Global Vision, Technological Skills, and Systems Thinking Are Essential Qualities for Peace Engineering. Compassion too?

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***Abstract*— What capacities must an engineer possess for peace engineering? In addressing that question, this paper highlights two initiatives of the National Academy of Engineering (NAE): a roundtable jointly sponsored with the United States Institute of Peace (USIP) and a workshop on Engineering, Social Justice, and Sustainable Community Development, a project of the NAE Center for Engineering Ethics and Society. Then-NAE president Charles (Chuck) Vest opened the workshop by emphasizing the "intricate connections between science and engineering and larger social, political, and economic systems," stressing that "as the complexity of these interactions increases, they can geometrically increase the difficulties of determining the right thing to do, and determining the pathways for achieving sought after solutions" [1]. He called on engineers to adopt a global vision. Assuming that global vision can be taught (or at least fostered by engineering education), what other qualities are needed for peace engineering? The paper considers the perspectives of three peacebuilders whose insights seem to suggest that peace engineering programs must strive to prepare engineers with technical skills and systems thinking. But what about compassion or empathy? Are these essential as well? Possibly not empathy, given its associated emotional risks. But cultivating compassion may be important.**

Keywords—*Compassion; Systems thinking; Global Vision*

I. INTRODUCTION

In reflecting on his life's work in striving for peace Charles F. (Chic) Dambach, founding director of the Alliance for Peacebuilding, said [2]:

> For the first time in human history, we are studying peace. We've always studied war to figure out how to win the next one; we're now studying war to figure out how to *prevent* the next one…. When I went to school 50 years ago…there were no programs anywhere in the world where you could study peace, conflict resolution…. Now there are over 200 certified graduate programs…. And we've built the institutions that can make it happen…government-related institutions, the private sector, nonprofit organizations, private citizens…. [My experiences indicate] what private citizens who care and are willing to put in the time and effort can do to make a difference…. Thousands of young people all over the world…are aware of and embrace the value of building a more peaceful world.

The evolution that Dambach celebrates includes peace engineering programs that apply engineering principles in promoting and supporting peace.

This paper highlights reports from two peace engineering initiatives of the NAE that could well be used as pedagogical resources for peace engineering programs: one a project of the NAE's Center for Engineering Ethics and Society, the other a joint effort with the United Stated Institute of Peace (USIP). The paper then turns to the overarching practical inquiry: What are the qualities an engineer must possess for peace engineering? The answer will have implications for engineering education.

II. NAE-USIP JOINT ROUNDTABLE ON TECHNOLOGY, SCIENCE, AND PEACEBUILDING

In 2011, through the National Academy of Engineering's Forum for Innovation in Preventing and Managing Violent Conflict, the NAE and USIP established a Roundtable on Technology, Science, and Peacebuilding. Its principal goals were to:

1. Accelerate the application of science and technology to the process of peacebuilding and stabilization;

2. Promote systematic, high-level communication between peacebuilding and technical organizations on the problems faced in and the technical capabilities required for successful peacebuilding; and

3. Collaborate in applying new science and technology to the most pressing challenges faced by local and international peacebuilders working in conflict zones.

The Roundtable sponsored four workshops:

The first, "Adapting Agricultural Extension to Peacebuilding," sought "to identify what peacebuilding activities could be delivered as components of existing extension services and what organizational modifications and new capabilities would be required to do so effectively" [3]. Or, as workshop co-chair Pamela Aall [4] put it, to determine whether extension services could be used for peacebuilding purposes, and if so, how (p. 4). The workshop built on the belief that extension agents may help manage conflict in rural communities by acting as honest brokers between groups, organizing producer associations or advising managers of shared resources to be inclusive and transparent, reducing conflict-related disruptions, and enhancing agricultural productivity (p. 4).

(Perhaps the point is less about charging agricultural extension agents to suddenly become peacebuilders, but that the extension service model seems to work and to be durable institutionally.) The co-chairs stressed that both collaboration and sustainability are critical to associated efforts to combine agricultural and peacebuilding activities in an extension system.

