2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #38970

Moving Technological and Engineering Literacy into Mainstream Conversation: The 2021 Whitepaper "Future Directions for Technological and Engineering Literacy and the Philosophy of Engineering" Revisited

Prof. Carl O. Hilgarth, Shawnee State University

Carl O. Hilgarth, M.S., is a past division chair of the Technological and Engineering Literacy / Philosophy of Engineering Division of ASEE. He is Professor Emeritus and former chair of engineering technologies at Shawnee State University, Portsmouth, Ohio.

Dr. John Heywood, Trinity College Dublin

John Heywood is professorial Fellow Emeritus of Trinity College Dublin- The University of Dublin. he is a Fellow of ASEE and Life Fellow of IEEE. he is an Honorary Fellow of the Institution of Engineers Ireland. He has special interest in education for th

Moving technological and engineering literacy into mainstream conversation … the 2021 Whitepaper *"Future Directions for Technological and Engineering Literacy and the Philosophy of Engineering"* revisited

Abstract

ASEE / TELPhE have offered numerous papers, proposed many approaches, and reported on many programs and initiatives to promote and implement technological and engineering literacy. Overall, these focused on increasing the understanding of engineering and technology among K-12, undergraduates who were not engineering or technology majors, and the citizenry. These comprised K-12 STEM initiatives, success stories from faculty who established general education courses and other initiatives on engineering and technology topics for non-engineering students at their respective institutions, and reports developed in conjunction with national bodies and associations through study and focus groups with the over-arching objective being to present the need for technological and engineering literacy as a positive and beneficial initiative. The hoped-for outcome was that those who experienced this initiative, regardless of its context, would be enjoined as advocates for the importance of technological and engineering literacy as they moved among the citizenry locally, nationally, and internationally. To this end, the division developed a pedagogy, researched history, offered definitions, developed theories, recorded data, and published studies, and offered some excellent examples of "*Why*?*"* concluding with a 2021 white paper, "*Future Directions for Technological and Engineering Literacy and the Philosophy of Engineering*" [1] proposing eight actions through which to discuss and assess:

- How to promote the "*importance of*" the message;
- How to get the "*benefits of*" rationale listened to;
- How to establish civic "*recognition / acceptance*" that technological and engineering literacy is a "*constituent part*" of many activities and decisions;
- How to present the discussion of technological and engineering literacy in a "*publicly accessible*" context?

This paper considers these questions vis-à-vis moving technological and engineering literacy / philosophy of engineering into mainstream conversation.

TELPhE is needed …

The 2002 publication of *Technically Speaking: Why All Americans Need to Know More About Technology* [2] and the April 18-19, 2005, National Science Foundation (NSF) workshop [3] (reported at IEEE Frontiers in Education (FIE) conference in 2005 as *The Technological Literacy of Undergraduates: Identifying the Research Issues* [4]) led to recognition of the need for an organization to serve as the focal point for technological literacy. ASEE was seen as the appropriate base for this focal point and thus, the ASEE Technological Literacy Constituent Committee (TLCC) was formed June 2005 [1].

Drawing heavily on *Technically Speaking*, and the 2005NSF-sponsored workshop, Krupczak, Pearson, and Ollis [5] and Pearson and Ollis [6] presented papers to the American Society for Engineering Education (ASEE) at its 2006 Annual Meeting defining the concept of technological and engineering literacy, the beginning initiatives to promote it, and the benefits to accrue to the individual and society through it, thus forming the foundation for much of the subsequent interest, research, and promotion of regarding the importance and criticality of these literacies within the overall population. Subsequently, the TLCC became the Technological Literacy Division of ASEE in 2008, and after numerous further papers and discussion about the intersection of technological literacy and engineering, it became the Technological and Engineering Literacy / Philosophy of Engineering (TELPhE) division of ASEE in 2014 [1]. TELPhE's historical background and its publication of papers and research from diverse constituencies and international perspectives demonstrates its embrace of the goal of helping all Americans to a better understanding of technology as originally envisioned by the National Academy of Engineering [1].

In 2021, the white paper, *"Future Direction for Technological and Engineering Literacy and the Philosophy of Engineering"* [1] was posted on the TELPhE website to further discussion of the future direction and vision of TELPhE and was subsequently included as a TELPhE session topic during the 2021 Annual Meeting of the ASEE, but unfortunately, no record of the discussion is available.

