



2023 Issue 3 // Volume 119

THE BRIDGE

The Magazine of IEEE-Eta Kappa Nu

Humanitarian Technologies for a Sustainable Society

Leading the Global Frontiers of IEEE Humanitarian Engineering and Technologies Programs

Addressing the Digital Divide and Mitigating the Risk of AI by People-Centered, Collaborative Digital Regulation

Empowering Communities Through Emerging Technologies: Advances in Antennas for Software Defined Radios

Why Community Engagement (Still) Matters?

THE BRIDGE is recognized by APEX for the 10th year in a row

IEEE-Eta Kappa Nu



Humanitarian Technologies *for a Sustainable Society*



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The Magazine of IEEE-Eta Kappa Nu



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Dr. Jason K. Hui

Epsilon Delta Chapter

THE BRIDGE, October 2023

Letter from the Editor-in-Chief


Dear IEEE-HKN Members and Friends,

The theme of this issue of *THE BRIDGE* magazine is "Humanitarian Technologies for a Sustainable Society," and we're pleased to highlight content written by some of the most dedicated individuals involved in the humanitarian engineering space, all with a passion and vision of advancing technology for the benefit of humanity. We express our gratitude to guest editor, Professor Mohamed Essaaidi, 2023 IEEE Special Interest Group on Humanitarian Technology ([SIGHT](#))

Committee Chair and Sampathkumar Veeraraghavan, 2023 IEEE-HKN President, for planning and coordinating the feature articles. This month's society spotlight is fittingly on the [IEEE Humanitarian Technologies Board \(HTB\)](#), which was formed in November 2022 after the IEEE Board of Directors approved its elevation from the IEEE Humanitarian Activities Committee. Lwanga Herbert, 2023 IEEE HTB Chair, is our featured professional member.

The fall is always an exciting time as students are back in school and HKN activities are in full swing. The premier event of the society is the IEEE-HKN Student Leadership Conference (SLC), taking place this year on November 3-5 at the University of Houston. More information on how to donate to the SLC fund to support our students can be found on [page 31](#).

We're pleased to announce that for the tenth consecutive year, IEEE-HKN and *THE BRIDGE* have been recognized with an [APEX Award for Publication Excellence](#). Congratulations to former Editors-in-Chief Dr. Sahra Sedigh Sarvestani and Dr. Steve Watkins and IEEE-HKN Director Nancy Ostin for receiving a Grand Award for the October 2022 issue on Engineering Space Exploration. Additionally, kudos to Dr. Katelyn Brinker, Dr. Jason Hui, and Nancy Ostin for being recognized with an Award of Excellence for their contributions to the IEEE-HKN website redesign. This issue also recognizes the winners of the 2023 IEEE-HKN Awards for their outstanding accomplishments and contributions, exemplifying a balance of scholarship, service, leadership, and character.

IEEE-HKN strives for effective communication through its various channels, including our [website](#), YouTube, Facebook, LinkedIn, and this magazine. The Editorial Board welcomes your ideas and content and can be contacted by email at info@hkn.org. And as always, *THE BRIDGE* is available on the [IEEE App](#) (older archival issues can be found in the [Engineering and Technology History Wiki](#)). 



Prof. Mohamed
Essaaidi

IEEE SIGHT Chair

THE BRIDGE, October 2023

Intro from the Guest Editor


Dear IEEE-HKN Members and Readers,

We are pleased to introduce this special issue of *THE BRIDGE* magazine dedicated to Humanitarian Technologies and their outstanding potential to address the most pressing challenges of our time, such as sustainability and climate change, and to contribute to the achievement and acceleration of the 2030 UN Sustainable Development Agenda. As our planet faces ever-increasing environmental, social, and economic challenges, the role of technology and engineering in addressing these challenges and promoting sustainable solutions has never been more critical.

The theme of Humanitarian Technologies transcends boundaries and touches every aspect of our lives, from the energy we use to the food we eat, the transportation we rely on, and the way we design and build our communities. Engineers and technologists play a pivotal role in shaping a more sustainable world.

In this issue, we have gathered insightful articles, thought-provoking essays, and inspiring contributions from distinguished authors from various backgrounds and organizations who explore a wide range of topics in relation with Humanitarian Technologies and their impact on addressing all kinds of challenges facing our society. We extend our heartfelt gratitude to all of them for making this special issue possible. Your passion, expertise, and unwavering commitment to leverage technology and innovation to address global societal challenges have enriched our pages with valuable insights and solutions.

We hope this special issue serves as a source of inspiration and a catalyst for change. It is our belief that by sharing knowledge, fostering technology, engineering, and innovation, and encouraging collaboration across disciplines, we can pave the way for a more sustainable, equitable, and prosperous future.

The journey towards the wide-spread use of humanitarian technologies to address global challenges and to build sustainable and prosperous society is ongoing, and the IEEE-HKN community is at the forefront of this transformative endeavor. Together, we can leverage technology, engineering, and innovation to create solutions that protect our planet, improve the well-being of all its inhabitants, and ensure a brighter future for generations to come. 

With warm regards,

Prof. Mohamed Essaaidi, IEEE SIGHT Chair, essaaidi@ieee.org



Sampathkumar
Veeraraghavan

Global President, 2023
IEEE Eta Kappa Nu

Greetings!

Dear HKN Members,

I'm excited to connect with you all through this message. First, I'm really proud of the IEEE-HKN *THE BRIDGE* editorial team's effort for this issue on Humanitarian Technologies (HT). This is such an important global topic of interest. Engineers through their technological innovations and solutions, play a critical role in solving universal sustainable development challenges. Personally, my journey with IEEE started as a student involved in developing assistive technologies to help children with disabilities in developing nations. The social impact of those projects inspired me to work on a portfolio of global programs in the humanitarian engineering space, serving millions of marginalized populations over the last two decades. HKN played a vital role in shaping my leadership skills and nurtured my interest and passion to serve humanity at large. As a HKN member, I find the humanitarian engineering and technology programs strongly align with HKN's founding principles of scholarship, attitude, and character. For HKN student members, the HT programs provide key opportunities to apply their skills for social good.

For this issue, we closely partnered with leading global programs to feature their original articles. I express my sincere appreciation to the authors and our partnering organizations including the National Academy of Engineering, People-Centered Internet, IEEE Humanitarian Technologies Board, EPICS, and IEEE Antenna Propagation Society, for their support and contributions. I'm confident the featured articles will inspire, connect, and engage HKN members to carry out grassroots efforts to address universal challenges faced in their local communities.

Next, I'm thrilled to share with you a few key highlights of HKN's global activities and their impact to date. We started the year with a focus on delivering value-driven global programs to enrich the HKN membership experience. To achieve that goal, we scaled up our global partnership efforts across and beyond IEEE. We partnered closely with all 10 IEEE Regions, key IEEE technical societies, IEEE Technical Activities Board, IEEE Member and Geographic Activities Board, and the IEEE Humanitarian Technologies Board. We have established joint efforts with these organizational units to increase the visibility of HKN across IEEE and deliver key opportunities to benefit our chapters and members at the grassroots level.

Under our global expansion efforts, we successfully organized several workshops on HKN and conducted six professional induction ceremonies of the Eta Chapter at major IEEE regional meetings and Board series to welcome new HKN professional members. We inducted 24 international leaders into HKN at IEEE Sections Congress in Ottawa, Canada which, is one of the largest induction ceremonies in recent times.

One of our top priorities is to deliver an exceptional membership experience and address the key challenges faced by chapter leaders. Our chapter support grant program is growing impressively and has approved grant support for 13 chapters through August 2023. Also, we have successfully coached close to 27 chapters. We have organized a number of podcast sessions on professional skill development. We also approved three new chapters from India, Hungary, and the U.S. Welcome Obuda University, Sri Sairam Engineering College,

You can choose to directly [support IEEE-HKN](#) via the IEEE Foundation to one of the IEEE-HKN Funds: Chapter Support Initiative, including Chapter Support Grants and the "Passing the Gavel" officer training, and Student Leadership Conference. Invest in the next generation of HKN leaders!

and Purdue North West University into our global HKN family!

We received fantastic member engagement in our conference programs. The HKN Tech-X conference received participation from 30 countries, with nearly 300 participants. Similarly, the Pathways to Industry conference received 500 participants globally. I deeply appreciate and thank our speakers, organizing teams, and sponsors from industry and academia for investing in and supporting our conferences.

I'm thrilled to announce the HKN eminent membership elevation to Dr. Sandra Magnus, Ming Hsieh, and Dr. Frank Chang. Congrats to them on this global honor, which is the highest member grade elevation in HKN. This is an outstanding achievement, and it's a reflection of their excellent leadership and significant contributions to the engineering field. I thank the eminent member recognition committee for their excellent work this year.


Our awards committee did a great job this year. We are proud to recognize the 2023 HKN award winners for their outstanding achievements. Please join me in congratulating the 2023 HKN eminent members and the 2023 HKN award winners.

I'm happy to share that the IEEE-HKN *THE BRIDGE* has won the 2023 APEX Grand Award for Publication Excellence in Electronic Media for the October 2022

"Engineering Space Exploration" issue. This global honor reflects the outstanding contributions and leadership of our editorial team and HKN staff team in delivering high-quality content.

Finally, I invite you all to join us at the flagship [Student Leadership Conference \(SLC\)](#) scheduled between November 3rd and 5th, 2023 in Houston, Texas. Also, I request that all chapters actively participate in the 2023 HKN election to select future leaders of the HKN Board of Governors. I look forward to hearing about the HKN Founder's Day activities planned by your chapters.

As your 2023 HKN president, I'm here to serve our members and chapters. Together as a team, I'm confident in building a vibrant life-long global community that will inspire, connect, and engage IEEE-HKN members to advance technology for the benefit of humanity and deliver an inclusive and prosperous future for everyone.

I appreciate and thank all the HKN volunteers, chapter leaders, advisors, alumni, and our staff team for enabling us to deliver a strong bar-raising performance this year. Please contact us for any support. 

Wishing you all the best!

Sincerely,

Sampathkumar Veeraraghavan

THE BRIDGE is recognized by APEX for the 10th year in a row

IEEE-HKN is pleased to announce it has received an APEX Award for Publication Excellence 2023. *THE BRIDGE*, October 2022, has won a Grand Award in the Electronic Media category for the issue "Engineering Space Exploration" https://www.nxtbook.com/nxtbooks/ieee/bridge_issue3_2022/ and an Award for Excellence in the category Websites: WordPress Sites for our website, www.hkn.org. To see the list of all winners, go to: <https://apexawards.com/winners-2023>

This is the 10th consecutive year IEEE-HKN and *THE BRIDGE* has been recognized with an APEX Award. Congratulations to Editors-in-Chief Steve Watkins and Sahra Sedigh Sarvestani for *THE BRIDGE* and to Katie Brinker and Jason Hui for their work on the IEEE-HKN website redesign.





Global Impact: SIGHT global leaders visiting a power plant in Abuja, Nigeria

Leading the Global Frontiers of IEEE Humanitarian Engineering and Technologies Programs

Sampathkumar Veeraraghavan, Senior Member, IEEE; Mohamed Essaaidi, Senior Member, IEEE

Abstract

We are living in the age of mass personalization, where advancements in artificial intelligence and emerging technologies are revolutionizing the way people interact and live. At the same time, we still live in an era where millions of people are living in extreme poverty, lacking access to clean water, basic sanitation, electricity, the Internet, quality education, and healthcare. To address these global challenges, a systematic framework to drive a collective commitment for sustainable development is offered by the **United Nations (UN) Sustainable Development Goals (SDGs)**. The 2030 Agenda for Sustainable Development, embraced globally in 2015, outlines a shared blueprint for peace and prosperity through 17 SDGs. To achieve these goals, we need global solutions to tackle the grandest challenges facing our planet. Thus, engineers play a key role in driving sustainable development through their innovations and solutions. The Institute of Electrical and Electronic Engineers (IEEE) is the world's largest technical professional organization dedicated to advancing technology for the benefit of humanity.

In recent years, IEEE and its members have become increasingly involved in humanitarian technologies and sustainable development programs. Today, IEEE offers a

portfolio of global programs to inspire, connect, and engage its members at the grassroots level so they can leverage their technical and leadership skills to address universal challenges. IEEE established the Humanitarian Technologies Board (HTB) in 2022 to offer a centralized platform to nurture and support various IEEE humanitarian engineering programs. Today, IEEE offers several key programs in the humanitarian space, including IEEE Special Interest Group on Humanitarian Technologies (SIGHT), IEEE Smart Village, IEEE Engineering Projects in Community Service (EPICS), IEEE Mobile Outreach Vehicle (MOVE) for disaster relief and outreach, and IEEE Empower a Billion Lives. These programs support a wide range of projects that use technology to address universal challenges and contribute to the SDGs and sustainable growth. This article will highlight key challenges related to SDGs, climate change, IEEE humanitarian programs, emerging technologies for SDGs, and critical design factors to implement technology-based humanitarian programs.

Keywords: IEEE, IEEE HTB, SIGHT, IEEE Smart Village, EPICS, MOVE, Humanitarian Technologies, sustainable development, UN SDGs, climate change, IEEE Eta Kappa Nu, social innovations, Humanitarian Engineering, Emerging Technologies, and Brahmam Innovation Model.

I. Introduction

Universal challenges and SDGs: According to recent United Nations studies, nearly 50% of the world's population still faces various universal challenges like poverty, hunger, disease, and environmental degradation, which are further exacerbated by ongoing climate change challenges. These challenges are significant in nature. For example, about 800 million people globally have no electricity, about 2.6 billion people lack access to clean cooking fuels, about two billion people worldwide don't have access to safe drinking water today, roughly 50% of the world's population is experiencing severe water scarcity for at least part of the year, and nearly three billion people are yet to have access to the Internet, creating a huge digital divide.

Importance of SDGs: To address these pressing universal challenges, the 2030 Agenda for Sustainable Development created the Sustainable Development Goals [1], which were adopted by all United Nations Member States in 2015. The SDGs provide a shared blueprint for peace and prosperity for people and the planet, now and into the future. It provides a coherent direction and an actionable framework, bringing together all UN member states to address universal challenges collectively through global partnership.

The UN SDGs represent a collection of 17 global goals with 168 targets that aim to address pressing global challenges. The COVID pandemic in 2020 has had a tremendous impact on progress towards achieving the SDG targets by 2030. According to the 2023 Sustainable Development Report [2], only 18% of the SDGs are on track to be achieved by 2030. This is particularly true for goals related to basic health outcomes and access to basic infrastructure and services. Also, climate change is another major threat to the achievement of all of the SDGs, and SDG 13 (climate action) is essential for addressing this threat. By taking action to address climate change, countries can help protect people and the planet, and they can also help promote sustainable development. Thus, there is an increasing sense of urgency to deliver both engineering solutions and policy that will accelerate progress towards achieving the SDG targets.



UN SDGs

Why do SDGs and Humanitarian Challenges Matter to Engineers?

Addressing the SDGs provides a novel opportunity for engineers, both from an innovation and economic standpoint. The field of sustainable development and humanitarian engineering is a multi-dimensional domain. It provides a great opportunity to bring together engineers, policymakers, governmental organizations, non-profit players, global organizations like the UN, and local communities to leverage technology for the greater good of humanity.

The SDGs and engineering solutions are strongly interconnected. At the core of the innovation cycle, the needs of humanity at large drive the advancement in science and engineering domains. Engineers develop solutions to meet community needs through research and product development. The utilization of those solutions by communities again leads to emerging needs, which drives the cycle of innovation. Thus, solving universal challenges provides an excellent opportunity for engineers and IEEE members to deliver solutions that will have a broader impact on a global scale. Tackling the universal challenges at the grassroots requires strong capacity building and global partnership. For example, the Brahman Innovation Model published in [9] offers an ecosystem and a systematic framework to engage a network of locally trained engineers to partner with local communities, policymakers, and local partners to collectively deliver solutions at the grassroots to achieve the SDGs. Hence, fostering collaboration and strong coordination among the stakeholders, such as engineers, policymakers, local partners, and the community, becomes a key factor in delivering a high-impact humanitarian engineering program.