The aim of the second workshop, *Using Data Sharing to Improve Coordination in Peacebuilding* [5], was "to investigate data sharing as a means of improving coordination among US government and nongovernment stakeholders involved in peacebuilding and conflict management activities" (p. 1). The workshop explored the question of what needs a data-sharing system must address to create more effective coordination in conflict zones and to promote the participation of federal agencies and nonfederal organizations in peacebuilding. The workshop also served to obtain feedback on the UNITY system, a data-sharing platform developed by the Department of Defense (DOD) and the United States Agency for International Development (USAID). Four themes emerged from the workshop discussions:

1. data sharing requires working across a technology-culture divide,
2. information sharing requires building and maintaining trust,
3. information sharing requires linking civilian-military policy discussions to technology, and
4. collaboration software needs to be aligned with user needs.

Workshop co-chair Melanie Greenberg [6] noted that norms around the creation and use of information sharing are changing rapidly, with significantly more data being generated and communicated, and analyzed much more quickly, with results disseminated much more broadly than in the past. She further observed that "new technological capabilities to produce, analyze, and disseminate data are generating moral, ethical, and cultural challenges for producers and users alike" [5]. During the closing discussion, participant Michael Shipler [7] stressed that peacebuilding organizations must remain impartial to be effective and sharing information with one side but not another may compromise this ability. "If this trust is violated," he declared, "people go quiet or stop creating access to information (p. 22).

The third workshop, *Sensing and Shaping Emerging Conflicts* [8], considered uses of technology to sense emerging and ongoing conflicts and provide information and analyses that can be used to prevent violent and deadly conflict, based on the realization that technologies such as cell phones, the Internet, satellites, drones, and sensors of various kinds "are transforming the work of mitigating conflict and building peaceful societies" (p. 1). The report begins with the assertion that:

These technologies enable one-to-one and one-to-many flows of information, connecting people in conflict settings to individuals and groups outside those settings and, conversely, linking humanitarian organizations to people threatened by violence. Communications within groups have also intensified and diversified as the group members use new technologies to exchange text, images, video, and audio. Monitoring and analysis of the flow and content of this information can yield insights into how violence can be prevented or mitigated. In this way technologies and the resulting information can be used to detect and analyze, or sense, impending conflict or developments in ongoing conflict. (p. 1)

Workshop participants sought to identify "major opportunities and impediments to providing better real-time information to actors directly involved in situations that could lead to deadly violence." In the workshop's wrap-up, workshop participants were urged to clearly identify peacebuilding problems and then ask how technology could help solve those problems, which might be related to conflict prevention, conflict management, dispute resolution, postconflict reconciliation, or opposition to authoritarian regimes. Of note was the urging by participant Patrick Vinck [8, 9]:

Whoever compiles and provides information to a community has a responsibility for what happens with that information, which raises a host of ethical questions. What does information mean? How should it be interpreted? How should it be shared and with whom? Finally, technology can bear witness to what has happened. And that furthermore, Sensitive data need to be archived and protected. Many groups in the public and private sectors have collected large amounts of data, but there is no clear responsibility for storing the data.

The fourth and final workshop of the USIP-NAE Roundtable, *Harnessing Operational Systems Engineering to Support Peacebuilding* [10], sought to answer the question: "When can operational systems engineering, appropriately applied, be a useful tool for improving the elicitation of need, the design, the implementation, and the effectiveness of peacebuilding interventions?" (p. 1). An example given was "depicting context, trends, and triggers as a systems map" (p. 16). Given that peacebuilders tend to generate and use metrics to assess and measure progress, the workshop sought to initiate a dialogue between peacebuilders and operational systems engineers in order "to begin to identify what additional types of nonnumeric systems methods might be applicable to peacebuilding" (p. 4). Participant Sharon Morris [11] stressed that field-based peacebuilding projects tend to operate in environments with extremely poor technical support: "I have seen some very complex systems being developed, and they are not going to work. Our field team in Iraq is all Iraqi, they are living under deep violence every day, and asking them to take on a whole new complicated system isn't going to work. So the simpler we can keep these tools and approaches, the better" (p. 20).

Reports of all four workshops are available to the public and may well be used as pedagogical resources in peace engineering curricula.