The paper considered eight actions:

1. **Emphasize informed decision making on technological issues.**
   Direct future efforts of the division toward enhancing informed decision making on technological issues which also advances social justice. Technological literacy could be framed as informed decision making and a social justice issue. Implications of informed decision making on technological issues for the philosophy of engineering and engineering education should be pursued [1].

2. **Address "technological literacy" label misunderstandings.**
   Solve the "technological literacy" label problem. The term "technological literacy" remains open to wide interpretations obscuring efforts to develop a broad understanding of technology by all citizens. Targeted conference sessions or panel discussions may be appropriate actions to consider [1].

3. **Advance understanding of necessary versus contingent.**
   Promote clarification and broader understanding of the distinction between the necessary and the contingent. It is difficult to have the necessary conversations around necessity versus contingency approaches even in the literature. Work could be done in developing a language around discussing these issues [1].

4. **Create case studies.**
   Consider what pedagogical approaches may be effective to achieve the envisioned competencies and informed decision making. Case studies may be a productive direction in which to begin. It could be useful to examine what case studies might be suitable for teaching in this area [1].

5. **Develop new dissemination approaches.**
   Developing literature accessible to both the public and educators should be a priority. There is a need for more widespread promotion of the division's work. Materials that empower individuals to make more informed decisions on technological issues should be disseminated widely. The division should consider a working group to examine options for a "TELPhE Press" or similar publications effort of the division. Existing provisions in the by-laws could be activated [1].

6. **Study models of technological decision making.**
   Clarify models of technological decision making. To enhance technological decision making a good understanding of how it does (and doesn't) occur is needed. A TELPhE call for papers could be made to initiate this work [1].

7. **Develop collaborations and partnerships.**
   TELPhE should seek partners and collaborators in these efforts outlined above. These could be both within ASEE and outside of the organization [1].

8. **Monitor progress annually.**
   Each year the Divisional Business meeting at the ASEE annual conference should include discussion of the question: What is TELPhE doing that is central to our mission? This practice might assist the division in maintaining consistently impactful work [1].

The historical activity of the division has essentially conformed to these actions, each being visible in the collective work of the division as a function of ASEE conference themes, division member interest and scholarship, panels, distinguished lectures, and collective discussion. Much of this work remains available in ASEE conference paper archives. Further activity includes the TELPhE-edited Philosophical Perspectives on Engineering and Technological Literacy volumes [7][8][9][10] accessible through the division's website, http:www/TELPhE.org, the Morgan & Claypool Publishers' lecture series currently available through Springer Publications [11][12][131][14][15], and division membership participation in ASEE's Transforming Undergraduate Education in Engineering (TUEE) Engineering Education Phase IV Workshop: Views of Faculty and Professional Societies [16]. Thus, the division has contributed to the development of the research base, scholarship, and pedagogy needed to improve and promote the understanding of technology and engineering literacy and the philosophy of engineering in the United States [1], and in doing so has also fostered the international awareness of the importance of these areas in education and public policy as well as bringing to the forefront the contributions of social and cultural factors that further define these literacies and philosophy [17][18]. Thus, starting from the original constituent committee, TELPhE progressively broadened its vision and scope to address diverse pedagogies, emerging challenges and opportunities, evolving definitions, and many other topics and contexts in which technological literacy and a philosophy of engineering exist. The "*white paper*" summarizes this work as:

- Personal Empowerment with Respect to Hardware: Some faculty and researchers have made efforts in helping non-engineers develop a more empowered relationship with modern technological hardware. These efforts focus on a "how things work"

understanding of technology. This might also be considered as qualitative or conceptual engineering. The goal is that non-engineers should be more informed users of technology and this information can be gained by people who are not necessarily STEM professionals. Division members have developed a considerable amount of research around this approach [1].

- Responsible Citizenship: Some work emerging from TELPhE has advocated for technological literacy as a component of responsible citizenship. A key theme in this group is the idea that given the pervasive nature of technology as part of everyday life, technological and engineering literacy should include an ability to understand the social, political, economic, and ethical implications of technological developments [1].

- Engineering Literacy for Engineers: Another perspective that has been advocated from within the TELPhE division is engineers themselves are not engineering literate. The argument here is mainstream engineering education is too narrowly focused on engineering sciences. Engineers would benefit from the broader range of topics encompassed through technological literacy [1].

