,” in *Critical Perspectives on Nonacademic Science and Engineering*, P. Durbin, Ed., Bethlehem, PA: Lehigh University Press, 1991.
[19] “Education for the Profession Formerly Known as Engineering,” The Chronicle of Higher Education. Accessed: Apr. 28, 2025. [Online]. Available: https://www.chronicle.com/article/education-for-the-profession-formerly-known-as-engineering/
[20] M. Connolly and E. Seymour, “Why Theories of Change Matter (Examples from EHR Programs),” National Science Foundation, Washington, DC, 2012.

[21] “Mindset.” Accessed: Jan. 14, 2025. [Online]. Available: https://mindset.asee.org/
[22] E. Klein, “Opinion | ‘Now Is the Time of Monsters,’” *The New York Times*, Jan. 12, 2025. Accessed: Jan. 14, 2025. [Online]. Available: https://www.nytimes.com/2025/01/12/opinion/ai-climate-change-low-birth-rates.html