Technology as a whole, and in particular emerging technologies, have the potential to play a major role in addressing sustainable development, and SDG-related challenges, including climate change. For instance, technology can be used to improve agricultural yields, reduce poverty, provide clean water and sanitation, deliver healthcare, and mitigate the effects of climate change.

II. IEEE Humanitarian Technologies Board (HTB)

IEEE is a global professional organization for the advancement of technology. IEEE, with its tagline "Advancing Technology for Humanity," has a long history of working to use technology to solve problems and improve people's lives. In recent years, IEEE has become increasingly involved in humanitarian technologies and sustainable development.

In November 2022, the IEEE Board of Directors approved elevating the IEEE Humanitarian Activities Committee (HAC) to the newly formed IEEE Humanitarian Technologies Board (HTB).

HAC's achievements set the stage for HTB to build upon its growth by deepening partnerships with IEEE organizational units, providing members with engaging opportunities, and representing IEEE externally to build awareness of the role of technology in sustainable development. The HTB transition is a major milestone for humanitarian technology activities at IEEE.

The core vision of HTB inspires and empowers IEEE volunteers around the world to carry out and support impactful humanitarian technology activities at the local level. HTB's mission is to support impactful and ethically informed volunteer-led initiatives, programs, and projects, and mutually beneficial partnerships, as well as inform policy formulation that harnesses technology and innovation to address societal challenges (including disaster recovery) in a responsive, effective, and sustainable way.

Today, HTB is centered on the following four areas of strategic focus:

- 1) Raising Awareness:** HTB increases understanding of the role of engineering and technology in sustainable development.
- 2) Training:** HTB provides educational resources and opportunities so that humanitarian technology participants can have a greater positive impact.
- 3) Supporting Humanitarian Technology and Sustainable Development Activities:** HTB awards funding for grassroots IEEE member projects that utilize technology to address local challenges.
- 4) Building a Sustainable Development Community:** HTB collaborates across and beyond IEEE to foster opportunities in sustainable development.



Raising
Awareness



Providing
Training



Supporting
Humanitarian
Technology and
Sustainable
Development
Activities



Building a
Sustainable
Development
Community

IEEE HTB Strategic Areas of Focus

III. IEEE Special Interest Group on Humanitarian Technologies

IEEE SIGHT is a popular feet-on-the-ground initiative operating as an HTB program. SIGHT's global network of volunteers partner with underserved communities and local organizations to leverage technology for sustainable development. As of August 2023, there are over 42,000 individual SIGHT members in 131 countries; 68% are

students or graduate students. Membership grew by over 50% in 2022 and is on track to do the same in 2023.

SIGHT encourages members to form groups to learn about sustainable development, build relationships within their local communities, and implement projects that utilize technology to tackle key challenges that the community is facing. Since SIGHT's inception in 2011, 221 SIGHT groups have been established in 50+ countries.

IEEE SIGHT's vision is that "underserved communities around the world are able to benefit from technology as they seek sustainable solutions to development challenges."

Its mission is to be a network of IEEE volunteers around the globe that partner with underserved communities and local organizations to leverage technology for sustainable development.

IEEE SIGHT's values are:

- To focus on sustainable solutions that make a long term difference in people's lives.
- To operate through local volunteers and partners working with local communities.
- To consider success is only achieved through partnerships, starting with the community and extending to government organizations, NGOs, schools, hospitals, companies, and others.
- For SIGHT and its volunteers to be both effective and sustainable, continuous training and education are essential.
- "Local" is defined by the fact that key leaders of the project are citizens and/or permanent residents of the geographical area in which the project is to take place.

IV. HTB/SIGHT Funded Project Case Studies

The role of engineers in sustainable development is vital, as they are well equipped to implement designs and solutions that address humanitarian issues in the sustainable development space. IEEE facilitates technological solutions to challenges around the world through HTB and its volunteers, who make an impact in the lives of many people in their surrounding communities.

One of HTB's areas of focus is "Supporting Humanitarian Technology and Sustainable Development Activities," such as funding for grassroots IEEE member projects that utilize technology to address local challenges. Since 2013, IEEE HTB (and its predecessor HAC) and IEEE SIGHT have provided funding to IEEE members who have prepared and implemented humanitarian technology and sustainable development projects in their local communities. Since 2013, IEEE HTB and SIGHT have awarded over USD \$3.29 million to 507 humanitarian technology projects and

events so that IEEE members can implement them in their local communities. Projects are required to address one or more of the UN SDGs. Project teams build relationships with the partner community to identify a specific need and develop a plan to address it through the development, customization, or deployment of technology. They consider the relevant environmental, cultural, socio-economic, and infrastructural issues that could affect the project and its impact. Teams partner with local governments, NGOs, schools and universities, neighborhood associations, or companies to deploy the solution effectively.

HTB/SIGHT recognizes that there is a broad range of challenges in the local communities in which IEEE members live worldwide. The starting point for a project should always be the needs of the community, as evidenced through dialogue and relationships with local community organizations and leaders. Projects must focus on people first rather than starting with a particular technology that needs to find a use. That being said, there are areas of particular technical interest for HTB/SIGHT that can act as a guide when determining the technological solution to the community's needs. These include: Agricultural Technology, Climate Sustainability Technology, Information and Communications Technology (ICT), including rural communications and connecting the unconnected, Sustainable Power Technology, Water, Sanitation, and Hygiene (WaSH) Technology, and other technologies to address pressing community needs.

The IEEE HTB/SIGHT direct calls for proposals focus on pressing community needs and typically receive hundreds of submissions each year. For example, in 2021, there were 317 proposals from 45 countries and 59 projects were awarded funding; in 2022, there were 144 proposals from 19 countries and 43 projects were awarded funding; and in 2023, 203 proposals from 23 countries were received.

Impact: In 2021 alone, over 600 volunteers participated in funded project teams. Nearly 20,000 people benefited in communities all over the world. And, almost 120 of the volunteers involved became IEEE members as a direct result of participating. The IEEE HAC/SIGHT Projects Program received the American Society of Association Executives (ASAE) "Power of A" Summit Award in its Global Development category in 2022. This was a historic milestone for IEEE humanitarian activities by winning the ASAE's highest honor for associations that go above and beyond their everyday mission to undertake initiatives that benefit America and the world.

V. Humanitarian Technology Programs

IEEE Smart Village (ISV) has a unique approach to supporting the world's energy-impovertised communities by providing a comprehensive solution combining

renewable energy, community-based education, and entrepreneurial opportunities. ISV provides seed funding to carefully selected community entrepreneurs based upon a credible business plan that will impact a significant number of people with electricity, education and jobs.

IEEE EPICS was founded in 1995 at Purdue University. It was created to meet a two-fold challenge: providing community service organizations with the technology they need to improve and deliver services, and providing undergraduate students with educational experiences to broaden their skills. EPICS helps fulfill the IEEE core purpose of fostering technological innovation and excellence for humanity. We provide funding, support, mentorship, and visibility for engineering projects in four core categories of community improvement.

The IEEE MOVE initiative encompasses a dual-purpose objective: providing support for mobile communications and engaging in STEM (Science, Technology, Engineering, and Math) education outreach efforts. IEEE is expanding this award-winning program to provide relief and outreach on an international basis. The next phase of deployment includes India and the Caribbean, which are frequently affected by severe storms.



2021-2022 IEEE HAC Global Chair, Sampathkumar Veeraraghavan receiving the Global Development Award at the 2022 ASAE Summit

IEEE Empower a Billion Lives is a global competition aimed at fostering innovation to develop solutions for electricity access. Solutions are expected to be scalable, regionally relevant, holistic, and leverage 21st-century technologies at an exponentially declining price.

IEEE Climate Change Initiatives [14] launched recently in 2023 focuses on creating activities to engage the IEEE community of engineers and technologists worldwide, to use their expertise and develop solutions for many critical climate change issues.

IEEE HTB and SIGHT Joint Society programs: HTB has a strong partnership with many leading societies like IEEE APS, MTT-S, ComSoc, SPS, RAS, PES, etc. which runs its version of SIGHT programs and humanitarian activities.

VI. Harnessing Emerging Technologies for SDGs and Climate Change

Engineers through their technological innovations change the way the world interacts, works and lives. They play an important role in bringing positive changes to the lives of people from underrepresented communities across the globe. While technology evolves rapidly, there is a pressing need to develop solutions that cater to solving the most pressing global humanitarian issues [9]. Technology and especially emerging technologies can play a major role in helping to achieve the SDGs, and address and mitigate the effects of climate change. The following are some specific ways in which technology can help:

- **Reduce greenhouse gas emissions:** Technology can help to reduce greenhouse gas emissions in a number of ways. For example, renewable energy technologies, such as solar and wind power, can help to replace fossil fuels. Energy efficiency technologies can help to reduce energy consumption. And carbon capture and storage technologies can help to capture and store carbon dioxide emissions.
- **Improve energy access:** Technology can help to improve energy access in developing countries. For example, solar powered lamps can provide light to people who do not have access to electricity. And mobile phones can be used to provide access to financial services and education.
- **Protect water resources:** Technology can help to protect water resources by reducing water pollution and increasing water efficiency. For example, water treatment technologies can help to remove pollutants from water. And drip irrigation systems can help to reduce water waste.
- **Improve food security:** Technology can help to improve food security by increasing crop yields and reducing food loss. For example, drought-resistant crops can help to cope with climate change. And smart farming technologies can help to improve crop management.
- **Build resilient infrastructure:** Technology can help to build resilient infrastructure that can withstand the impacts of climate change. For example, flood resistant buildings can help to protect people from flooding. And early warning systems can help to warn people of impending natural disasters.
- **Promote sustainable consumption and production:** Technology can help to promote sustainable consumption and production by reducing waste and increasing the use of recycled materials. For example, 3D printing can help to reduce waste by creating products from recycled materials. And smart transportation systems can help to reduce traffic congestion and emissions.

These are just a few of the ways in which technology can help to achieve the SDGs and address and mitigate climate

change effects. As technology continues to develop, we can expect to see even more innovative ways to use technology to solve the world's most pressing problems. The following are some specific examples of emerging technologies that have the potential to help achieve the SDGs and address climate change:

- **Artificial intelligence (AI)** can be used to develop new ways to reduce greenhouse gas emissions, improve energy efficiency, and protect water resources. For example, AI can be used to optimize traffic flow, which can reduce emissions and improve air quality.
- **Blockchain** can be used to create more transparent and efficient supply chains, which can help to reduce food waste and improve food security. For example, blockchain can be used to track the movement of food from farm to table, which can help to ensure that food is not wasted.
- **Internet of Things (IoT)** can be used to collect data about the environment and to monitor the performance of infrastructure. This data can be used to improve decision making and to identify opportunities for improvement. For example, IoT can be used to monitor water levels in rivers and lakes, which can help to prevent flooding.

VII. Critical Design Factors for Implementing Technology-based Humanitarian Programs

To deliver an effective technology driven humanitarian engineering program, one should follow a “bottom-up” approach. First, we should always work backwards from the needs of the local communities/end-users. We should engage closely with the community and understand their ecosystem to address their short-term and long-term needs.

Most importantly, we should check whether the proposed solution is relevant to the problem at hand or investigate if a meaningful alternative approach exists. In addition, understand how the solution will deliver value to various stakeholders involved and positively contribute toward achieving SDG for local communities. It is also important to measure the impact both qualitatively and quantitatively so define a suite of metrics to measure various dimensions of the program success.

The following are some key factors to consider while designing a technology centric sustainable development program:

- **Needs Assessment:** Conduct a thorough assessment of the specific humanitarian needs in the target area.
- **Understand the challenges,** demographics, cultural nuances, and existing resources to tailor the technology solution to the actual requirements.

- **Appropriate Technology:** Choose appropriate and accessible technology that suits the local context. Consider factors like infrastructure, available resources, technical expertise, and scalability.
- **User-Centered Design:** Prioritize user-centric design principles. Involve the beneficiaries and local communities in the design process to ensure the technology solution addresses their unique needs and preferences.



Key design factors for Humanitarian Engineering Programs

- **Sustainability:** Develop a plan for the long-term sustainability of the program. This includes considerations for maintenance, training, capacity-building, funding sources, and partnerships.
- **Localization and Cultural Sensitivity:** Ensure that the technology solution is culturally sensitive and relevant to the local community. Adapt interfaces, content, and communication methods to resonate with the target audience.
- **Data Privacy and Security:** Implement robust data privacy and security measures to protect sensitive information and maintain the trust of beneficiaries. Comply with local and international regulations.
- **Scalability and Flexibility:** Design the program to be scalable and adaptable to changing circumstances. Consider how the technology solution can be expanded to reach more beneficiaries or address evolving needs.
- **Partnerships and Collaboration:** Collaborate with local organizations, governments, NGOs, and other stakeholders to leverage their expertise, resources, and networks. Joint efforts can enhance the program's reach and impact.

- **Training and Capacity Building:** Provide comprehensive training and capacity-building programs to empower local communities to use and maintain the technology. This fosters ownership and ensures the program's sustainability.
- **Monitoring and Evaluation:** Establish clear metrics and indicators to measure the program's impact. Regularly assess the effectiveness of the technology solution and make necessary adjustments based on feedback and data.
- **Communication and Engagement:** Develop effective communication strategies to engage beneficiaries, gather feedback, and foster a sense of ownership. Maintain open channels for dialogue and continuous improvement.
- **Resilience and Adaptation:** Account for potential disruptions such as natural disasters, conflicts, or economic challenges. Design the program to be resilient and capable of adapting to unforeseen circumstances.
- **Ethical Considerations:** Address ethical concerns related to the use of technology in humanitarian contexts. Ensure the program respects the dignity, rights, and autonomy of beneficiaries.
- **Local Empowerment:** Empower local communities to take an active role in the program's design, implementation, and decision-making processes. This helps build trust and ownership.
- **Documentation and Knowledge Sharing:** Document the program's processes, lessons learned, and best practices. Share this knowledge within the humanitarian community to contribute to broader learning and improvement.

By carefully considering these critical design factors, a technology-based humanitarian program can be better equipped to address the unique challenges and opportunities of the target area, ultimately leading to a more effective and impactful intervention.

VIII. Relevance of IEEE-HKN with Humanitarian Technologies

IEEE Eta Kappa Nu (IEEE-HKN) is an international honor society founded in 1904 and merged with IEEE in 2010. Today, IEEE-HKN has over 200,000 lifetime members and 269 global chapters. The core founding principles of HKN are Scholarship, Attitude, and Character. These core tenets resonate harmoniously with the society's overarching mission, which centers on promoting excellence in engineering and fostering ethical leadership among its members.


Through the lens of humanitarian technologies, HKN members are equipped with the tools to transcend traditional engineering boundaries, addressing real-world challenges and affecting positive change on a global scale. By embracing technological advancements that prioritize social impact, HKN not only aligns with its founding principles but also emboldens a generation of engineers to channel their expertise toward creating solutions that improve the human condition.

IEEE-HKN students are well positioned to engage with humanitarian technologies through their affiliation with the organization. By becoming members of IEEE SIGHT, they gain access to a platform that empowers them to translate their technical acumen into meaningful action. This translates into forming SIGHT groups that function as dynamic hubs for collaboration, driving the development of projects that target critical societal issues. These projects, guided by the principles of humanitarian technology, not only showcase the practical applications of engineering but also demonstrate the profound impact that technology can have on underserved communities.