- Engineering as a Missing Element of General Education: Work within the division has advanced the belief that engineering represents a unique way of thinking and knowing and should therefore be included as an element of general education for all students. Some aspects of engineering seen as essential to general education include the design process, engineering thinking, systems thinking, and quantitative reasoning [1].

- Engineering Minor: A group of educators lead by Mani Mina at Iowa State University developed the approach of an engineering minor to provide a means for non-engineering undergraduates to develop technological and engineering literacy. These degrees do not focus on teaching specific engineering technical content but on teaching students how to develop the broad understanding and practical technological competence outlined by the National Academy of Engineering [1].

- Course Development: TELPhE members have reported on courses developed and taught for undergraduates to further engineering and technological literacy. Several broad categories can be discerned [1].

- Survey Courses*:* Some division members have created what might be termed Technology Survey Courses. These courses address a range of technologies. In some cases, course content may include social and historical dimensions of engineering and technology. Approaches are varied including lectures, demonstrations, and laboratories. Scientific principles involved in technological applications are often a major component of these courses [1].

- Technology Focus Courses*:* These courses tend to address a single technological topic or issue. Subject matter is intentionally focused rather than intentionally broad. In some cases, the courses have a substantial technical or quantitative component. The classes frequently include laboratories or projects. In some courses the social and historical aspects of the topic are introduced. Examples include the hydrogen economy, energy, materials, and bridges and civil infrastructure [1].

- Engineering Design for Everyone: These courses focus on the engineering design process. In some implementations the courses include engineering majors along with non-engineering majors. Not uncommon in this group are introduction to engineering courses that are open to students not majoring in engineering [1].

- Technological Impacts, Assessment, and History Courses: These courses emphasize the relation between technology and culture, society, history. There is considerable overlap between courses offered by TELPhE members (primarily taught by engineers) and similar courses offered in Science, Technology and Society Departments [1].

The impact of TELPhE

Nevertheless, even considering these accomplishments, the "*white paper*" expresses a concern that the current structure and activities of TELPhE, as they have evolved, may not be optimal in terms of achieving the broader goals of the division. This is recognition that much of the division's published work is in contexts that may not necessarily reach the larger national and international constituency of policy-makers and the public-at-large that are affected, influenced, or governed by actions, policies and regulations, decisions, and incidents, the outcomes of which are intimately linked to having a technological and engineering literacy, as well as an understanding of the philosophy of engineering [19][20][21][22][23][24], and a sense of how cultures and societies understand and adapt these literacies and philosophy [17][18]. This is reinforced by the "*white paper*" observation that a goal included in the NAE's 2002 recommendations to "enhance informed decision making on technological issues" has been under-addressed [1], and that while the work of division members has developed the research base to support efforts to improve literacy, advancing informed decision making at all levels has not yet received significant attention [1]. The outcome noted by the "*white paper*" is that the public good suffers when individual and collective decision making on technological issues is trapped between a tyranny of the experts and a largely scientifically and technologically challenged media [1]. Thus, there remains a need to bring the models and processes of technological decision making into the public and policy making domain using understandable, readily accessible communications. Enhanced decision making requires a good understanding of how this process occurs [1].

Thus, the "*white paper*" proposes:

- Directing more effort to enhancing informed decision making on technological issues helps to answer the question of "Why is technological and engineering literacy

necessary?" It is now more apparent than ever that informed decision making on technological issues is vital at all levels ranging from individual to global [1].

- Enhancing informed decisions furthers social justice and the common good. The social justice perspective can be seen as a clear imperative that all individuals should be empowered to be able to make informed decisions about technological issues that impact them on a personal and societal level [1].

- Decision making can be interpreted broadly and in doing so the education of engineers is included within technological literacy. Engineering design is a decision-making process. The factors involved in that process are multiple and including engineering design as one type of technological decision making raises fundamental issues about the underlying philosophy of engineering and engineering education [1].

Coming to the fore, from all the division's activities, these three factors combine to form the ultimate drivers to technological and engineering literacy / philosophy of engineering. Thus, with a division and membership already knowledgeable of these three factors, the ultimate measure of the success of all that which the division has accomplished will be the ability of the division to move into a more public focus.