III. CEES Workshop: Engineering, Social Justice, and Sustainable Community Development

Through an initiative of the NAE's Center for Engineering, Ethics and Society (CEES), a workshop was held on *Engineering, Social Justice, and Sustainable Community Development* [14]. The second of the workshop's four goals was to improve engineering practice in situations of crisis and

conflict. Of particular relevance to peace engineering was the session on Engineering and Special Vulnerabilities, summarized as:

> Engineers and engineering organizations operate in circumstances of crisis, ranging from conflict to disaster. They operate where human rights problems are highly visible and where issues of sustainable community development arise. This session reports perceptions about the technical and social constraints and opportunities they face and whether and how aims for humanitarian action, social justice, and sustainable community development can be met. (p. 5)

Charles M. Vest, then NAE president, opened the workshop by emphasizing the "intricate connections between science and engineering and larger social, political, and economic systems," stressing that "as the complexity of these interactions increases, they can geometrically increase the difficulties of determining the right thing to do, and determining the pathways for achieving sought after solutions" [1] He called on engineers to adopt a global vision. In a similar vein, participant Christopher Seremet [13] reflected:

> In emergency situations, constraints over human rights and social justice affect technological decisions, and engineers must be prepared to operate beyond their normal comfort zone. They will be forced to deal with situations for which traditional educational programs have not prepared them, and they must put aside deliberate, thorough processes of data collection, analysis, and planning and identify problems and formulate solutions quickly, often during the initial visit to the site. These constraints raise substantial concerns, particularly for inexperienced engineers. Decisions made under these circumstances, which can have life or-death implications, may have to be based on inadequate information, rapidly changing conditions, and a very slow rebuilding process. Such situations call for empathy and other "people skills" as much as, or perhaps even more than, engineering skills. It might even be difficult to identify an effective engineering solution. (p. 7)

While Vest called for global vision in the face of social-political-economic-technological complexity, Seremet called for empathy in dire circumstances. Are global vision and empathy necessary qualities for peacebuilders? For Chic Dambach the answer is yes; these are necessary, but not sufficient. It's essential, he says, that engineering skills are also leveraged for a combination of skill sets not provided by higher education, because "There is a gap in the engineering education."

IV. Filling the Gap in the Education of Engineers

Chic Dambach is president emeritus of the National Peace Corps Association, former president of the Alliance for Peacebuilding, and former chief of staff for Congressman John Garamendi. His career began as a Peace Corps volunteer in Colombia, and his memoir, *Exhaust the Limits: The Life and Times of a Global Peacebuilder*, features a lifetime of service and successful initiatives for peace in Africa [14]. He has been nominated for the 2017 Nobel Peace Prize, and the Institute for Economics and Peace presented him with the Leadership and Service for Peace Award in 2016. He was named the 2016 Peace Corps Champion for keeping the spirit of service alive.

In reflecting on the qualities needed by engineers working for peace, Dambach stressed the crucial need for "systems thinking."[15] "We peacebuilders," he explained, "are increasingly incorporating systems thinking into what we do. We work with engineers who understand the dynamics of systems thinking and how it's done when applied to the peacebuilding world." As for the question of compassion, he light-heartedly responded: "Compassion, yes—even among engineers!" He continued: "Can compassion be a quality we cultivate in engineering education, along with acumen for mathematics and attention to the details of design, systems thinking, and the like? Systematic, logical, critical thinking must be a part of bringing peace into the world. Overly idealistic thinking will not solve the problem."

"Peacebuilding is at the heart of it," exclaimed Dambach, explaining that the Norwegians came up with that term in the 1970s. The Alliance of Peacebuilding, which he served as president, thought the new term was important because the peacebuilding concept is not something that just happens; it is something that has to be designed, developed and sustained. "This engineering element is a massive change in the approach over the last couple decades. It used to be approached from a religious or ideological standpoint," Dambach recalled, "but without thinking about how. Now the peacebuilding community is asking, How do you actually make it happen?" Through systems thinking, Dambach answered. "It's crucial, and is now a universally accepted premise in the peacebuilding world." For examples, he pointed to the Global Peace Index and the Positive Peace Index, declaring,

> Those indices came from an engineer—a high school dropout, self-taught, welcomed by computer scientists as a software engineer. Someone who, after great professional success, turned his attention to peacebuilding, applying data analysis and systems analysis and engineering approaches to better understanding the dynamics of peace and conflict, and how one builds the infrastructure of peace…. At least we now have the work of Steve Killelea!