By fostering an environment that encourages the exploration and implementation of innovative solutions to global challenges, HKN instills in its members a sense of purpose that extends beyond traditional academic pursuits. In this way, the partnership between humanitarian technologies and IEEE-HKN catalyzes a holistic approach to engineering education that marries technical excellence with social responsibility.

IX. Conclusion

This article has shed light on the transformative potential of technology in addressing the world's most pressing challenges, as encapsulated by the UN SDGs and the urgency of climate change. IEEE's unwavering commitment to fostering a culture of social responsibility within the engineering community has yielded a rich tapestry of innovative programs and initiatives such as HTB, SIGHT, ISV, EPICS, and MOVE.

From the formation of SIGHT groups that champion local solutions aligned with the SDGs, to the creation of Humanitarian Technology education resources that cultivate a new generation of environmentally conscious engineers, the IEEE-Humanitarian Technologies Programs stand as a testament to the organization's dedication to making a positive impact on both people and the planet. Furthermore, the collaboration between IEEE HTB, through its diverse humanitarian programs, and IEEE-HKN fosters a comprehensive approach to engineering education, uniting technical proficiency with a strong sense of social responsibility. 

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Addressing the Digital Divide and Mitigating the Risk of AI by People-Centered, Collaborative Digital Regulation

Mei Lin Fung and Jascha Stein

Abstract

The digital divide continues to persist, with profound negative impacts on people's lives such as poorer health outcomes, social isolation, and reduced access to jobs and education. We explore the various and complex reasons for the digital divide, including regional, demographic, and event-driven factors, highlighting the urgent need for agile and precise policy interventions. To address this challenge, we propose a value-based, participatory approach to digital regulation, synergizing technological opportunities with a humanitarian ethos.

We introduce methodologies like the Cross-Sector Digital Regulatory Sandbox, Independent Trust Agents, and Prosperity Data Networks, creating an artificial intelligence (AI)-supported, people-centered digital world. By prioritizing regional collaboration, public involvement, and the inclusion of Small Medium Enterprises, we envision bridging the digital, economic, and social divides. Our research underscores the importance of tangible and intangible societal contributions and maps a route to a globally equitable digital future enhanced by AI, where technology augments human capabilities and reinforces resilient, inclusive, prosperous societies.

I. Introduction

"The international community has a long history of responding to new technologies with the potential to disrupt our societies and economies.... The AI for Good summit, convened in Geneva last month, brought together experts, the private sector, UN agencies, and governments to help ensure the groundbreaking technology serves the common good. ... We must work together for AI that bridges social, digital, and economic divides, not one that pushes us further apart. I urge you to join forces and build trust for peace and security".

Antonio Guterres UN Secretary General July 21, 2023 [1]

Today, digital technology has revolutionized the way we connect, creating a world where communication is instant and borders are transcended. Mobile phones, the devices and symbols of this global unity, have brought people closer than ever before, but they have also exposed a worrying and widening divide. While digital integration extends across the global North and South, reshaping lives, families, businesses, and institutions, the expanding use of technology simultaneously creates a profound digital divide that persists in various forms.

This divide is not just a technological challenge but a complex societal issue that demands immediate attention to sidestep a

preventable crisis. The digital divide stretches across regional, demographic, and socio-economic boundaries, contributing to disparities in access to technology, information, jobs, healthcare, education, and opportunity. While we expected bridges to connect and bond people living in different worlds, digital bridges highlight and expose stark differences when people living in poverty and facing disasters and hardship watch videos of wealth, waste, and indifference. The mingling is often discordant, causing people, families, and communities to be caught in a tumultuous crossfire between contrasting values and ideals, a collision of western science and ancient philosophies.

Moreover, the digital evolution has led to a blurring between our homes, workplaces, and community spaces, while also widening the gap in capabilities between those with access to technology and those without. Children with less access to technology fell behind in schooling during COVID.^[2] The promising renaissance of digital innovation is now being overshadowed by the realization that digital tools often best serve elite for-profit entities, restricting opportunities for many, particularly the marginalized, women, poor, rural, elderly, handicapped, and indigenous.

Amid this complexity, the rise of AI adds another layer to the dilemma. While many tout the new horizons AI promises, others raise alarms about its potential risks, including exacerbating the digital divide. AI's transformative potential can either bridge or widen the gap, making the response to these challenges a matter of profound societal significance. The future of our humanity cannot be sorted out based only on maximizing profit or power. People make decisions and act for many reasons, not all of which can be simultaneously optimized for the individual, for the family, or the community. Therefore, we call attention to the critical need for a people-centered, collaborative approach to digital regulation. By introducing concepts like the Cross-Sector Digital Regulatory Sandbox, Independent Trust Agents, and Prosperity Data Networks, we identify practical ways to leverage technology's immense potential while addressing the complex and nuanced challenges of the digital divide. We, the people, must be involved in developing digital regulation that serves the people with participative governance, emphasizing people-centeredness and integrity. Our goal is to actively address and humanely and lovingly close the digital divide, crafting a globally equitable digital future that enhances human capabilities and where technology serves as a bridge rather than a barrier. We now have the tools to practically plan and engineer a path to a world where digital inclusion is a driving

force, paving the way to an AI-supported, people-centered digitized world that fosters resilient, inclusive, prosperous societies.

2. Fostering Unity through Dialogic Public Participation

In addressing the current digital and other divides, the emphasis on a dialogic approach to public participation emerges as not only crucial but also powerful and transformative. An ongoing, inclusive dialogue among stakeholders can form the backbone of collective decision-making, intertwining diverse perspectives to craft policies and strategies that resonate on multiple levels.

The essence of this participatory ethos, while idealistic in some aspects, is foundational to the Digital Cross-Sector Regulatory Sandbox Network and builds on research conducted by one of the authors,^[3] which documented how networks of communities and multi-sector players achieved breakthrough outcomes through structured collaboration. The network of sandboxes tracking cross-sector impacts, deeply influences the digital regulatory mechanisms, encompassing both design and implementation.

Within the contemporary backdrop of swift societal transitions and escalating complexities, there is an evident and pressing need for astute public participation in developing and recognizing insights to shape future regulation. Far from being a mere process, participation, feedback, and collectively learning how to improve how to digitize can serve as a stabilizing anchor in turbulent times. Such active public engagement fortifies societal bonds, bringing about a renewed sense of shared responsibility, shared learning, and shared ownership over policy decisions.

This collective approach inherently boosts public trust and broad acceptance of policies, which are in effect the best that we could all come up with together. When structured and executed with care and precision, public participation acts as a catalyst for fostering a harmonious and equitable society. In the broader context, this engagement empowers societies with the essential skills and cultivates the 'can-do' resilience needed to tackle challenges, whether they are faced within small communities, expansive states, diverse regions, or on a global scale.

3. Applying the Sandbox Concept for Adaptive Digital Regulation to Evolve Regulation Securely

Originating from software development, the 'sandbox' concept provides a controlled environment for testing digital solutions and regulatory frameworks.^[4] This method offers real-world testing without posing significant risks to the broader ecosystem. Adopting sandboxes in policymaking is done to foster agility, adaptability, and innovation, ensuring regulations remain relevant amidst fast-paced digital changes.

Many countries are exploring regulatory sandboxes. Since 2000, the World Bank and the International Telecommunications Union have worked with 12 countries and are pioneering 5th generation collaboration regulation.^[5] Over 70 countries have launched sandboxes,^[6] including 14 in Africa.^[7]

Example: Singapore's FinTech Regulatory Sandbox

Notably, the Monetary Authority of Singapore launched the FinTech Regulatory Sandbox in November 2016^[8], sharing insights at the annual Singapore Fintech Festival^[9] which in 2022 attracted a global audience of 62,000 from 115 countries.

4. Collaborative, Regionalized Digital Regulatory Sandbox Networks Addressing Individuals and their Community's Needs

Operating sandboxes within a sandbox network at national, multi-country, and global levels creates opportunities for parallel experimentation. This approach can inspire and accelerate localized learning, collaboration, and teamwork while generating data that can materially guide, align, and harmonize digital regulations, fostering a cohesive digital regulatory environment.

Regional collaboration allows countries to not only expedite their learning processes but also share common challenges and co-create solutions with neighboring states. Such collaboration enhances the innovation process and increases the efficacy and pertinence of regulations in both digital and analog spaces. By fostering a collaborative network, individuals from different regions facing similar problems can unite in a continual cycle of experimentation, learning, and refinement to devise collective solutions.

In software development, sandbox networks like GitHub and Stack Overflow have received acclaim for their success. Governmental sectors are beginning to adopt similar models. For example, the United States Federal Health and Human Services' Health Resources and Services Administration (HRSA) serves 30 million people in underserved communities. Since 1995, a HRSA network of nearly 9,000 US Federally Qualified Health Centers has engaged multi-sector stakeholders in thematic "Breakthrough Collaboratives" using "Plan-Do-Study-Act" improvement methods. Over the past 27 years, community multi-stakeholder partnerships that materially address nationwide health challenges and improve population health have been documented by professors at Duke University Medical School.^[10]

5. Role of Independent Trust Agents for People and their Organizations

The Digital Cross-Sector Regulatory Sandbox Network is built on three core values: participation, people-centeredness, and integrity. These principles not only drive decision-making but also assist in resolving conflicts and foster relevance and sustainability. Central to upholding and governing these values is the Independent Trust Agent (ITA). While the decentralized nature of a network of sandboxes could lead to disarray, ITAs play a pivotal role in ensuring structure, integrity, outcomes improvement, and people-focused conflict resolution in the digital regulatory framework. Operating as non-governmental organizations, ITAs serve as bridges, promoting information and data exchange across the private, public, and social sectors. They set standards for data sharing, access, analysis, and aggregation.

We propose merging two distinct types of ITAs—financial and data protection—to forge an ITA tailored for digital regulation. In financial regulation, an independent trust agent is an external body responsible for verifying compliance with financial norms. They ensure businesses uphold rules and prioritize their clients' or investors' best interests, using audits and investigations to bolster trust in the financial ecosystem.

In data protection and privacy, an independent trust agent is a third-party entity that evaluates and confirms a company's adherence to data handling standards, ensuring user privacy. They also mediate disputes between data subjects and controllers.

Merging the functions of financial and data protection ITAs into a digital regulation ITA harmonizes industry objectives and government oversight, and serves the public interest. By promoting trust and transparency, ITAs have an essential function to assure a solid foundation underpinning an equitable digital ecosystem, so we can nurture inclusive and prosperous societies.

6. Integrating Small Medium Enterprises and Prosperity Data Networks to Enable People's Participation in Business

Small Medium Enterprises (SMEs), often considered the backbone of the economy, play a crucial role in ensuring a balanced digital regulatory landscape. The integration of SMEs into digital regulation development can offer a vital counterbalance to the dominance of large corporations, particularly multinationals, in the digital regulatory decisions of a region or country. This is especially significant for developing regions and countries that are embarking on their digital transformation journeys. The economist Frederich Hayek emphasized the significance of harnessing diverse "knowledge of specific circumstances in time and space," which individuals acquire throughout their life experiences.^[11] For this unique knowledge to effectively translate into innovative products and services, SMEs require accessible credit avenues.^[12]

Presently, microenterprises and SMEs in developing countries can access only 42% of the investment funding necessary for growth and job creation. To bridge this gap, we suggest the formation of Data Cooperatives^[14] for SMEs, known as Prosperity Data Networks (PDNs).^[15]

PDNs are envisioned as vital components for broader, risk-managed financing for SMEs, facilitating access to global institutional and private finance. A PDN node is a data repository authorized by SMEs who contribute data to be shared for the purpose of accessing finance or other (intangible) assets. Each data repository within the PDN functions as a cooperative, managed by its data contributors – the people and their respective organizations.

Composed of federated (local, state, national, regional, and international) layered AI-powered data repositories,

the PDN for a community, a region, or a country may be analyzed and compared with regional, national, or global PDNs in order to facilitate cross-border financing for SMEs. PDNs increase access and participation to valuable information, finance, and (intangible) assets, enabling businesses, especially SMEs, to flourish in a competitive global landscape.

7. Digital Assets for All: Crucial for Inclusive Participative and Fair Economies

Over the last 40 years, the percentage of intangible goods in the S&P 500 has increased from 30 to 90%.^[16] Stock markets enable public companies to access finance, particularly in developed markets where intangible assets are prevalent. As the world digitizes, valuing these intangible assets leads to clearer assertions of title or property rights. While established companies and renowned artists capitalize on this trend, SMEs and budding artists face challenges. While top musicians can sell their rights to specialized management groups, emerging artists struggle to find channels to assert and manage their rights.^[17]

SMEs, pivotal to economies, have historically faced challenges asserting ownership of digital assets.^[18] To tackle this, we suggest the establishment of digital registry research labs. These labs would focus on how digital asset registries can empower local businesses and individuals to define, claim, and manage ownership over their digital assets. These assets can be artistic, intellectual, cultural, and more.

For example, the prints on batik cloth produced in an Indonesian village could be 1000-year-old patterns, but how does the village "assert ownership" of the national and global digital rights to various uses of their traditional patterns? Beginning to sort out these issues in digital registry research labs can support all enterprises as they digitize, enhancing the innovation and resilience of the business models of the future.

8. The Digital Cross Sector Regulatory Sandbox Network connecting the Regional Sandboxes as Nodes: Addressing Digital, Economic, and Social Divides

Our vision of the Digital Cross-Sector Regulatory Sandbox Network transcends digital regulation and does so to achieve the aim of bridging digital, economic, and social divides, fostering an inclusive environment where every individual, regardless of gender or marginalized status, has a voice. Inclusivity in shaping the digital landscape and the associated institutions and regulations is vital to avoid neglecting the perspective of active members of society who have not, up until now, been included in digital dialogs.

By using voice-enabled conversational AI and PDNs to qualify and quantify participation in the informal sector, irrespective of financial valuation, we can collect data that reveals the value of family, friendship, caregiving,

and respecting elders who paved the way for us. This broader view promotes equality and dignity and recognizes contributions that extend beyond monetary worth.

The proposed regulatory sandbox network, using AI-driven insights into both formal and informal societal and economic structures and prioritizing SMEs, advances social and economic equality. The sandbox network informs our understanding of the task that digital regulation can do, so we can design and apply “law of the land” digital regulation that works for the people in each local community. Furthermore, we can monitor the consequences of the “law of the land” digital regulation in the sandbox network to understand if it is working as intended or if unforeseen consequences are causing harm, and be effective and responsive.

The accelerating rate of change in digital transformation requires digital regulatory mechanisms that can keep pace. No one regulatory regime in one sector or in one country can do this, but collectively in regional sandboxes and in global tracking of regulatory decisions, we can learn faster to mitigate risks, prevent harms, be more resilient, and increase opportunities for prosperity. By championing inclusivity, ensuring transparency, and encouraging public engagement, collaborative digital regulation can significantly complement national digital transformation journeys to build fairer societies that are responsible to all who live in them.

9. Conclusion: Closing Digital Divide to Craft a Harmonious, Inclusive Tomorrow

As we navigate the rapidly expanding landscape of digital technology, our journey takes us to the precipice of vast possibility and profound responsibility. The digital divide we confront, shaped by intricate complexities and multifaceted disparities, is not just a hurdle to overcome but stands as a critical challenge to the very essence of our shared humanity.

Our exploration of various methodologies and approaches has led us to a deeper understanding, not just of the technology that defines our era but also of the values, principles, and ethics that must underpin our collective digital future. More than a national quest for digital transformation, it is a global call to action for a more just, empathetic, and inclusive world.


The future we envision is not one of isolated solution but of interconnected opportunities where digital tools and AI not only augment our capabilities but also strengthen our connections, bridging societal divides and fostering universal access. This goes beyond mere policy interventions or technological advancements; it encapsulates a philosophy, a human-centered ethos, that places people, in all their diversity, differences, history, heritage, traditions, culture, and potential, at the core of the digital revolution.