Normally, these discussion points would lead to the development of an organizational structure, attendant positions, and an operating plan aimed at their achievement. However, TELPhE is a volunteer organization within ASEE and must function as such. Thus, TELPhE has by-laws establishing a formal leadership structure, annual program chair, and other elected and appointed positions deemed necessary for the division to function and fulfill its mission. The division has a 4-year leadership structure with respect to the program chair (2-years) becoming division chair (2-years). Other elected and appointed leadership is renewed in two-year cycles. While the ASEE umbrella and the division's leadership structure provide stability, the individuals serving in these positions are volunteers. Thus, they are subject to the ebb and flow of the dynamics of their institutional affiliations and the willingness and available resources of these institutions to support travel and time available for TELPhE-related research and activities. This is in addition to their regular responsibilities, as well as the "pull" of other professional society and association affiliations. That TELPhE is in the ASEE funding structure also affects the availability of resources. Thus, it is that other of the division's needs, such as web site hosting, are supported by the generosity of institutions where division members hold appointments, and by the success of division members negotiating with publishers, and the success of receiving research grants and sabbaticals to undertake research, serve as researchers at national foundations and institute, and obtain supporting financial support from non-academic entities. It is with these constraints, and especially as this paper is written, that the division's ASEE BASS account will be unfunded for the foreseeable future, the accomplishment of the goals and objectives of TELPhE must be considered.

The profile of TELPhE

The trout hatchery organization model: Visiting a state wildlife commission run trout hatchery, one would find it comprised ponds connected by waterways through which "adventurous" trout

could swim to enter another pond, i.e., constituency, and so forth. Such is TELPhE: an organization of "ponds" in which membership interacts collectively and as needed, and as focused and special interest groups as appropriate, bringing together diverse and similar ideas, concepts, and scholarly work at ASEE annual meetings and through activities, largely academic, outside this venue. It is here, outside the "pond" of TELPhE – the interaction with non-TELPhE constituencies – that the exchange of ideas, undertaking of research, preparation of manuscripts, stimulation of the imagination, and implementation of initiatives related to technological and engineering literacy / philosophy of engineering begins to enter a more public arena.

When this interaction occurs, it is not with great fanfare, with great discovery or flourish, but rather in a quiet, persistent, systematic, and scholarly approach (given our academic backgrounds) and mostly individual or small group interaction that is usually not in a setting available to the public. Were it possible to trace and document TELPhE influence through individual division member contacts and activities, and the subsequent implementation of technological and engineering literacy and philosophy of engineering initiatives, outside of some specific contexts such as academia and research grant institutions and agencies, TELPhE is a niche. And while within this niche, the work, devotion, and expertise of individual members have been invaluable, TELPhE is not an identifiable face of the technological and engineering literacy / philosophy initiative. What has been done is such that through our institutions, through our students, and through our contacts the hope is that what was presented in terms of technological and engineering literacy / philosophy of engineering will become part of their thoughts and considerations as they progress through their activities, lives, and careers. So, the immediate response to these essentials:

- ✓ Directing more effort to enhancing informed decision making on technological issues [1].
- ✓ Enhancing informed decisions furthers social justice and the common good [1].
- ✓ [Technological and engineering] decision making can be interpreted broadly [1].

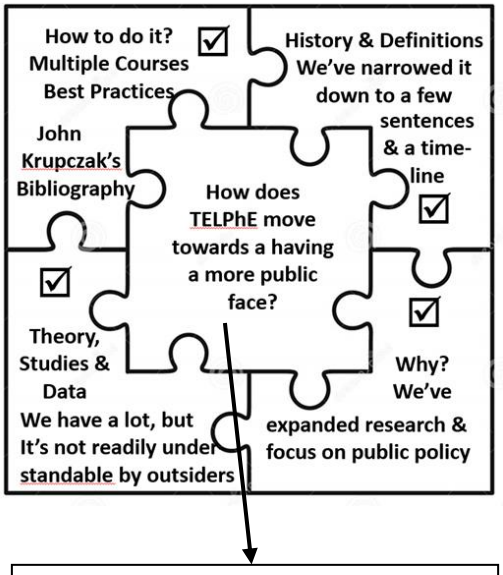
is a qualified yes … yes, we are doing them … though aside from visible curriculum elements in those institutions that have adopted technological and engineering literacy in their academics, the effectiveness and discernability of the work of the division is just not in a way that is formally and measurably discernable.