Stressing Killelea's [16] application of technical skills to peace engineering, Dambach asserts that engineering acumen and systems thinking are essential for peacemaking. Similarly, Sheldon Himelfarb [17], in his opening remarks to the 2018 Peace Tech Summit, spoke of building an international Peace Tech Industry where the power of data, tech, and media combine to prevent violence, create jobs, and build peace. Implicating technology as a significant factor in the tripling of major civil war outbreaks over the last decade, he lamented that technology has largely been blamed for the dramatic rise in conflict. But what's actually happened, he explained, is that technology has been hijacked by bad actors for warring purposes, for example in Rwanda, where radio was used to spread hate propaganda. However, Himelfarb clarified that although technology is blamed, the solution is more technology, not less. Technology has the power to change attitudes and behaviors and to promote speech. The question he poses is, "How do we get smarter about using technology to prevent the

cycle of violence, and to anticipate the use of technology for those purposes?" [18] Technology can be used just as effectively to promote peacebuilding as it has been used by others to promote hatred. Training, he said, is key, with over 1200 civil organization worldwide, having been trained by the peace lab he created to use technology for peace building. As a proof of concept, Himelfarb points to Drexel University, which created the first master's program in peace engineering. The Peacetech Lab, pioneering Drexel University, and now other schools of engineering are beginning to fill the knowledge gap, Dambach noted, by using technology for the purposes of peace. In filling the knowledge gap of engineers, as identified by Damback [14], ought Peace Engineering programs to also attend to the need for cultivating global vision, as called for by Vest? [1].

In 2008, the NAE identified 14 Grand Challenges for Engineering in the 21st Century, as a call to action and a focal point for society's attention to opportunities and challenges affecting our quality of life. The NAE Grand Challenges Scholars Program [24] offers a combined curricular and extra-curricular program (including service learning), designed to prepare students to be the generation that solves the grand challenges facing society in this century. Current NAE president Dan Mote speaks of the Grand Challenges for Engineering as the first global vision for engineering in history: *continuation of life on the planet, making our world more sustainable, secure, healthy, and joyful*. Perhaps in that way, the Grand Challenges Scholars program could help Peace Engineering programs to cultivate global vision in its students As for Seremet's [13] call for cultivating empathy among engineers, not everyone would agree on empathy's being a worthy quality for these purposes. Adam Waytz [19] describes it this way:

> Empathy is all the rage pretty much everywhere…. It's at the heart of design thinking, and innovation more broadly defined. It's also touted as a critical leadership skill…. But recent research (by me and many others) suggests that…though empathy is essential to leading and managing others—without it, you'll make disastrous decisions and forfeit the benefits just described—failing to recognize its limits can impair individual and organizational performance.

Waytz argues that empathy can be exhausting, zero-sum, and can erode ethics. What about teaching compassion instead, he suggests. Empathy means putting oneself in another's place; compassion, he explains, literally means "to suffer together." He asserts:

> Among emotion researchers, it is defined as the feeling that arises when you are confronted with another's suffering and feel motivated to relieve that suffering…. Compassion is not the same as empathy…. While empathy refers more generally to our ability to take the perspective of and feel the emotions of another person, compassion is when those feelings and thoughts include the desire to help. (What is Compassion?)

Germer and Bonhoff (see ch. 4 in [20]) point to compassion as fundamentally relational and as an inner strength that improves psychological well-being, a skill that can be enhanced through practice, and an emotional resource that can be directed toward oneself. The question is how and whether to integrate compassion into a peace engineering program.

V. Can Compassion Be Taught?

According to Thomas G. Plante [21], some young children appear to be born more compassionate than others and are more attentive to the needs and concerns of others. Studies from his research lab at Santa Clara University suggest that compassion can be taught throughout the lifespan. Plante found that college students who participate in either domestic or international service learning immersion trips, spending time with people who are economically impoverished and marginalized, do, in fact, become more compassionate (based on follow-up assessments). Kolher-Evans and Barnes [22] developed the "model of influence (MOI)," a theoretical framework that defines four levels to facilitate the development and teaching of value-oriented concepts such as compassion, which they attest lead to "taking action and embracing the influence we have to make a difference in the lives of others through compassionate acts" (p. 34). Level one of the model is to "Develop Consciousness." They explain:

> The teacher of older students can use her students' interests to build a curriculum that allows them to become more aware of a global issue, problem, or situation, then begin to engage in activities and instruction, which affords them an opportunity to learn about the subject at a deeper level. (p. 35)