In this vision, small and large enterprises, marginalized communities, and global institutions coalesce in a harmonious symphony of collaboration, where prosperity and opportunity are not just buzzwords but tangible outcomes

accessible to all. It's a world where digital assets are not confined to enriching the elite but are part of a broader social and economic tapestry that enriches everyone's lives.

At the heart of this vision is a commitment to integrity, transparency, and participative governance. It's a future where technology is not a distant, abstract concept but an intimate part of our lives, a tool that resonates with our values and amplifies our aspirations.

The urgency of closing the digital divide is not a fleeting concern but a lasting testament to our ability, or lack thereof, to create a world where technology serves all of humanity. The solutions we have explored and the insights we have gleaned are stepping stones on a path that leads to a future where digital inclusion is not an ideal but is becoming a lived reality.

In the end, our collective response to the digital divide will be a defining chapter in our shared story. It's not just about closing glaring gaps; it's about weaving a global tapestry of interconnected lives and destinies where technology is a harmonious counterpoint to the melody of our shared commitment to equality, dignity, and the enduring spirit of human connection. It's a vision of a world not divided by digital lines but united by digital connections, leading to resilient, inclusive, and prosperous societies for all. 

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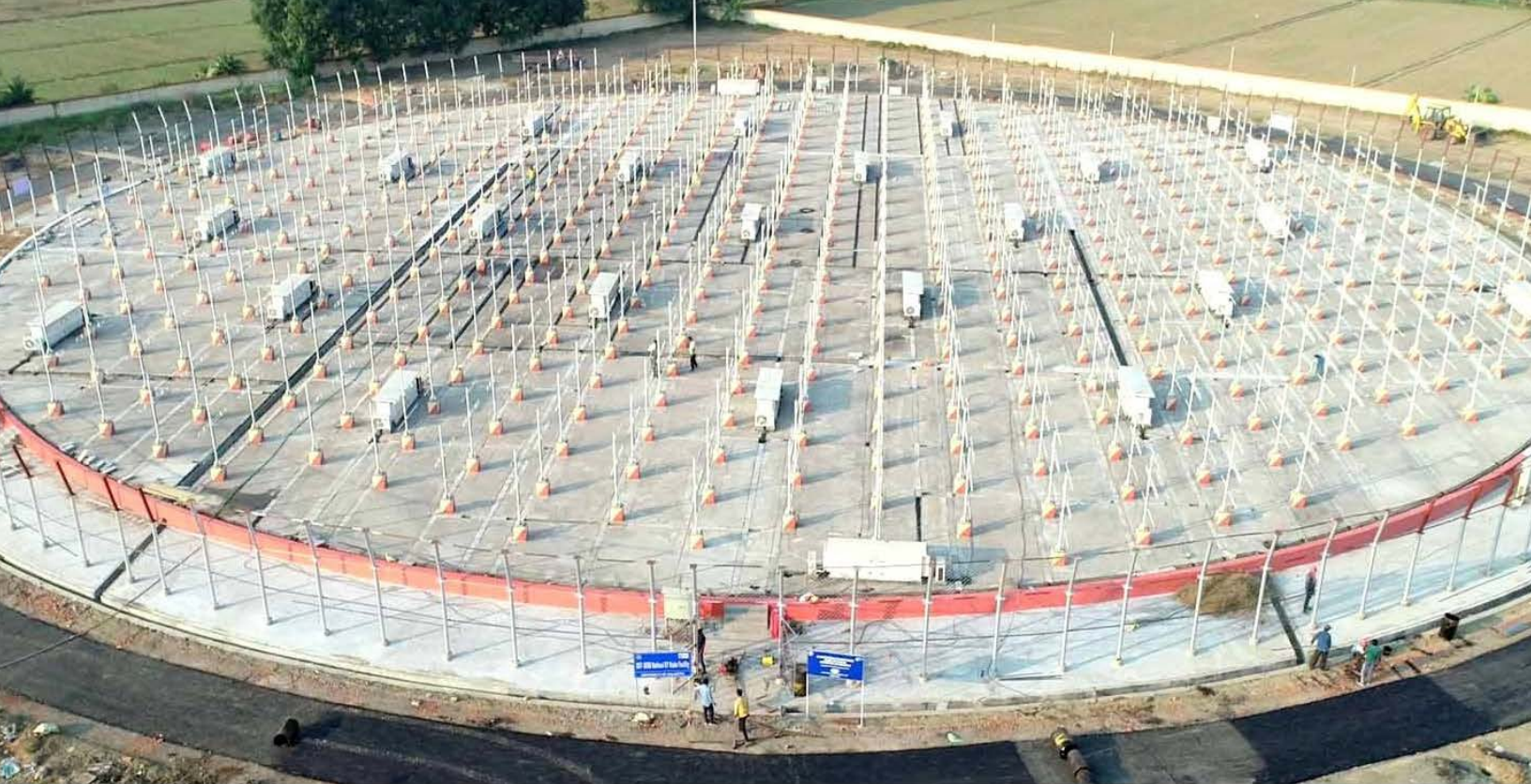


Figure 1. A 53 MHz stratosphere troposphere radar at University of Calcutta

Empowering Communities Through Emerging Technologies: Advances in Antennas for Software Defined Radios

Jawad Y. Siddiqui, Senior Member, IEEE; Ajay Poddar, Fellow, IEEE; Ulrich L. Rohde, Life Fellow, IEEE

Abstract

There are several emerging technologies in the field of antennas and propagation that are shaping the future of wireless communication systems. Some notable examples are advanced new antennas for software-defined radios (SDRs). These advancements in antennas for SDRs have the potential to revolutionize wireless communication. This article explores some of the key future directions for antenna technology for the new generation of SDRs that will drive the next wave of connectivity revolution and their indispensable role in humanitarian efforts, ranging from disaster response to bridging the digital divide.

Index Terms— Antennas, Humanitarian Antennas

I. INTRODUCTION

In today's interconnected world, communication plays a pivotal role in responding to humanitarian crises and driving positive change in underserved communities. Antenna technology is the backbone of modern communication systems and has witnessed remarkable advancements over the years. Antennas serve as the foundation of wireless communication systems, enabling the transmission

and reception of signals over various frequencies. They are essential components of satellite systems, mobile networks, and radio technologies, facilitating data exchange across vast distances. In humanitarian contexts, where traditional infrastructure may be lacking or compromised, antennas become invaluable assets in establishing reliable communication channels. During natural disasters or humanitarian emergencies, conventional communication infrastructure often suffers severe damage, leaving affected communities cut off from external aid and assistance. In these critical situations, portable and resilient wireless solutions come to the forefront. Humanitarian organizations deploy rapidly deployable antennas, satellite communication systems, and mesh networks to reestablish connectivity swiftly. These wireless systems enable vital communication between responders, government agencies, and affected individuals, allowing for coordinated relief efforts and efficient allocation of resources.

Access to quality healthcare remains a challenge in remote and underserved areas. Wireless systems have revolutionized telemedicine, enabling healthcare professionals to provide remote consultations,

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diagnostics, and medical advice [1]. Satellite-based wireless communication in mobile medical units [2] and community health centers extend the reach of healthcare services to isolated regions, improving overall health outcomes and reducing healthcare disparities.

Climate change has emerged as one of the most pressing global challenges of our time. As we strive to comprehend and mitigate its effects, advanced technologies like weather radar have proven invaluable in enhancing our understanding of climate change's impacts on weather patterns, precipitation, and extreme events. Climate change is often associated with a rise in the frequency and intensity of extreme weather events like hurricanes, typhoons, and heavy storms. Weather radar plays a critical role in tracking the formation, movement, and intensity of these events. By capturing data on wind speeds, rainfall rates, and storm structures, radar systems help predict and respond to these events, mitigating their impact on communities and infrastructure. Weather radar is a sophisticated tool that offers real-time insights into various meteorological phenomena, enabling meteorologists and scientists to monitor and analyze changes in weather patterns. Antennas play a critical role in weather radar systems by transmitting and receiving electromagnetic signals to detect and measure weather phenomena such as precipitation, clouds, and other atmospheric conditions. Phased array antennas are commonly used in weather radar systems due to their ability to electronically steer the direction of the beam without physically moving the antenna [3]-[4]. A 53 MHz stratosphere-troposphere radar [4] using 475 Yagi Uda antennas for wind profiling is shown in Fig.1.

In the digital age, access to information and the internet is fundamental to economic and social development. However, many communities around the world still lack reliable internet connectivity. Antennas, particularly those used in long-range point-to-point communication, play a crucial role in bridging the digital divide. By establishing wireless internet connections, remote schools, community centers, and businesses gain access to educational resources, e-commerce opportunities, and global markets.

Antennas are also instrumental in the development of smart agriculture techniques that optimize resource utilization and enhance food security. Through remote sensing and Internet of Things (IoT) technologies, farmers can monitor soil conditions [5], weather patterns, and crop health in real time. This data-driven approach empowers farmers to make informed decisions, leading to increased crop yields and more sustainable agricultural practices [6].

In regions where conventional educational infrastructure is limited, wireless connectivity enables remote learning opportunities. Educational institutions can broadcast lectures and instructional content to students in distant areas via radio or television frequencies. Additionally, satellite-based internet connectivity supports e-learning

platforms, ensuring that students in remote communities have access to quality education and are not left behind in the digital era.

Several new-generation wireless systems are equipped with SDR, where the entire radio would be digital and thus reconfigurable using software. Antennas are a critical component of any communication system, including new-generation SDRs. The choice of antenna can significantly impact the performance, range, and capabilities of an SDR.

Throughout the evolution of antenna technology, from the simple dipole antennas of the past to the advanced phased arrays and printed antennas of today, they have been instrumental in shaping the interconnected world we live in. As we look to the future, exciting prospects for antenna technology emerge, promising enhanced performance, greater efficiency, and novel applications. In the realm of modern communication, the quest for ever-improving performance has led to the exploration of unconventional materials and structures. Metamaterials and reconfigurable intelligent surfaces have emerged as groundbreaking technologies that are transforming the landscape of antenna design. These revolutionary concepts are pushing the boundaries, offering the potential to create antennas with unprecedented capabilities and functionalities.

This article explores some of the key future directions for antenna technology for the new generation of SDRs that will drive the next wave of connectivity revolution and their indispensable role in humanitarian efforts, ranging from disaster response to bridging the digital divide.

II. ANTENNAS FOR SOFTWARE DEFINED RADIOS

A SDR system is a radio communication system where hardware components (e.g., mixers, filters, amplifiers, modulators, demodulators, etc.) are implemented using software. This enables the radio's behavior to be altered and adapted through software rather than requiring hardware changes.

As SDRs continue to advance, the role of antennas in these systems is evolving to match the growing demands for connectivity, adaptability, and efficiency. The future of antennas for SDRs promises to reshape the landscape of wireless communication and redefine how we stay connected in a rapidly changing world. Here are some key trends and developments:

Wideband/Multiband and Reconfigurable Multifunctional Antennas: As SDRs can operate across a wide range of frequencies and communication standards, the demand for antennas that can cover multiple frequency bands or operate over a wide frequency range will increase. Wideband and multiband antennas and reconfigurable multifunctional antennas will become essential to support the diverse capabilities of SDRs, enabling seamless

communication across different networks and protocols. Recent works on multifunctional antennas are documented in [7]-[13]. In [8], a multi-functional and reconfigurable antenna is realized using a pair of split ring resonators (SRRs) and PIN diode loaded in the coplanar waveguide (CPW) feed lines, which constitute a dual-state filter section, exhibiting frequency-notched or narrow band-pass response depending on the status (ON/OFF) of the PIN diode as shown in Fig. 2. Due to this integrated dual-state filter section, the antenna exhibits a unique frequency reconfiguration capability that transforms a frequency-notched wideband antenna into a narrowband antenna. Thus, a single printed monopole antenna loaded with SRRs and PIN diodes on the feed section provides the dual functionality. The design is realized using a printed circular monopole antenna with a wide bandwidth, as shown in Fig. 2(a). It was further demonstrated that the notch frequency and the narrowband frequency can be tuned by changing the physical dimension of the SRR geometry as well as the shape of the SRRs without perturbing the radiator dimension. Potent applications of such reconfigurable antennas are: i) multiple-input multiple-output (MIMO) systems used for high-data-rate applications; ii) cognitive radio (CR) systems of SDR, which demand wideband and narrowband antennas [14], and iii) multiservice, multiband, and multi-standard radio (MSR).

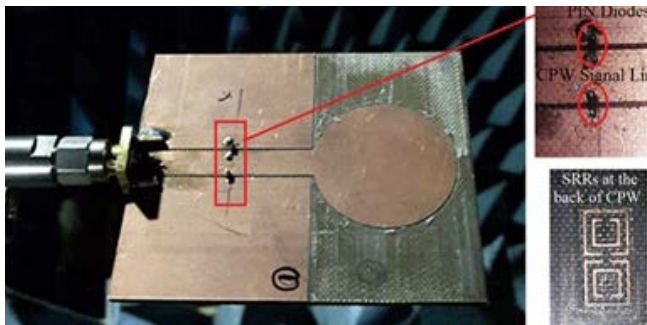


Figure 2(a): SRR loaded multifunctional wideband monopole antenna [8]

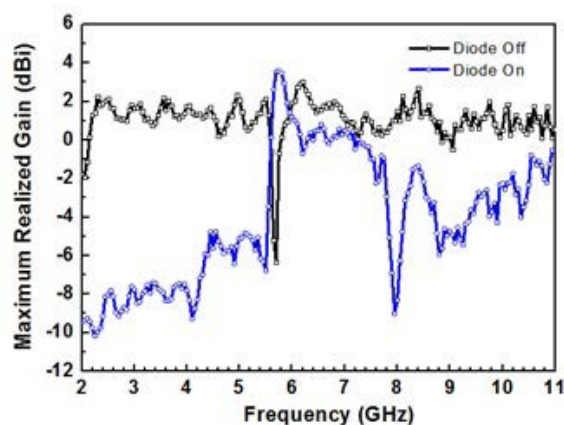


Figure 2(b): Measured realized peak gain of the SRR coupled PIN diode loaded CPW fed printed circular monopole active antenna with diodes OFF and ON conditions [8]

Active Phased Array Antenna for SDRs: The RF environment is often polluted by noise, with interference signals falling in the band of interest with a multipath fading effect on the desired frequency. An active phased array antenna is an array of antenna elements designed to adapt and change the antenna radiation pattern in order to adjust to the radio frequency (RF) environment. The adaptations are realized by performing electrical beam tilting, and beam width adjustments. The antennas can direct beams toward particular users and track user movement; they are also able to steer nulls, reduce sidelobes and self-heal in case one of the array elements stops functioning. An active phased array antenna system helps reduce signal fading, phase cancellation due to multipath and co-channel interference. A combination of antenna array and digital signal processing (DSP) running algorithms makes it possible for the antenna to transmit and receive signals, adapt, and hence perform smart beamforming measures. Every active array comes equipped with a passive radiating element connected to each transmit receive module in the RF subsystem, as shown in Figure 3.

The flexibility inherent in SDRs pairs well with active phased array antennas. These arrays can dynamically adjust their radiation patterns, polarization, and beamforming characteristics to optimize communication in varying environments. This adaptability will be crucial for maintaining reliable connections in scenarios with changing interference, propagation conditions, and network requirements.

Miniaturization and Integration: The trend towards smaller, more compact devices extends to antennas as well. Antennas integrated into SDR modules or devices will need to be designed with miniaturization in mind. This is particularly important for applications like wearables, IoT devices, and portable communication tools used in humanitarian efforts or remote areas.