So, what should we do; why should what we do be taken seriously; how can a uniform technological literacy / philosophy of engineering message be broadcast; how can we identify our real audience and influence policy; how does this lead to a larger message; how can we educate the public to ask the right questions... the people we need to reach, the people outside academia are ones who speak a different language [1][3][4]. In addressing these questions, has making the case for technological literacy / philosophy of engineering been too inward a discussion, and therefore left to engineering practitioners and academics, and social scientists? Years ago, technological literacy / philosophy of engineering was simple know-how. Today, it encompasses social consequences, political and economic implications, international concerns, government regulation, communications technology, and product and process risks [17][18]. In these arenas, the consequence of not having an understanding of technological literacy / philosophy of engineering can lead to a society falling prey to unfounded fears and over-reaction resulting in an inability to truly understand and assess the important technological issues and

attendant decision processes to the detriment of that society's well-being [21][22][25]. From TELPhE's inception, more than by any focused initiative, the individual members of the division through professional society meetings, publications, research grants, and time spent with institutions and agencies such as NSF have – probably without attribution – entered the broader technical and non-technical educational and public policy discourse.

Thus, the division through its membership has continued to publish, continued to research, continued to seek NSF grants, continued to emphasize informed decision making on technological issues. As the division membership continues interacting within spheres of influence, and as external opportunities afford, through representation in the technological and engineering literacy / philosophy discussion outside of academia and those specifically focused and interested agencies historically associated with the division's work TELPhE's "public face" slowly emerges. To continue emergence, given the resources and forum opportunities – private, academic, and public – available to the division. This will require membership to become involved on a national scope through NAE, NSF and policy-making entities … though it is not clear how best to do this as in the author's preliminary research, other than NSF grants received by division membership, and aside from the ASEE *Transforming Undergraduate Education in Engineering* (TUEE) initiative [16], there appears no one associated with the division being invited to, or serving on, a national policy-making body.

Figure 1: Fitting TELPhE's Pieces Together



Fitting TELPhE's Pieces Together (Figure 1) models the current state of TELPhE. The model is updated from the image presented in "*Where do we go from here …*" [26]. At that time (2019), the work of the division exhibited a dearth of content addressing the "*Why?*" of technological and engineering literacy content, a situation improved upon through more recent work and direction of the division in terms of its ASEE published technical papers and the collected, publicly available, work of division members. Thus, "*How*?, *History*, *Data*, and Why?" now frame a new fifth piece: "*Moving towards a more public face*." Placing the eight points of the "*white paper*" in this context substantiates that the division has been effective in promoting enhanced and informed decision making on technological issues, that it has incorporated and furthered social justice and the common good as a component of its work, and that it recognizes that technological and engineering literacy can be interpreted broadly. But the most immediately important of the of the eight points, #7 remains elusive.

This leads to:

- How to promote the "*importance*" of the message?
- How to get the "*benefits of*" rationale listened to

- How to establish civic "*recognition / acceptance*" that technological and engineering literacy is a "*constituent part*" of many activities and decisions?
- How to present the discussion of technological and engineering literacy in a "*publicly accessible*" context?

Focus: courses or curriculum?

Historically, 2006 was a critical year for technological and engineering literacy. It emerged from the obscurity of ASEE "division-hood" into a higher education academic initiative. It was manifest through initiatives, programs, and courses offered either as stand-alone or as components of general education programs with the expectation that it would be networked into the public arena – the public at large, the policy makers, etc. – by those who had participated in or had partaken of. But, considering representative historical events [19]-[24], did this really come to pass? Was the outcome of the initiative a grade assigned for a course whose content became moot once the academic term ended? The ultimate intention, of technological and engineering literacy is not so much as to have courses, the easy way of addressing this literacy, problem, but to adopt the broader vision, that of inculcating it into a curriculum, such that it becomes part of the very being of everyone whom it engages. The conclusion of the ASEE 2006 paper by Krupczak, Pearson, and Ollis, "*The concept of technology literacy itself remains open to debate and discussion*." [5] appears to still be where we are at now - sixteen or so years later. In these sixteen or so years, courses and programs have become readily available, and many that were presented at ASEE sessions or offered through institutions or other interested parties have come and gone. Thus, as depicted by Figure 2, advocating, and influencing curriculum is, for TELPhE, the suggested initiative with respect to action #7: "*Develop collaborations and partnerships that could be both within ASEE and outside the organization*" [1].