Level two, "Acknowledge Perspectives and Affirm Beliefs," fosters acceptance of new ideas, compassion, and awareness that various perspectives (beyond one's own) do exist. The authors propose offering students "other ideas" to consider or engage in perspective taking, "to deepen their knowledge of how others may interpret, analyze, and reflect on various concepts, thoughts, statements, and ideas" (p. 35). "Realizing the benefit to oneself and to others" is the third level of their model. While it is often easier for individuals to identify how something will benefit themselves, it is more difficult is for students to recognize the relevance of their lives to others. "In other words," the authors ask, "how is each life connected to others' lives, and how can lives be used to be productive, compassionate, and caring members of mankind?" The fourth level of the Kolher-Evans / Barnes model for teaching compassion represents the highest level of the framework because it requires one to take some courageous steps to initiate necessary change—steps that might seem daunting, challenging, foolish, or daring. Each previous level requires one to "do something" such as study more, ask more questions, engage in more discussion, do more research. This level of action and embracing influence encourages students to develop and seek a sustainable response to an issue, problem or concern. It might be difficult for some students who may not necessarily see themselves as difference makers, nor might they recognize the gifts and talents they have to offer. (p. 35)

While most of the academic literature on teaching compassion is focused on health care, nursing, physician training, and the elementary and secondary educational setting, there is a growing body of literature on bringing mindfulness practices into engineering education. Brown and Ryan [23] define mindfulness as a state of consciousness that involves attending to one's moment-to-moment experience. Concerned that engineering education typically focuses on narrow analytical training at the expense of fostering important skills in creative thinking that are fundamental to developing innovative solutions to these engineering challenges, Ricken et al. [24] have found that "a mindful attitude is correlated with innovation self-efficacy and that students with a highly mindful attitude tend to participate in learning experiences related to design and innovation," suggesting that mindfulness "may promote foundational skills for successful entrepreneurship such as innovation, learning, and motivation" (np). Research has yet to be done correlating mindfulness training of engineering students to a quality of compassion, as such nay be important for peace engineering.

VI. Conclusion: Peace Engineering Education and Resources of the NAE

Engineering has a tremendous capacity for making significant contributions to achieving peace, for short-term conflict resolution, and longer-term preventive and peace-keeping measures. And in its capacity to draw from some of the best engineering minds in the world, the NAE can contribute to that effort. For one, the Grand Challenges Scholars Program identifies fourteen critical areas in need of engineering vision and skill, arguably also needed to secure peace. For another, in addition to the availability of workshop reports (as outlined earlier), the Online Ethics Center of the NAE's Center for Engineering Ethics and Society is considering the possibility of an OEC section for "ethics and peacemaking," inviting contributions of cases, studies, presentations, and multimedia resources for peace engineering education.

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[4] Pamela Aall is a senior advisor for conflict prevention and management at the US Institute of Peace (USIP) and senior fellow at the Center for International Governance Innovation (CIGI). She was founding provost of USIP's Academy for International Conflict Management and Peacebuilding and headed the Institute's education and training programs for a number of years.: Summ

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[6] Melanie Greenberg is president and CEO of the Alliance for Peacebuilding (AfP). She is a leader in the peacebuilding and conflict resolution field, and a subject matter expert in countering violent extremism, atrocities and conflict prevention, conflict affected countries and fragile states, and international transitional justice and international law. Before joining the AfP, she was the president and founder of the Cypress Fund for Peace and Security, a visiting scholar at the Johns Hopkins School for Advanced International Studies, and director of the Conflict Resolution Program at the William and Flora Hewlett Foundation.

[7] Michael Shipler is associate vice president, Strategy and Program Quality for Search for Common Ground. He previously served as Asia Regional Director for Search for Common Ground where he oversaw programming in eleven countries and offices in Indonesia, Kyrgyzstan, Myanmar, Nepal, Pakistan, Sri Lanka, and Timor Leste. He established SFCG's program in Myanmar and Central Asia.

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[9] Patrick Vinck is a research scientist at the Harvard School of Public Health and Associate Faculty with the Harvard Humanitarian Initiative (HHI). Before joining HHI in 2011, he directed and cofounded the Initiative for Vulnerable Populations at UC Berkeley's Human Rights Center, where he focused on managing and implementing empirical studies on the process of social reconstruction in countries affected by mass violence.

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[11] Sharon Morris is deputy assistant secretary of state for Near Eastern, Western Hemisphere, and European Affairs in the Bureau of Conflict and Stabilization Operations (CSO). Before joining USIP, she directed Mercy Corps's Youth and Conflict Management Office (2008–2013). In 2007, she worked at the State Department as the senior advisor for Darfur to the Special Envoy for Sudan.

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