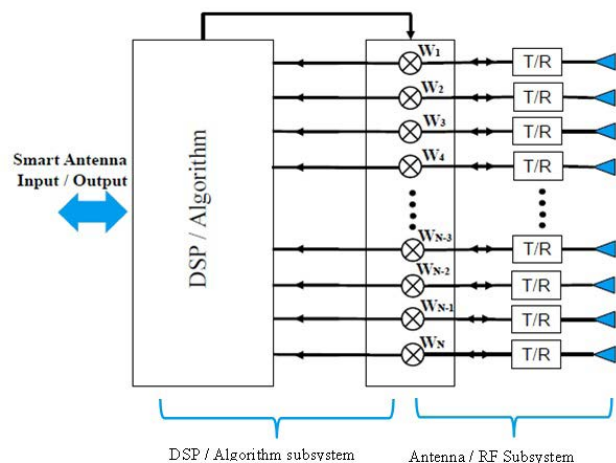


Figure 3: Block diagram of an active antenna

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Smart Antennas and Beam Steering: SDRs' ability to rapidly switch between communication protocols and standards aligns with the capabilities of smart antennas. Smart antennas, equipped with beamforming and beam-steering capabilities, will enable SDRs to optimize signal strength, minimize interference, and dynamically adapt to the direction of communication. This feature will be valuable for high-density urban environments, where signal congestion and interference are common challenges.

Energy-Efficient Antennas: SDRs are becoming more energy-efficient, and antennas will follow suit. Energy-efficient antennas can contribute to prolonging the battery life of portable SDR devices, making them well-suited for extended fieldwork, disaster response, and remote operations.

Localization and Indoor Positioning: SDR antennas could play a significant role in indoor positioning and localization systems. By leveraging signals from multiple sources, such as Wi-Fi, Bluetooth, and cellular networks, SDRs could contribute to accurate and reliable indoor tracking, enhancing navigation and safety in complex environments.

III. APPLICATIONS AND FUTURE PROSPECTS

Massive MIMO and Phased Array Antennas: Massive MIMO and phased array antennas are at the forefront of enhancing wireless communication capacity and coverage. By employing a large number of antenna elements, these systems can simultaneously serve multiple users and dynamically steer beams. As we move towards 6G and beyond, these antennas will be vital in achieving higher spectral efficiency, reduced interference, and better user experiences in dense and dynamic communication environments.

Integrated Antennas for Wearable Devices

The rise of wearable technology calls for compact, low-profile, and efficient antennas that seamlessly integrate into clothing and accessories. Future antenna designs will prioritize miniaturization without compromising performance. These antennas will support a range of applications, including health monitoring, smart textiles, and personal communication devices, transforming the way we interact with technology on a daily basis.

Metasurface Antennas: The recent advances in metasurface antennas are propelling us towards a future where communication systems are more adaptive, efficient, and capable of supporting a wide range of applications. As these technologies mature, we can expect to witness innovations in areas such as satellite communication, IoT networks, autonomous vehicles, and smart cities. The ability to tailor electromagnetic wave behavior with such precision opens up opportunities for solving complex challenges and realizing the full potential of wireless communication. These engineered materials enable antennas with unconventional shapes,

compact form factors, and exotic radiation patterns that were previously unattainable. Metasurface-based antennas are capable of steering beams without moving parts, allowing for agile beamforming and beam-steering applications in communication and radar systems.


Metasurface Antennas for Holographic Beamforming: One of the most remarkable recent advancements in metasurface antennas is the development of holographic beamforming. By tailoring the phase distribution across the metasurface, these antennas can generate complex radiation patterns and dynamically steer beams in real time. This capability has the potential to revolutionize wireless communication systems by allowing for adaptive and efficient use of spectrum resources, improved signal quality, and reduced interference.

Flat Lenses and Imaging: Metasurface antennas are being explored for their ability to create flat lenses that manipulate electromagnetic waves in ways that were previously unattainable with traditional lenses. This technology holds promise in areas such as high-resolution imaging, security screening, and even medical imaging. The precise control over phase and polarization that metasurfaces offer can lead to significant advancements in imaging quality and accuracy.

Quantum Metasurface Antennas: In the realm of quantum communication, metasurfaces are also finding applications. Quantum metasurface antennas can be engineered to emit and receive single photons, enabling quantum information exchange over long distances. This could pave the way for secure and ultra-fast quantum communication networks [15].

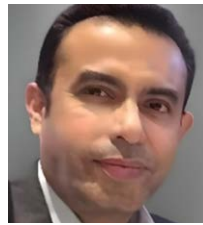
Advanced Materials and Manufacturing: Antenna design will continue to benefit from advancements in materials science and manufacturing techniques. Materials with unique electromagnetic properties and manufacturing processes like 3D printing will enable the creation of innovative and customized antenna solutions.

IV. CONCLUSION

The future of antennas for software-defined radios is exciting and promising. Antennas will play a pivotal role in enabling SDRs to maintain reliable, high-quality communication across diverse scenarios, from urban environments to remote regions and disaster-stricken areas. The synergy between SDRs and advanced antenna technologies will undoubtedly contribute to building more connected, adaptable, and efficient communication systems that meet the ever-evolving needs of our modern world. As technology continues to advance, antennas will remain at the forefront of enabling connectivity and communication, ensuring that no community is left isolated or excluded from the benefits of the digital age. Embracing the full potential of antennas in humanitarian efforts is essential to building a more inclusive and resilient world for all. 

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Why Community Engagement (Still) Matters?

Mary Mathias; Guru Madhavan, Senior Member, IEEE

In the early 1970s, when a group of technocrats took the Green Revolution to Bali, Indonesia, the results were catastrophic. They insisted that the island inhabitants redesign the subak—a centuries-old rice paddy irrigation system deeply rooted in the community's history and values. In place of the sophisticated system with excellent rice yields and means of pest eradication, officials inserted a system of "technology packets" that combined new rice varieties, fertilizers, and an aggressive harvesting schedule, all in the name of increasing production. What they ended up with were decimated rice paddies full of pests and fungus [1, 2]. Had the officials responsibly engaged with the Balinese people and learned about the subak system as well as the community's values and traditions that supported it, the destructive results of their intervention could have been easily avoided.

Engineers affect society in ways unlike many other professions. They can consciously and unconsciously transform lives and affect generations through their creations, and so they spend years training and countless hours designing, testing, and iterating. However, a fundamental portion of any engineering project, particularly with civic objectives, is far too often overlooked or dismissed: *community engagement*. We argue that it's impossible to complete any engineering project successfully without community involvement. And as with Bali, not engaging the public can have pernicious consequences.

The term "community engagement" can and does have multiple connotations depending on how one views it. In general, it is an explicit action focused on working with a community for the community's benefit [3]. This can take many forms for engineers, such as educational programming, town hall meetings, or even focus groups, but at its core, community engagement should ideally deepen the understanding between the engineers and the community and the impacts a project can have over its intended life course.

A key first step in any engineering project should be to listen and reflect. Who is this project for, and whom is it affecting? This necessitates community involvement in every step of a project, from planning and design through execution and evaluation, and all groups within a community, particularly those traditionally marginalized, need to be identified and included [4]. The hallmark of engineering design is to operate under constraints. While some contractors may see community engagement activities as an unnecessary delay for a pre-laid schedule, engineering design should also operate with the highest level of accountability. It is vital that everyone who will be impacted by the work be heard and considered.

In far too many cases over the history of modern engineering, underrepresented and marginalized communities have been overlooked and adversely affected

as a result. Without being a member of a community—be that geographical, racial, cultural, or socioeconomic—a person can't fully understand what it is to be a part of that community: how that community functions, what their needs are, or how something will affect that community. An engineering firm can design a construction project that seems exceptional on paper and perhaps appealing to investors and policymakers, but what if it doesn't lead to where the community needs to go or disrupts an ecosystem the community uses in an altogether different way? Or what if a bridge is helpful but far down the list of priority projects that would benefit a community? These are not novel thoughts. Yet, as engineers, we raise them because assuming we know what the best course of action for a community is will only perpetuate the cycle of marginalized communities being handed technology they cannot or do not want to use, or worse, unintentionally being harmed by projects in which they have no input.

Consider another classic example: People around the world depend on burning wood, coal, or other materials in their homes in order to generate heat and prepare food. These stoves often have detrimental health and environmental consequences, so many, many clean stoves have been created to mitigate these effects. And yet millions of people continue to use these harmful stoves. Why? In many cases, clean stoves don't function in the context of the end user's daily life [5]. Had the engineers who created the un-used stoves engaged with the communities they were trying to help in the development phase of the stoves, they could have learned about how the stoves are actually used, what the community's needs and concerns are, and what stumbling blocks the engineers' initial assumptions may confront.

Community engagement isn't a one-way street. The community too needs to learn from engineers in order to become informed—and constructive—collaborators in a project. With a more nuanced understanding of the background, project, and process, community members would be in a better position to inform the project team of related values and concerns in the planning stages—and even to guide the project team. And they are more likely to accept and integrate the value of a proposed or completed project into their lives. The technology being introduced may be safer, "greener," and cleaner, but common sense suggests that if the intended users don't see its direct value, they will not accept it [6].

Engineers can't merely stop at surveying a community's needs and concerns. They must invest time to share their ideas and the reasoning behind them with the intended community, however controversial. For a technology project with humanitarian intent to be effective, engineers need to discuss and demonstrate the ideas and prime a conversation based on their comfort levels, buy-in, or


dissent. Again, does in-depth community engagement slow a project down? Yes, but by consciously slowing down in this way, projects are better and project teams are more connected with the actual needs of communities, which allows for faster, more prudent advancement overall.

More directly in our work at the National Academy of Engineering, through the Inclusive, Diverse, and Equitable Engineering for All (IDEEA) outreach initiatives focused on K-12 students, we have learned that future engineers want to slow down to better engage with communities. The next generation of engineers, particularly girls and students from other groups underrepresented in engineering, are more interested in engineering if they see it as a career where they can meaningfully contribute to social good [7]. As part of the academy's EngineerGirl program, established in 2001 to bring national attention to the exciting opportunities that engineering represents for girls and women, high school students have served as ambassadors trained in community engagement. The ambassadors have introduced engineering to younger students in their communities, focusing on students with little access to engineering education and role models. Through their efforts, the ambassadors have introduced thousands of students to engineering who otherwise may not have had the opportunity to explore the subject. Not only do the ambassadors better understand the importance of community engagement through direct action as they pursue engineering careers, but all the participants also now have a better understanding of engineering, which will help them be more informed and responsible citizens in the future. Community outreach and engagement can be a tellingly fulfilling cycle.

Involving community members in the process doesn't need to be limited to discussions, debates, and demonstrations. The growing movement of "citizen science" can bring community members in as active participants. Exchanging knowledge between the community and the project team is incredibly valuable, but taking it to the next level and making community members collaborators in the project can lead to all participants being more invested and better outcomes overall [8].

Monitoring a project after it is complete is necessary for evaluation and future work. This is standard practice in engineering. Going back to the clean stoves example, community members using them can report on functionality, gather readings from monitors, and have follow-up conversations with the project team. This was the case in stove-related sensor projects in Uganda and Honduras in 2017 and 2018, respectively, and led to beneficial design changes [5]. By engaging community members in that monitoring and evaluation process, they become more invested in the project, and the project team continues to learn from the community about how their work is being used and they maintain that connection for future projects.

Engineers have an opportunity to delve into the successful—and not so successful—case studies of community engagement to present a path for more

responsible technology development, especially the ones people least understand or are most affected by. As sociologist James Scott observed in *Seeing Like a State*, while discussing examples of the push for advancement leading to new systems being imposed on communities, "formal schemes or order are untenable without some elements of the practical knowledge that they tend to dismiss" [9]. Engineers cannot afford to discount the knowledge and existing systems of the communities they aim to serve. If we fail to focus on the "human" part of humanitarian engineering and technology, we've lost sight of its purpose. 

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Mary Mathias is program officer for the Inclusive, Diverse, and Equitable Engineering for All (IDEEA) outreach initiatives and **Guru Madhavan** is the Norman R. Augustine Senior Scholar and senior director of programs at the National Academy of Engineering.
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Celebrating the Research Contributions of Our Graduate Student Members

Graduate students, an important and growing part of the IEEE-HKN global community, are performing groundbreaking research. We have developed this award-winning section in *THE BRIDGE* to celebrate and elevate their research contributions. The HKN Graduate Student Research Spotlight is a standing feature in *THE BRIDGE*. The profiles of the students and their work will also be shared on our social media networks.


Each profile will showcase the intellectual merit and broader impact of HKN graduate student members' research and provide information about the students' backgrounds and where people can learn more about them and their work.

We will spotlight these achievements while also showing potential graduate students what is possible!

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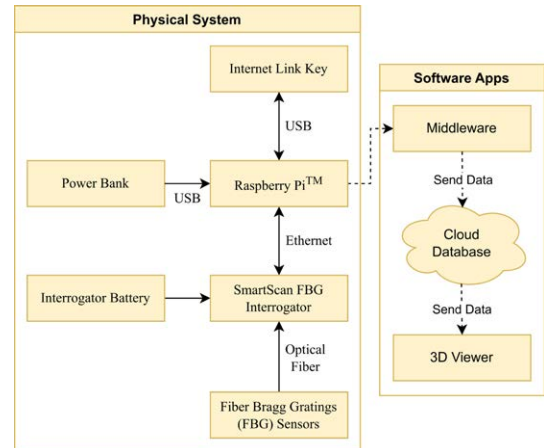
Politecnico di Torino, Ph.D. Student in Computer and Control Engineering



RESEARCH TOPIC

Multivariate Analysis in Research and Industrial Environments

In the metrological field, the sensor can be identified as the component in direct contact with the quantity to be measured. As a result of this contact, it can vary one of its properties, such as electrical resistance or length. This variation can directly provide the measurement of interest, can be indicated via a common display, or can be recorded to carry out checks at a later time. Sensors can be classified according to several factors, including the principle of operation, the application of interest, the measured quantity, and the output quantity. They can produce large amounts of data that can reveal hidden links between the data. Visualization is often used to investigate these properties. The main objective of Antonio's research is therefore to intuitively and innovatively analyze, visualize, and propose the user data from different types of sensors. One of the projects he is involved in is the creation of a system for ground-based, near-real-time recording and display of data from Fiber Bragg Gratings (FBG) sensors mounted on a model aircraft while it is in flight. This type of optical sensor can measure temperatures, strains, pressure, and other quantities. For this reason, interest in it is constantly increasing, especially for monitoring activities concerning structures in general, human health, environmental conditions, and more. This project, therefore, aims to further study this sensor in an unconventional way by recurring to a flying test bench.



Block diagram of the flying test bench. It consists of the physical system, the FBG sensors, the devices needed to measure them, and the software applications needed to send and display data from the sensors



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Han Xu

Alpha

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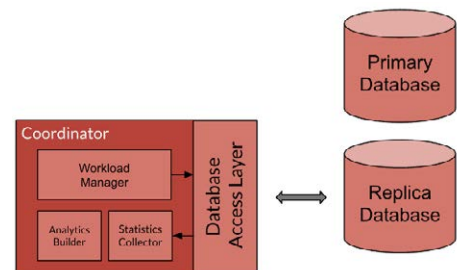


RESEARCH TOPIC

Open-Source Framework for Evaluating Database Replication Performance

Database replication duplicates data from a primary database to one or more replica databases. This process enhances data availability as well as system fault tolerance and reliability. Typically, database replication occurs in real-time as data is created, updated, or deleted in the primary database. Despite its significance, current approaches lack a defined paradigm and specific tools for evaluating the performance of database replication. In previous work, Han focused on assessing the benefits of Read Free Replication (RFR), a feature designed to expedite replication throughput between MyRocks primary and replica databases.