Figure 2: Advocating and Influencing Curriculum

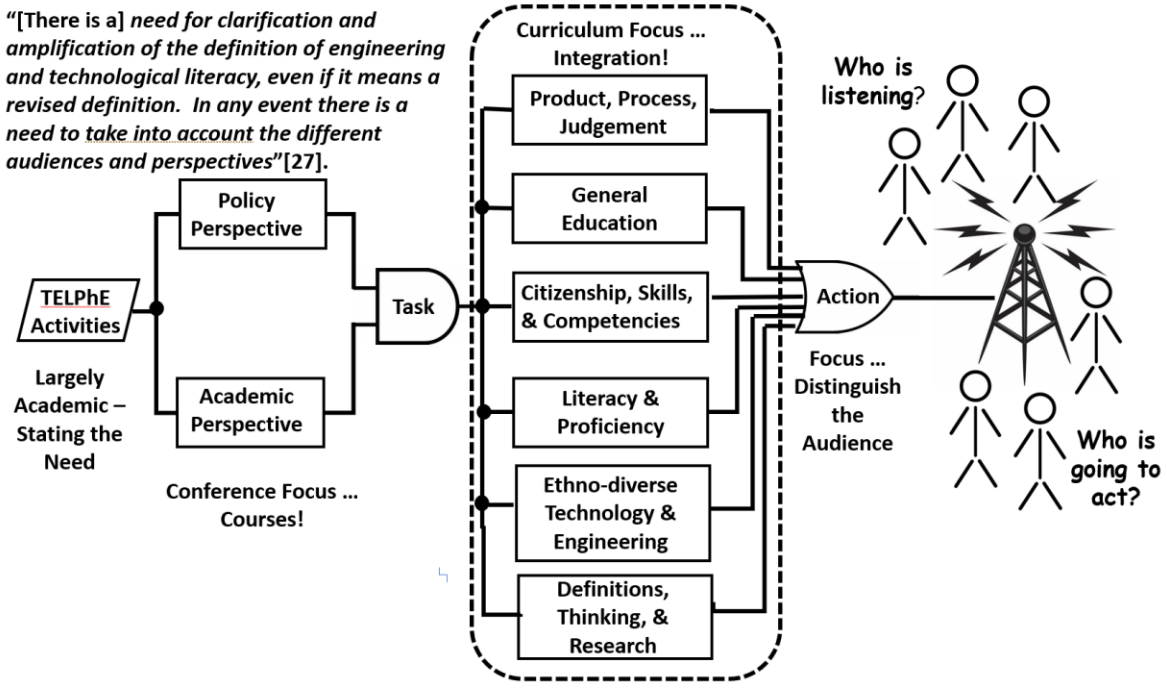


Figure 2: Advocating and Influencing Curriculum, is addressed by Heywood [28]. From a course perspective, the outcome would be to show students the relevance of a technological or engineering application or solution as it is related to a particular problem, the intent being to develop and extrapolate capabilities that can be subsequently used to assess and judge the mertits of these type solutions as they are proposed in a societal context. This perspective implies giving them experience which might be through case studies ort some kingd of investigation or project. The shortcoming is that this approach will not show the interconnectedness between engineering and the larger context of its understanding and relevance in the forum beyond the classroom. In all probalility, the student having completing such a course will have considered it a requirement for graduation rather than as preparation and equiping for a career and lifetime in which having even a modicum of technological and enginering literacy, even if not so employed, will serve in good stead in any career and a lifetime of decision makeng. Thus, the argument for a curricula that emphasizes the societal implication and interconnectedness of technological and engineering literacy through the development of generic skills related to understanding problems and assessing solutions.

Inertia or action … ?

Using the keywords "*technological literacy society*" to search ASEE Proceedings, the first paper returned in the search was, "Whose Job is it? Technological Literacy in Society" with the primary author being Shayna Stanton, student at Brigham Young University. Shayna's paper was presented to the TLCC at ASEE 2007! The final paragraph states: "A combined effort of engineers, policy-makers, educators, and parents is required to create a society of knowledgeable, capable, critical thinking and decision making individuals. The next stage of research should be for these four groups to unite in developing a plan to help average American families, especially parents, become technologically literate. This plan should include policy changes to improve the safety of technology (including media content). It should also include education on the fundamentals of technology, how families can use it for their benefit, how they can protect themselves, and how it can enable efficiency in their daily lives. The ways in which this information will be disseminated should also be included in the plan. Whose job is it to teach technological literacy? It is all of ours in a united effort" [29].