Building on these findings, Han is leveraging his expertise in software engineering and database systems to create an open-source framework. This work enables a more nuanced and customizable measurement of database replication performance across a variety of database systems. The research makes three main contributions: 1) a pluggable design that can accommodate any database system; 2) more customizable workload definitions compared to existing state-of-the-art (SOTA) approaches; and 3) a novel paradigm in measuring database replication.



The architecture of the open-source framework



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Luca Mannella

Mu Nu

Politecnico di Torino (Polytechnic University of Turin), Italy, Ph.D. Student in Computer and Control Engineering



RESEARCH TOPIC

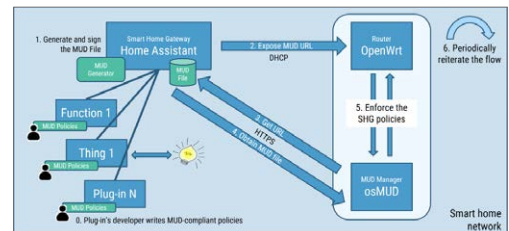
Supporting Developers in the Cybersecurity of IoT Systems

Internet of Things (IoT) systems are still in a critical situation. Currently, despite their widespread adoption, IoT applications often lack adequate protection, leaving them vulnerable to attackers. In light of these challenges, Luca Mannella's research focuses on securing IoT systems by assisting developers, particularly those with limited IoT or security experience. By analyzing prevalent security issues in IoT development, he identifies common pitfalls and proposes guidelines, best practices, and tools for building robust and resilient IoT solutions.

One aspect of Luca's research involves analyzing the security issues that arise when novice programmers develop cloud-IoT systems. His studies reveal typical developers' misconceptions that can sometimes be easily managed by the cloud platform if the developer follows a set of proper guidelines.

Another contribution from Luca's research is the definition of a threat model for extensible smart home gateways. This model helps identify potential issues that may arise from malicious or defective plug-in implementations, promoting the development of more secure gateway applications. He is currently further studying to comprehend if novice programmers can accidentally produce these threats.

He also recently proposed a gateway-based Manufacturer Usage Description (MUD) architecture, extending the MUD standard and leveraging a smart home gateway to protect devices through plug-ins developers' intervention.



A schema of the proof-of-concept implementing the extended MUD architecture



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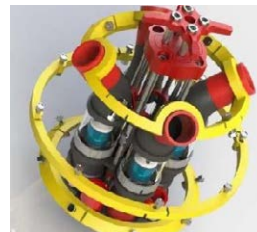
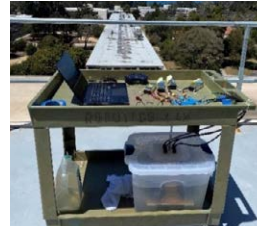
Theta Delta
Naval Postgraduate School, M.S. Student in Electrical Engineering



RESEARCH TOPIC

Modeling and Implementation of Spherical UUV Platform Control System for Littoral and Confined Space Operations

Unmanned underwater vehicles (UUVs) offer a unique opportunity to safely explore areas too dangerous for human divers. The purpose of this research was to model and implement a robust closed-loop control method for the Wreck Interior Exploration Vehicle (WIEVLE), a novel UUV conceptualized, built, and tested exclusively on the Naval Postgraduate School campus. This work builds on previous open-loop testing and experimentation by a capstone Systems Engineering team of students in 2020. Expanding on their work, a MATLAB/Simulink simulation was created to test the proposed control scheme. Further, an implementation was attempted using a drone autopilot adapted for underwater use. In the future, additional components can be integrated with the COTS solution for use. Also, a Robot Operating System (ROS) network architecture can be implemented through an additional Simulink controller and sent to Gazebo simulation software to be tested on a model WIEVLE, shifting the vehicle classification from a UUV to an Autonomous Underwater Vehicle, able to follow position commands and explore environments autonomously. Once the project has matured to physical testing, the ROS network architecture will remain valid, and the Gazebo simulation can be substituted with a physical WIEVLE.



(1) Possible Commercial-off-the-shelf solution adapting a Pixhawk Autopilot to underwater use via ARDUSUB.
(2) Physical WIEVLE Disassembled.
(3) WIEVLE SolidWorks Model.



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EPICS and HKN: Students Improving Communities Through Engineering

Ashley Moran, EPICS in IEEE Program Manager

Engineering Projects in Community Service (EPICS in IEEE) is a program that enables university students in engineering to use their talents for good in their communities worldwide. EPICS in IEEE provides grants for service learning projects in the areas of access and abilities, environment, education and outreach, and human services. EPICS in IEEE projects provide students the opportunity to develop engineering solutions to impact their local community while also gaining critical skills to help them in their future careers. EPICS in IEEE is proud to partner with IEEE-HKN as one way for HKN students and chapters to fulfill their service requirements.

EPICS in IEEE partners with the IEEE Foundation, and our projects are supported by donors. "EPICS is proud to partner with HKN and support the students doing amazing work at their universities," says Stephanie Gillespie, chair of EPICS in IEEE. "By providing EPICS project funding, we hope the chapters will be able to deploy successful projects to better their communities while also engaging the students in their HKN chapters."

In 2023, EPICS in IEEE awarded grants to the [Kappa Psi Chapter](#) at the University of California, San Diego, and the [Iota Delta Chapter](#) at the Stevens Institute of Technology for engineering projects.

Engineering Outreach in K-12 Schools: Kappa Psi

Access to education in engineering in K-12 schools is often reflective of one's socioeconomic status. The Kappa Psi Chapter at the University of California, San Diego, teamed up with the San Diego Unified School District and took note of this issue. With the help of an EPICS IEEE grant of \$2,670.00, the HKN chapter provided support to local residents in San Diego. Twenty-five university students took part in this project, with the help of five non-student IEEE volunteers, to make it come together.

Kappa Psi's project aimed to bridge the STEM education gap by traveling to schools near the university and teaching project-based lessons in mechanical, aerospace, electrical and computer engineering, and computer science. "Our

hope with outreach is that we are able to encourage students to pursue higher education and allow them to explore their capabilities within STEM fields," said Katherine Vu, Outreach Co-Vice President. "We look forward to continuing outreach in this upcoming school year and expanding our program. Specifically, we are gearing our attention towards incorporating teaching pedagogy in our lessons in order to increase student engagement and retention."

Kappa Psi used their grant for transportation costs and for the supplies they needed to conduct the lessons. For example, they used Arduinos, breadboards, household materials, and more.

For this project, the HKN officers created group study classes in which HKN students volunteer and create their own original lesson plans for K-12 students. The officers then contacted the schools that Kappa Psi worked with and organized the lessons and transportation.

One example of these lessons was created about Artificial Intelligence (AI). The lesson begins with gauging the students' knowledge of the topic. The slides have a lot of information about AI, yet they ensure that the student experience is interactive. At one point in the lesson, there is a live demonstration with ChatGPT, which is a popular topic that has been in the news often in recent months. The high school students are learning relevant and current information about the STEM field, participating in the hands-on experience with the program, and having fun while doing so.

The sustainability and maintenance of this project are well organized. Should the HKN officers involved want to continue their service during their time at the University of California, San Diego, they can continue the facilitation of that module. However, if a student graduates or is ready to have other HKN members lead the activity, the officers work to train their successors in what is expected of them in the role. "It has been a pleasure to watch our Kappa Psi students participate in this program. They are motivated to help the students; they have the gusto and find it very rewarding and fulfilling," said Dr. Rakesh Kumar, Faculty Adviser.

Kappa Psi is measuring their success based on student enjoyment, a factor that is important for the continued success of the program. If the students are interested in the topics and the lessons that they are given, it could spark a passion for any type of STEM field. According to Kappa Psi, more than 100 students from socioeconomically disadvantaged backgrounds have benefited from the program as of summer 2023.





Soft Exosuit for Spinal Muscular Atrophy: Iota Delta

To encourage proposal submissions in strategic areas, EPICS in IEEE holds competitions, such as their Access and Abilities competition. University student teams from around the world submit project ideas that are meant to improve accessibility in many different ways, with the top proposals selected for funding. This competition is an IEEE Foundation donor supporter program funded by the [Jon C. Taenzer Memorial Fund](#) established in 2019. This fund is specifically targeted for engineering students in developing countries to support breakthroughs to aid those who are disabled.

The Iota Delta Chapter of HKN at the Stevens Institute of Technology is creating a Soft Exosuit for Spinal Muscular Atrophy (SESMA). Damiano Zanotto, PhD, Associate Professor in the Mechanical Engineering Department at Stevens Institute of Technology, is in charge of the project. Professor Zanotto's group at Stevens has been working with Dr. Jacqueline Montes, who is faculty at Columbia University Medical Center and an expert physiotherapist in the area of neuromuscular disorders. To support their collaborative projects, Zanotto and Montes have received research grants from nonprofit organizations, including CureSMA and the Muscular Dystrophy Association.

This project was awarded a grant of \$4,000 as part of the competition from EPICS in IEEE. Ten university students are involved in the project, with two IEEE volunteers aiding in the process.

The SESMA is an assistive device designed to aid ambulatory patients with Spinal Muscular Atrophy (SMA). According to the team, SMA mainly affects proximal muscles, such as the muscles that flex the hip and extend the knee. This selective muscle weakness makes it difficult for SMA patients to walk, get up from a chair, and climb stairs as they get older. The goal of the proposed solution device is to improve the patient's ability to perform sit-to-stand tasks while being minimally obtrusive.

A wearable technology that meets these needs, such as the SESMA, has the potential to enhance the quality of life of these individuals and their ability to walk. The proposed SESMA design fills gaps that typical ambulatory aids such as ankle-foot orthoses (AFOs), customized semi-rigid footwear inserts, and crutches have. While these devices are helpful,

they call for movements to compensate, which can be detrimental. Existing powered devices are also heavy and bulky, which is not ideal for movement. SESMA has been created to combat these issues and offer an alternative to traditional designs.

The device has been created to be lightweight, semi-active, and focus on knee extension when someone goes from sitting to standing. SESMA is designed to be more comfortable than other solutions as well. The SESMA itself is similar to a pair of compression pants, with a cable that runs down the back to a small actuation unit. The movement of sitting activates the device, using force to compress a spring located in the actuation unit of the exosuit with a small pulley. The gravitational potential energy is converted into elastic potential energy. Once the user sits down, the complete clutch disengages the pulley from the spring.



SESMA is a soft exosuit to assist those with SMA Type in the sit-to-stand movement through reducing total muscle activation and joint torque in the hip, ankle, and knee.

For the standing motion, a different series of actions occur. When the wearer goes to stand, the cable clutch is engaged, and the motor clutch is disengaged. Then, the spring exerts a tensile force on the exosuit cable. The routing path of the exosuit cable is optimized so that a tensile force in the cable generates moments about the hip and knee articulations, which extend the two joints, helping the wearer stand up. When the motion is completed, the pulley clutch is disengaged so that it does not impede the user's motion.

Once the initial prototype is complete, testing will begin following university lab guidance and review. The team is also committed to sharing the designed resources and will create a website to post the code and software for anyone interested in continuing the project. The team's advisers will also be responsible for the maintenance of the project and are committed to following proper testing protocols to see if this device can work in the broader community.

Both EPICS in IEEE and the wonderful members of IEEE-Eta Kappa Nu have used their resources and knowledge to improve communities around the world through the power of engineering. While both projects are still underway, the EPICS in IEEE committee is excited to see the final results when the projects are complete. 

HKN Career Conversations Podcast Offers Crucial Advice for Budding Professionals

In an ever-evolving job market, the journey from commencement to a successful career can seem like an intimidating maze. Enter "Career Conversations," HKN's podcast offering tailored specifically for young professionals embarking on their next steps after graduation. Hosted by HKN Young Alumni Committee members and featuring seasoned industry experts, this podcast offers a treasure trove of insightful career advice, empowering listeners to build a foundation for continued success.



Amy Jones is an HKN Governor-At-Large and Chair of the Young Alumni Committee.

The podcast delves into topics crucial for budding professionals, providing guidance on career planning, navigating workplace conflicts, and managing mental health in the workplace. Each episode features engaging discussions, real-life anecdotes, and actionable takeaways that bridge the gap between academic preparation and the demands of the corporate world and professional academia. The podcast series has built a listenership of over 900

through its various platforms, including YouTube, Spotify, Google Podcast, RSS, and Radio Public.

Listeners can expect to hear from accomplished guests who share their own career trajectories and expertise, offering a diverse range of perspectives and experiences. These conversations not only inspire but also focus on concrete actions. Whether it's understanding the role of public policy in a professional's career, finding and making the most of a mentorship, or defeating imposter syndrome, "Career Conversations" equips its listeners with the tools they need to excel.

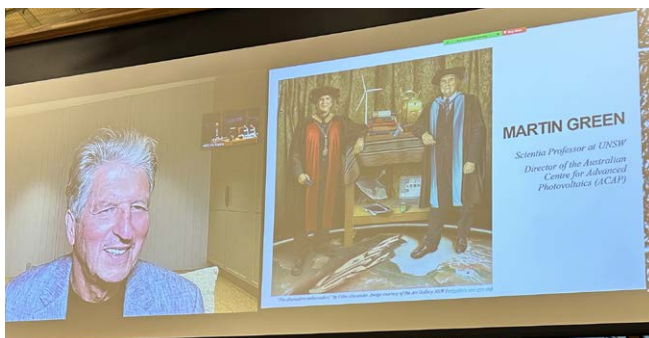
As young professionals contend with the uncertainties of today's world, this podcast represents HKN's dedication to being a source of support for our members throughout their careers. You can subscribe to Career Conversations on [IEEE-HKN's YouTube channel](#), or tune in on Spotify, or your favorite podcast app and unlock the secrets to a successful career!

If you or someone you know would be interested in joining our Young Alumni Committee or in being a guest on Career Conversations, please contact Amy Jones (jonesamyk@gmail.com).

Amy Jones is an HKN Governor-at-Large and Chair of the Young Alumni Committee. 


Mu Kappa Chapter Hosts Lecture by Solar Cell Expert

The Mu Kappa Chapter at the University of Queensland, Australia, organized a technical lecture as a service for its St. Lucia campus. This is the second year that the chapter has taken the lead in hosting such an event. It was held on 19 May 2023 and was open to chapter members, the campus community, and local industry. It featured an online lecture from



Chapter President Sam Mull introduces speaker Dr. Martin Green

Dr. Martin Green, Director of the Australian Centre for Advanced Photovoltaics (ACAP) and Scientia Professor at the University of New South Wales, Sydney. Dr. Green, an alumnus of the University of Queensland, is a prominent researcher in the development of silicon solar cells. His online presentation discussed the history, economic impact, and current research in photovoltaics.

The event was attended by over 69 professionals and students. The chapter was supported by Professor Tapan Saha, faculty advisor for the Mu Kappa Chapter and Professor Michael Bruenig, Head of the School of Information Technology and Electrical Engineering at the University of Queensland. The chapter plans to host similar events in the future. 


New Asad, Gowhartaj, and Jamal Madni Family Scholarship Announced

Thanks to the generosity of the Madni family, a newly-established scholarship will help support three qualified undergraduate student recipients and up to two qualified graduate student recipients pursuing a degree in the fields represented by IEEE-HKN, from an active IEEE-HKN Chapter. The scholarship is another manifestation of the Madni family's commitment to education having already established a scholarship at UCLA. Asad Madni is an Eminent Member of HKN and winner of the Vladimir Karapetoff Outstanding Technical Achievement Award in recognition of his illustrious career as the President of BEI Technologies where he led the development and commercialization of intelligent sensors, systems and instrumentation including the control system for the Hubble Space Telescope's Star Selector.