Is TELPhE researching and publishing without any acknowledgment that the work done is significant, even though it should be considered significant if it were viewed by others? Considering the availability of resources, especially that division's finances are a function of the financial well-being of ASEE, and that TELPhE, as a unit of ASEE which has ***its*** technological and engineering "worldview," initial actions would be to update the division's bibliography [30], and per the division's bylaws [31] fill the position of Technological Literacy Advocate with the purpose focusing on curriculum rather than courses and course content, to support this position with creation of the Technology Literacy Committee, and appoint either a publications or newsletter editor to provide content for this focus/initiative. The Technological Literacy Advocate position can represent the division in a variety of contexts, internal and external to ASEE. The availability of Skype and Zoom conferencing and digital media offers TELPhE the opportunity to maintain a visible public presence with an accessible and searchable web page and an editorial or two in ASEE Prism, and with division membership receiving communications

during the "*tween time*" of ASEE meetings, these might be the initial steps in the central piece of the puzzle to give the division a more public face … to move from course-centered to curriculum-centered. Yes, we are a volunteer organization, yes, our resources are limited … but, we have the ability … Thoughts … ?

References:

1. Krupczak, Jr., John, Heywood, John, and Cheville, Alan. *Future Directions for Technological and Engineering Literacy and the Philosophy of Engineering – A White Paper of the Technological and Engineering Literacy / Philosophy of Engineering (TELPhE) Division, American Society for Engineering Education*, Draft July 21, 2021. The "*white paper*" can be accessed at (https://sites.google.com/site/telpheorg//?pli=1).
2. Council, National Academy of Engineering and National Research. *Technically Speaking: Why All Americans Need to Know More About Technology*, 2002.
3. Krupczak, J.J., D. Ollis, "The Technological Literacy of Undergraduates: Identifying the Research Issues," A Workshop Sponsored by the National Science foundation, (2005).
4. Krupczak, John J. Jr., Ollis, David, Pimmel, Russell, Seals, Roger, Pearson, Greg, and Fortenberry, Norman. *The Technological Literacy of Undergraduates: Identifying the Research Issues.* https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=1611924
5. Krupczak, J., & Pearson, G., & Ollis, D. (2006, June), *Assessing Technological Literacy in The United States* Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. 10.18260/1-2--396.
6. Pearson, G., & Ollis, D. (2006, June), *What Is Technological Literacy and Why Does It Matter?* Paper presented at 2006 Annual Conference & Exposition, Chicago, Illinois. 10.18260/1-2--391.
7. John Heywood and Alan Cheville, in John Heywood, (Ed), *Philosophical and Educational Perspectives in Engineering and Technological Literacy*, Vol. 1, June 2014. https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnx0ZWxwaGVvcmd8Z3g6NzhkYWI5YTY2YTRhY2ZmNA
8. John Heywood, (Ed) P*hilosophical and Educational Perspectives in Engineering and Technological Literacy*, Vol. 2, June 2015. https://dr.lib.iastate.edu/server/api/core/bitstreams/307c5b6e-bae9-4084-914e-443f2ccb0ce5/content
9. John Heywood and Alan Cheville, in John Heywood, (Ed), *Philosophical and Educational Perspectives in Engineering and Technological Literacy*, Vol. 3, June 2016. https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnx0ZWxwaGVvcmd8Z3g6NjM2Mzg3NGMyNGE3ODQ5MQ
10. John Heywood, Suzanne Keilson, Aaron Krawitz, Sheila Tobias, et al. *Philosophical and Educational Perspectives on Engineering and Technological Literacy, IV*. (2017). https://works.bepress.com/mani_mina/23/
11. Heywood, John. "*Designing Engineering and Technology Curricula Embedding Educational Philosophy*." Springer, 2022. https://link.springer.com/book/10.1007/978-3-031-03762-7
12. Heywood, John. "*Empowering Professional Teaching in Engineering Sustaining the Scholarship of Teaching*." Springer, 2018. https://link.springer.com/book/10.1007/978-3-031-79382-0