To qualify for the Madni Scholarship, a student must be a U.S. citizen enrolled as a full-time student in electrical engineering or related fields at an accredited U.S. university or college. Further qualifications include being an inducted member of

IEEE-HKN having completed his or her third year in an IEEE-HKN field of interest. The award will be \$1,000 per student to cover school expenses such as tuition, books, and fees.

The scholarship will be launched at the upcoming Student Leadership Conference. Applications will be accepted from December until April 1. Recipients will be announced by July 30, 2024. The annual selection of scholarship recipients will be administered by IEEE-HKN.

We are grateful for this gift that will help so many students! 




Twenty-three Professional Members Inducted at IEEE Sections Congress

On 12 August 2023, in front of nearly 100 guests and attendees, 23 newly-inducted IEEE-HKN Eta Chapter Professional Members promised to uphold the tenets of HKN, Scholarship, Character, and Attitude at a special ceremony held in Ottawa, Canada, as part of IEEE Sections Congress 2023. The energy was palpable as each new member was called up to be recognized and sign the membership book. The following outstanding members were nominated by their peers in recognition of their contributions to the electrical and electronic engineering fields:



Abdullateef Aliyu
Ravikiran Annaswamy
Esteban Arias-Mendez
Brandy Armstrong
Barbara Bancroft
Robert Becnel
Marc Beebe
Fawzi Behmann
Srikanth Chandrasekaran
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Luis Kun
Maira Marques Samary
Dennis Michaelson
Peter Nagy
Glenn Parsons
Jeewika Ranaweera
Jawed Siddiqui
Christopher Udeagha
Ahmed Yousef

Seven Professional Member inductions have been held so far this year, inducting over 60 new HKN members into the Eta Chapter of the IEEE-HKN Board of Governors, with two additional ceremonies planned for 2023, including one at the November IEEE Meeting Series in Washington, D.C. Professional members play a key role as volunteers on committees, mentoring students, and speaking at HKN events. Congratulations to all! 

Asad M. Madni to Receive the 2022 IEEE Elmer A. Sperry Award at this Year's HKN Student Leadership Conference


IEEE, the world's largest technical professional organization dedicated to advancing technology for humanity, has announced that Asad M. Madni will be recognized with the 2022 Elmer A. Sperry Award in recognition of his leadership in the development and commercialization of the first solid-state gyroscope and its subsequent integration into a complete automotive inertial measurement unit integrated circuit for stability control.

[The Elmer A. Sperry Award](#) is given in recognition of a distinguished engineering contribution that, through application, proven in actual service, has advanced the art of transportation, whether by land, sea, air, or space. The Sperry Award is managed by a board representing six engineering organizations: the American Institute of Aeronautics and Astronautics, the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Institute of Electrical and Electronics Engineers, SAE International, and the Society of Naval Architects and Marine Engineers.

Dr. Madni will be receiving the Sperry Award at the IEEE-HKN Student Leadership Conference Dinner on Saturday, 4 November 2023. Learn more: <https://hkn.ieee.org/>

Dr. Madni was President, Chief Operating Officer, and Chief Technology Officer of BEI Technologies Inc., headquartered in California. His revolutionary contributions to sensors and systems for navigation and stability in aerospace and automotive safety applications have helped save countless lives around the world. The GyroChip and numerous other sensing, actuation, and signal-processing techniques developed by Madni are at the heart of vehicle dynamic control in intelligent and autonomous vehicles through capabilities such

as electronic stability control, rollover prevention, lane change assist, autonomous cruise control, navigation, drowsy-driver detection, drunk driver detection, child seat detection, memory seat sensing, and self-maintenance. They are also used for guidance, navigation, and control, and attitude heading and reference in commercial and military aircraft, UAVs, and space programs.

An IEEE Life Fellow, Madni received the 2022 IEEE Medal of Honor, IEEE's highest award, and the 2022 Prince Philip Medal, the Royal Academy of Engineering's highest individual honor. He is a Distinguished Adjunct Professor/Distinguished Scientist, and Co-supervisor of the High-Speed Electronics Laboratory at the University of California, Los Angeles (UCLA) Electrical and Computer Engineering Department. He is also a faculty fellow with UCLA's Institute of Transportation Studies and the Connected Autonomous Electrical Vehicle Consortium, Los Angeles, CA, USA. He is an HKN Eminent Member and received the HKN Vladimir Karapetoff Outstanding Technical Achievement Award in 2017. 



Princess Anne presents 2022 Prince Philip Medal

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Congratulations to the 2023 HKN Award Winners!

The IEEE-HKN Awards Committee is proud to announce the recipients of this year's awards, honoring those whose contributions define excellence and service to our profession:



Dr. Karen Panetta, 2019 IEEE-HKN President, Dean of Graduate Education of Tufts University, an IEEE Fellow, and member of the National Academy of Engineers and National Academy of Inventors, was named the recipient of the IEEE-HKN's highest honor, the Asad M. Madni Outstanding Technical Achievement and Excellence Award. Dr. Panetta received the award *"for her development of high impact computer vision and simulation algorithms, and for leadership in programs advancing female participation in STEM."* Dr. Panetta pioneered Human Visual System image processing algorithms that endowed computer vision to autonomously evaluate and measure optimal human perceptible imagery and her seminal contributions to concurrent simulation algorithms broke the computational boundary by co-creating the first known Digital Twin simulator. The Asad M. Madni Award is given to a practitioner for distinguishing himself or herself through an invention, development, discovery, or innovation in electrical or computer sciences, engineering, or technology with worldwide impact.



Dr. Colleen Bailey is the recipient of the IEEE-HKN C. Holmes MacDonald Outstanding Teaching Award *"for her impact on electrical engineering undergraduate education and STEM outreach."* Dr. Bailey is the Faculty Advisor of the Lambda Zeta Chapter at the University of North Texas. In addition to her many roles as a professor, advisor and through community outreach, she is an IEEE Stem Champion and is known for advocating for course

and curriculum improvements and prioritizing the quality of life for anyone enrolled at her university. This award was established in 1972 to recognize the important role of college professors in training and motivating future electrical and computer engineers. The award acknowledges engineering professors who, early in their careers, have demonstrated special dedication and creativity in their teaching.



John DeGraw is the recipient of the 2023 IEEE-HKN Distinguished Service Award *"for decades of service to Eta Kappa Nu in support of alumni and student award activities."*


DeGraw served on the HKN Board of Governors from 2018-2020. He has been a dedicated volunteer for over 40 years. This award was established in 1971 to recognize those members who have devoted years of service to Eta Kappa Nu (or IEEE-HKN), resulting in significant benefits for all of the society's members.



Dr. DongHyun (Bill) Kim has been awarded the IEEE-HKN Outstanding Young Professional Award *"for his outstanding contributions toward characterization and modeling of dielectric materials and via structures to ensure signal integrity and reduce crosstalk levels in high-speed digital channels."*

Dr. Kim is on the frontier of knowledge in the field of electromagnetic compatibility (EMC), including signal integrity (SI), power integrity (PI), and electrostatic discharge (ESD) with additional expertise in semiconductor physics. Dr. Kim is a member of the Gamma Theta Chapter at Missouri S&T.

This award, formerly the Outstanding Young Electrical Engineer (OYEE) Award, has been presented annually since 1936. It is presented to exceptional young engineers who demonstrate significant accomplishments in their career. Many recipients of this award have gone on to make major contributions to the electrical and computer engineering fields and hold noteworthy positions in academia, industry, and government.

The IEEE-HKN Awards will be presented at the IEEE EAB Award Presentation Ceremony, which will take place Friday, 17 November 2023, during the IEEE Meeting Series in Washington, D.C. USA. Congratulations to all! 



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HKN President Recognized with Two Awards



HKN President Sampathkumar Veeraraghavan is the recipient of two awards in recognition of his humanitarian efforts including:

2022 IEEE MGA Innovation Award and 2022 IEEE AP-S Ulrich L. Rohde Humanitarian

Technical Field Project Award *“given for his leadership and global impact on the Humanitarian engineering space.”*

2022 IEEE MGA Innovation Award: *“For exemplary innovations and inspiring leadership in delivering innovative, technology-driven, and sustainable programs, which resulted in significant growth for IEEE humanitarian activities and IEEE SIGHT globally”* This award was presented at the 2023 IEEE Sections Congress held in Ottawa in August.

2022 IEEE Ulrich L. Rohde Humanitarian Technical Field Project Award: *“For developing and launching a scalable and secured data analytics platform to support disease prevention and outbreak management in disaster-impacted local communities in Uganda”* This award was presented at the July 2023 IEEE AP-S meeting held in Portland, Oregon.

Congratulations, President Veeraraghavan, for your outstanding work! 




Congratulations to HKN Eminent Member Bob Metcalfe for Winning 2022 Turing Prize



Bob Metcalfe was named the recipient of the 2022 A.M. Turing Prize in recognition of his work that led to the invention, standardization, and commercialization of the Ethernet. Metcalfe is an Emeritus Professor of Electrical and Computer

Engineering (ECE) at the University of Texas at Austin and a Research Affiliate in Computational Engineering at the Massachusetts Institute of Technology (MIT) Computer Science and Artificial Intelligence Laboratory (CSAIL). The ACM A.M. Turing Award, often referred to as the “Nobel Prize of Computing,” carries a \$1 million prize with financial support provided by Google, Inc. The award is named for Alan M. Turing, the British mathematician who articulated the mathematical foundations of computing.

Metcalfe’s honors include the National Medal of Technology, the IEEE Medal of Honor, the Marconi Prize, the Japan Computer & Communications Prize, the ACM Grace Murray Hopper Award, and the IEEE Alexander Graham Bell Medal. He is a fellow of the U.S. National Academy of Engineering, the American Academy of Arts and Sciences, and the National Inventors, Consumer Electronics, and Internet Halls of Fame. He was elevated to HKN Eminent Member in 2019, and we congratulate him on this prestigious award! 



Three Prominent Engineers Elevated to HKN Eminent Members

IEEE-HKN's Eminent Member Committee is pleased to announce this year's elevation of Eminent Member status to three outstanding engineers whose creativity and scholarship have made great contributions toward the betterment of humankind: Ming Hsieh, Dr. Frank Chang, and Dr. Sandra Magnus. Elevation to Eminent Member status is IEEE-HKN's highest honor. Since it was instituted in 1950, only 144 people have achieved this honor.



Ming Hsieh was nominated for his major technical contributions to biometrics and genetic testing solutions. He is responsible for inventing a unique fingerprint modeling technique, the Programmable Matching Accelerator (PMA), for high-speed fingerprint

matching, which revolutionized the automated fingerprint identification system (AFIS) and dramatically reduced its computational complexity and implementation cost. More recently, Hsieh has pioneered genetic testing solutions to provide clinicians with actionable and diagnostic information they can use to improve the overall quality of personalized patient care. He founded Fulgent, a pioneer in cancer research and companion diagnostics, and works closely with the oncology community on personalized cancer treatments. Hsieh received his BS'83 and MS'84 in Electrical Engineering from University of Southern California (USC) and honorary doctorates from USC, West Virginia University, and the University of New Haven.




Dr. Frank Chang received this honor for being responsible for many breakthroughs in cellular phone technology including the high linearity and efficiency of GaAs Heterojunction Bipolar Transistors (HBT) and BiFET power amplifiers (PAs) which have

been the most prevalent IC technology to dominate worldwide cell phone transmitters over the past three decades. In addition to providing his technology leadership to the wireless industry, Dr. Chang also established a world-class high-speed electronics research group at UCLA to educate the next generation of engineers and lead them to explore new synthetic terahertz components and circuits. Between 2015 and 2019, Dr. Chang took a four-year leave from UCLA to serve as the President of National Chiao Tung University in Taiwan, where he established an international semiconductor school, implemented a new bio-electronic research center, inaugurated a bioICT research hospital, etc. to explore the emerging technology convergence of advanced electrical engineering with biomedical engineering.



Dr. Sandra H. Magnus, an HKN Professional Member of Gamma Theta since 2011, was awarded Eminent Member status for her contributions as the Deputy Director for Engineering within the Office of the Under Secretary of Defense

for Research and Engineering. She serves as the DoD's Chief Engineer for Advanced Capabilities. In this role, she is the lead for engineering policy, practice, and the DoD engineering workforce, as well as digital engineering and systems of systems engineering initiatives. She leads mission integration management, independent technical risk assessments, and program planning and execution. In addition, she served as a NASA astronaut (1996-2012), completing missions STS-112, STS-126, ISS 18, STS-119, and STS 135 on which she carried the HKN medal for her Chapter Gamma Theta.

Ming Hsieh and Dr. Frank Chang will be receiving their awards at HKN's Student Leadership Conference in November at the University of Houston. Dr. Magnus will be receiving her award at the IEEE Educational Activities Award Ceremony in November in Washington, D.C. 



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Lwanga Herbert


Global Chair of the IEEE Humanitarian Technologies Board (HTB)

Lwanga Herbert is a technology promoter, innovator, researcher, entrepreneur, and enthusiast best known for promoting technology, innovation, and entrepreneurship for the benefit of communities and society as a whole. Additionally, he puts his emphasis on promoting those technologies that address humanitarian challenges that prevail with diverse communities and the world at large. Lwanga Herbert currently serves as chair of the IEEE Humanitarian Technologies Board (HTB), which focuses on supporting impactful and ethically informed volunteer-led initiatives, programs, and projects, and mutually beneficial partnerships, as well as inform policy formulation that harnesses technology and innovation to address societal challenges in a responsive, effective, and sustainable way. Previously (2021 - 2022) he served as Global Chairman of IEEE SIGHT, where he managed a combination of sustainable development programs on a global scale. He is also a co-founder of the Logel Science Foundation, a non-profit organization that focuses on conducting research, development, and innovation activities whose end results are aimed at benefiting humanity. The organization also uplifts the efforts of upcoming innovators and technologists to ensure that they transform communities through concrete engineering and technology approaches.

In his career development, he also co-founded LOG'EL GROUP Ltd., a technology company that emphasizes the use of local talent to develop technology solutions that address locally-based challenges and concerns. Through this approach, local talent is bound to grow and develop as it addresses societal challenges using a home-grown approach. Previously, he has won multiple awards, including the 2005 Ugandan Presidential Innovation Award which focused on rewarding young innovators.

Lwanga chose to study engineering out of a childhood desire to create things that are useful and make life easier for the people in his community. He derives satisfaction from responding to life's challenges and creating solutions to make life better. He finds that engineering challenges his thinking and creativity, through which he is able to create unique and exciting solutions to prevailing challenges within society. Over the course of his engineering career, he has experienced the transition from analog to digital, which has made engineering products significantly more accurate and efficient, and the shift from manual to automated processes. Looking towards the future, Lwanga believes that we are heading in the direction where humanity will have access to engineering solutions that are more efficient, accurate, and human-centered, making life more predictable and controllable.



The most important lesson Lwanga has learned as an engineer is that engineering is valuable and useful when it is applied to create solutions that reduce challenges faced by humanity. By applying his engineering skills with that motivation, he can and has contributed to improving the comfort and satisfaction of humanity. His best advice to recent graduates is to cultivate and develop broad-based thinking that focuses on humanity as an overarching factor in driving the development process. Such a holistic approach will enable graduates to function effectively as they utilize the key resources to advance their engineering professions. He believes the greatest opportunities for IEEE-HKN over the next three years are: (1) mentoring and inspiring young engineering professionals to advance and consolidate their engineering careers; (2) volunteering to give back to the community; and (3) promoting IEEE-HKN activities within the wider IEEE space and society in general. 

HKN Students Reflect on how Humanitarian Service Impacts their Growth

HKN students have been putting service to humanity into action for over 100 years through their adherence to the principles of scholarship, character, and attitude. Last year, HKN students conducted over 100,000 hours of service to their community, including STEM tutoring in local schools, among other humanitarian activities. Not only does this service impact communities, but it also has a reciprocal effect on our students, helping them to grow into professionals who have sensitivity to community needs. Here are the reflections of two of our students.