13. Heywood, John, Grimson, William, Gravender, Jerry W., Bassett, Gregory, and Krupczak, John. "*Philosophy and Engineering Education New Perspectives, An Introduction*." Springer, 2022. https://link.springer.com/book/10.1007/978-3-031-03761-0
14. Russell Korte, Mani Mina, Stephen Frezza, David A. Nordquest. "*Philosophy and Engineering Education - Practical Ways of Knowing*." Springer, 2022. https://link.springer.com/book/10.1007/978-3-031-79207-6
15. John Heywood. "*The Human Side of Engineering*." Springer, 2017 https://link.springer.com/book/10.1007/978-3-031-79379-0
16. American Society for Engineering Education. (2018). "*Transforming Undergraduate Education in Engineering Phase IV: Views of Faculty and Professional Societies. Workshop Report*." Washington, DC., 2018. https://tuee.asee.org/phase-iv/report/
17. Hilgarth, C. O. (2020, June), *Should We Consider Transforming the Definition of Technological and Engineering Literacy…* . Paper presented at 2020 ASEE Virtual Annual Conference Content Access, Virtual Online. 10.18260/1-2--33964.
18. Hilgarth, C. O. Notes taken of the presentation and discussions during American Society for Engineering Education Annual Conference (2019) Session W249 – Distinguished Lecture: "*Pipeline, Pathway, or Ecosystem – Do our Metaphors Matter*?" Dr. Alan Cheville, Bucknell University.
19. G. L. Sills, P.E., M.ASCE; N. D. Vroman, P.E.; R. E. Wahl, P.E., M.ASCE; and N. T. Schwanz, P.E. Overview of New Orleans Levee Failures: Lessons Learned and Their Impact on National Levee Design and Assessment. Journal of Geotechnical and Geoenvironmental Engineering © ASCE / May 2008, pg. 556-565.
20. Foltz, Z., Kaur, A., Tushaus, W. H., Mikelson, C. S., Skalak, B. V., and Mina, M., The United States Energy Policy: *As Determined by Non-experts*. Proceedings of the 2012 American Society for Engineering Education Annual Conference (2012). American Society for Engineering Education.
21. Beever, J., & Hess, J. L. (2016, June), *Deepwater Horizon Oil Spill: An Ethics Case Study in Environmental Engineering.* Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26647.
22. Heywood, J., & Lyons, M. P. (2018, June), *Technological Literacy, Engineering Literacy, Engineers, Public Officials and the Public*. Paper presented at 2018 ASEE Annual Conference & Exposition, Salt Lake City, Utah. 10.18260/1-2--31069.
23. Heywood, J. (2021, July), *The Concept of Technological Literacy Examined through the Lens of a Case Study Concerning the Boeing 737 Max Accidents*. Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. https://sftp.asee.org/37844
24. Pittsburg Post-Gazette, February 4, 2923. "*50-car train derailment causes big fire, evacuations in Ohio*." https://hosted.ap.org/post-gazette/article/5d399dc745f51ef746e22828083d8591/50-car-train-derailment-causes-big-fire-evacuations-ohio
25. Heywood, J., *Why Technological Literacy and for Whom*? Proceedings of the 2016 American Society for Engineering Education Annual Conference (2018). American Society for Engineering Education.

26. Hilgarth, C. O. (2019, June), *"Where do we go from here?" A Discussion Regarding Technological Literacy / Philosophy of Engineering*. Paper presented at 2019 ASEE Annual Conference & Exposition, Tampa, Florida. 10.18260/1-2—31927
27. Heywood, J. (2019, June), *Cui Bono. Engineering and Technological Literacy and Higher Education*. Paper presented at 2019 ASEE Annual Conference & Exposition, Tampa, Florida. 10.18260/1-2—32572.
28. Heywood, J. (2010, June), *Engineering Literacy: A Component of Liberal Education* Paper presented at 2010 Annual Conference & Exposition, Louisville, Kentucky. 10.18260/1-2—16570
29. Stanton, S., & Bailey, M. (2007, June), *Whose Job Is It? Technological Literacy In Society.* Paper presented at 2007 Annual Conference & Exposition, Honolulu, Hawaii. 10.18260/1-2--2217
30. Krupczak, J., "Creating Engineering Classes Open to Non-engineers Bibliography and Reference Information," Workshop U249 at 2018 American Society for Engineering Education Annual Conference**.** The bibliography can be downloaded from Technological and Engineering Literacy Publications - Selected Bibliography: https://drive.google.com/file/d/1rCyppbLFLSkewphPvH_FBCXwlUDEmoNe/view
31. Technological and Engineering Literacy / Philosophy of Engineering (TELPhE) Division of the American Society for Engineering Education By-laws
    ASEE link:
    https://aseecmsduq.blob.core.windows.net/aseecmsdev/asee/media/content/member%20resources/pdfs/telphe-bylaws-2019.pdf
    TELPhE.org link:
    https://drive.google.com/file/d/1etWdoYLEr6gXA2aqUozMWd39zsXoyVZW/view?pli=1