Tara Len

Kappa Psi Chapter, University of California, San Diego, 2023 & 2024
Mechanical Engineering, B.S.
Engineering Sciences (Mechanical Engineering) M.S. Candidate


"My service activity consisted of running an outreach program through my HKN chapter that teaches K-12 students in socioeconomically disadvantaged areas around San Diego about computer science, electrical and computer engineering, and mechanical and aerospace engineering. *Through this endeavor, the most important lesson I learned is that even if it might seem as though some of the kids I work with don't seem to be interested in engaging in the program, there are always a couple students who actually want to learn, which makes running the program completely worth it for me because it feels like I am making a positive impact.* I have mainly been surprised by the program's success. During the pandemic, the program's reach was limited because only remote lessons could be implemented, and not many college students were involved in helping out. But through reaching out to more San Diego schools to teach in-person at those places, applying for and receiving funding from my university and EPICS in IEEE, and recruiting more college students to create and teach more varied engineering lessons, we have been able to reach out to more kids than during the pandemic, increase the number of leadership roles for college students within the program, and even start to host field trips on our campus for kids. I am extremely grateful for everyone who has contributed to the burgeoning of this program, and I look forward to seeing how much more the program will grow, especially since I now have successors for my role."



Sabrina Helbig

University of Pittsburgh Graduate Student; Electrical Engineering, BSEE
Dec. 2020; IEEE Eta Kappa Nu, Beta Delta, President; IEEE PES-PELS Student Chapter, Vice President

"In the Beta Delta Chapter, we have participated in a variety of volunteer and outreach activities over the years, including building circuits with local grade schoolers, picking up litter in a nearby town, and assisting logistics at the regional science fair. *At these and other service events, I have found that our invested effort and the relationships created are meaningful and significant, and that your time and energy could change the outlook and experience of someone's day (or possibly their life!).* A couple hours of picking up trash might sound boring, but spending that quality time with residents and witnessing their pride and satisfaction in everyone's work and in the outcome makes the effort worth it. I remember one time, a man thanked us for picking up litter and explained to his young daughter what it meant to have their neighborhood beautified – that brief interaction taught me to come to these tasks with care and enthusiasm.

Our chapter's service activities continually demonstrate to me that we, as individuals and groups, are both stakeholders and contributors in our schools and companies and in the places and spaces around us. Through volunteerism and outreach, I am frequently reminded that my actions and interactions have the power to teach, support, and inspire others. Further, as an engineer, I often think about the purpose, implementation, benefits, and risks of engineering work from a technical perspective, but service reminds me to also consider this work in the context of community and people." 

Interested in learning more about IEEE's humanitarian efforts? Check out these stories in [IEEE Spectrum](#).

- [This Nigerian Startup's Minigrid Began as a School Project > The solar-powered system now serves 30,000 homes and businesses](#)
- [This Rwandan Engineer is Learning How to Manage Humanitarian Projects](#)
- [Teen Wins Scholarship for His Glaucoma-Detection Device](#)
- [Students Use Their Tech Know-How to Protect the Environment](#)

Exploring the Technological Tapestry: A Reading List for Students and Early Career Engineers

Burt Dicht, Eta Chapter

There are many reasons for engineers and other technical professionals to study history. Studying the history of technology along with the great innovations and innovators will help you make more informed decisions as you progress through your career. Ultimately, history provides all of us with a context for understanding the present and a roadmap for navigating the future.

Engineers can learn valuable lessons from past successes and failures. By applying these insights to your own career, you might be able to avoid repeating a mistake or ensuring that you are on the correct path. Historical perspectives from key innovators and technical leaders can inform your own leadership style. A by-product of this historical review can reveal ethical dilemmas and choices made by individuals and organizations which could help you address similar challenges in your own career. Finally, learning from history can promote cultural sensitivity, aid in your global perspective, bring about empathy for groups of people whose lives are different from our own, and provide you with a broader perspective and a deeper understanding of human interactions.

With those goals in mind, I have assembled a technical history reading list to aid you in your development as an engineer and provide you with historical perspectives to guide your career path. These summaries are not meant as book reviews, although at times I include a description to provide you with context for what you can learn from reading these books. There is a mixture of genres including autobiographies and historical narratives. Enjoy the reading.

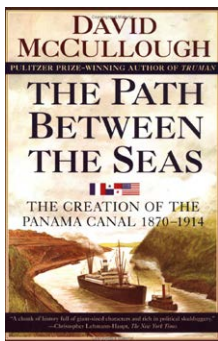


Photo credit: Simon and Schuster

David McCullough's book, *"The Path Between the Seas: The Creation of the Panama Canal, 1870-1914"* focuses on the construction of the Panama Canal, a monumental engineering feat that connected the Atlantic and Pacific Oceans, revolutionizing global trade. The construction of the canal had broader implications than engineering.

There were political, social and health challenges that confronted the builders and threatened its successful

construction. McCullough's narrative brings this to life with the introduction of the key players. Ferdinand de Lesseps, the French developer, led the construction of the Suez Canal in Egypt. He thought he could transfer the knowledge and

experience on the Suez Canal to building the Panama Canal. He learned fast that Panama was not Egypt and the French effort failed. The lesson for all engineers is that engineering solutions are not "one size fits all."

The story then turns to the Americans who took on the task of building the canal. Project engineers John F. Stevens and George W. Goethals brought new and innovative ideas to the construction. Engineers from all disciplines will be fascinated by how this massive project came to fruition. A key takeaway from the book is its message about the human cost of this project. It is estimated that between the French and American efforts, more than 25,000 people died during the construction, mostly from disease. Most of the labor force were immigrants, and while much has changed in the one hundred plus years since the canal was constructed, it is important for engineers to always focus on the health and safety of workers involved in any major project.

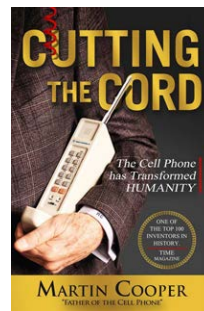


Photo Credit:

Rosetta Books

Martin Cooper is a pioneer in the wireless communications industry and an IEEE-HKN Eminent Member. In his book, *"Cutting the Cord,"* he tells the story of the creation of the cell phone. He recounts the challenges of balancing government regulators, lobbyists, the police, entrenched opposition, and many other factors in driving innovation. Many technologies have drastically changed our lives. The cell phone is one such breakthrough that has transformed how we communicate. Like many transformative technologies, it is not just about the technology itself. Many factors can influence how a product finally makes it to market.

Cooper focuses on the conditions at Motorola that created an open-minded environment and a culture of risk-taking. He mentions Motorola CEO Bob Galvin as a driving force that emphasized creativity and idea generation. The point Cooper is making is that "Eureka doesn't just happen," and that innovation is a process that must be managed. An important lesson that Cooper solidifies is that the "advancement of knowledge requires risk." For engineers starting out, recognize that not every idea will pan out, but to just "keep going and keep learning." These are important lessons for engineers in any industry.

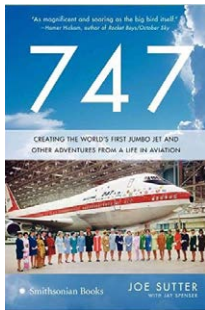


Photo Credit:
Smithsonian Books

Joe Sutter was a Boeing engineer who managed the development of the 747 aircraft. His book, *“747: Creating the World’s First Jumbo Jet and Other Adventures from a Life in Aviation”* offers great insight into the challenges in developing a new aircraft. The 747 aircraft is one of the most iconic aircraft of all time. First flown in 1969, more than 1,500 were manufactured, and while no longer in commercial service, they are still flying cargo routes today.

As the design concepts evolved, Sutter and the design team faced an immediate challenge in dealing with customer expectations. Juan Trippe, the president of Pan Am and one of Boeing’s biggest customers, was the impetus for the 747. He needed a new passenger jet that was 2.5 times as large as the 707 and one that would lower the cost per passenger mile. Trippe was going to buy this new jetliner, with Pan Am serving as the launch customer for Boeing. And he had expectations for a double-decker fuselage.

Boeing engineers started with that concept as they began the design process. They soon realized the double-decker design had many drawbacks, both technically and operationally. That led to the proposal to design the 747 as a wide-body aircraft (meaning two aisles). But how to convince Trippe that his double decker configuration wouldn’t work? Sutter and his team came up with a simple and innovative approach that involved a visual demonstration that impressed the Pan Am team. It was a lesson that good engineering can change closed minds. If you are interested in aviation, this book offers insights into working as an engineer in the aerospace industry. But many of the lessons apply to all industries.

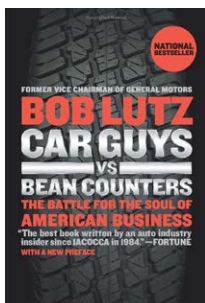


Photo Credit: Portfolio

Bob Lutz is a former automobile executive who worked for the big three car manufacturers in the U.S. He is most well-known for his time at General Motors (GM), and in his book, *“Car Guys vs. Bean Counters: The Battle for the Soul of American Business”* he shares his insights and experiences about the challenges and conflicts between the “car guys” (those who are passionate about designing and building cars) and the “bean counters” (those focused on cost-cutting and profitability) within the auto industry. This was Lutz’s second stint at GM, and he was brought back in 2001 to save GM from itself.

Lutz shares the conflicts he faced with the so-called “Bean Counters” who had lost touch with GM’s mission to sell cars that customers wanted and who became obsessed with financial metrics that had no connection to the business. It is an entertaining and eye-opening account of the car business and if you are interested in the automotive industry it is a must read. But more importantly, the lessons that Lutz shares extend to leadership in any industry and the importance of staying focused on your company’s mission.

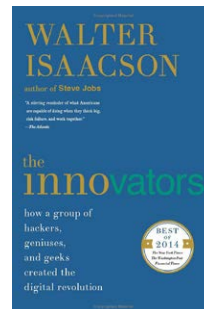



Photo Credit:
Simon and Schuster

The final selection that should be on your reading list is **Walter Isaacson’s** *“The Innovators: How a Group of Hackers, Geniuses, and Geeks Created the Digital Revolution.”*

In this historical narrative, Isaacson explores the history of the digital revolution from the 19th century to today. Individual chapters focus on key technologies such as the computer, programming, the transistor, the microchip and many more. Within each of the technology sections you will learn about the contributions of innovators such as Ada Lovelace, Alan Turing, John von Neumann, Claude Shannon, Grace Hopper, Jean Jennings, William Shockley, Gordon Moore, and many others.

In sharing these stories, Isaacson’s main intent is to demonstrate how innovation happens. Isaacson touches on the ingredients that produced these great leaps in technology and the skills these individuals possessed. One aspect that stands out is the truest creativity came from those that could connect the arts and sciences. The lesson here is to be well-rounded as technical knowledge alone does not lead to innovation. He makes the strongest case that the collaborative nature of technological innovation produces the most impressive results; that innovation is often the work of teams and communities rather than individuals, no matter how talented. So, a lesson for early career engineers is that you can’t do it yourself. Embrace teamwork and the diverse ideas that turn an innovation into reality.

The final point he makes is as you read about these innovations, you will gain an understanding of the ethical issues related to technology and innovation, including issues of privacy, security, and the responsible use of technology. Always keep these in your mind as you begin your career and work on your own possible innovations.

These books provide fascinating reads even for non-engineers. For those of you early in your career or about to enter the profession, I encourage you to start reading. All of these books are available for purchase, and your professional development and career will benefit from the lessons they provide. 

What are the IEEE Humanitarian Technologies Board and IEEE SIGHT?

The IEEE Humanitarian Technologies Board (HTB) inspires and empowers IEEE volunteers around the world to carry out and support impactful humanitarian technology activities at the local level.

The HTB mission is to support impactful and ethically informed volunteer-led initiatives, programs, and projects and mutually beneficial partnerships, as well as to inform policy formulation that harness technology and innovation to address societal challenges (including disaster recovery) in a responsive, effective, and sustainable way.

IEEE SIGHT is a program of HTB and a global network of IEEE volunteers partnering with underserved communities and local organizations to leverage technology for sustainable development.

HTB'S STRATEGIC AREAS OF FOCUS:



RAISING AWARENESS
HTB increases understanding of the role of engineering and technology in sustainable development.



PROVIDING TRAINING
HTB provides educational resources and opportunities so that humanitarian technology participants can have a greater positive impact.



SUPPORTING HUMANITARIAN TECHNOLOGY AND SUSTAINABLE DEVELOPMENT ACTIVITIES
HTB awards funding for grassroots IEEE member projects that utilize technology to address local challenges.



BUILDING A SUSTAINABLE DEVELOPMENT COMMUNITY
HTB collaborates across and beyond IEEE to foster opportunities in sustainable development.

HTB supports many impactful humanitarian technology and sustainable development projects with local communities around the world. The Board not only provides funding to support projects but also devotes

resources to developing educational materials to ensure project success and impact assessment to better understand what was accomplished. HTB looks at impact from a variety of angles through the lens of its four main areas of focus.

Opportunities to Get Involved:

- Submit a project proposal to one of the ongoing or upcoming [HTB funding opportunities](#). New calls for proposals are offered throughout the year.
- Add a free [SIGHT membership](#) to your IEEE membership.
- Form a [SIGHT Group](#) to assess needs in your local community, apply for financial resources from HTB/SIGHT, and implement a sustainable technological solution.
- Take part in the free, online courses on the [IEEE Learning Network \(ILN\)](#) to learn more about the role of engineering in sustainable development and other valuable themes.
- Donate to the [IEEE SIGHT Fund of the IEEE Foundation](#). Your contribution of any amount helps HTB/SIGHT transform the lives of individuals and communities around the world.

HTB is empowering IEEE members around the globe to collaborate with others and create meaningful change in their local communities. We invite you to join us in this impactful life-changing work.

Learn More and Reach Out:

We would love to hear from you; write to us for more information or to share an idea at htb-office@ieee.org.



About the Cover

IEEE-HKN is grateful for the photo contributions of IEEE Humanitarian Technologies Board.



1. Members of the IEEE Malaysia Section implemented an intelligent and renewable energy hydroponic agricultural system in a low-resource urban community; 2. STEM training and practical application of electronic engineering in the field. 3. Professional and student members from the Uganda Section install a solar power system at a school in a remote area of the country. 4. IEEE volunteers from the Sarawak Subsection SIGHT Group install a smart solar lighting and camera for crocodile surveillance to benefit a coastal fishing village in Malaysia. 5. SIGHT group in action installing solar panels in East Africa.



Beloved Former IEEE-HKN Governor, Dr. Kenneth Laker, Passes


Sadly, Dr. Kenneth Robert Laker, 76, of Yardley, PA, passed away on 2 August 2023. Ken was a towering figure who gave to IEEE-HKN throughout his illustrious career, serving on the IEEE-HKN Board of Governors from 2014-2016. Through his tireless service, he became beloved by all at HKN. He worked closely with the HKN Lambda Chapter at the University of Pennsylvania. According to his beloved wife of 55 years, Mary Ellen, "I remember when Ken was a student and how excited he was to become a member of Eta Kappa Nu, so it was a long relationship that he very much valued. It held a special place for him."

Tribute gifts in honor of Ken can be made to IEEE-HKN via the IEEE Foundation:



Despite being dyslexic and struggling in school, Ken persevered through Manhattan College and earned a Ph.D. in electrical engineering from NYU. He continued on to write several textbooks, teaching students and colleagues across the world in classrooms at Oxford, MIT, the National University of Singapore, and in his 35-year post as the Alfred Fitler Moore Professor at the University of Pennsylvania. He was also proud to serve as President of the Institute for Electrical and Electronics Engineers (IEEE) in 1999, helping over 400,000 fellow members from 190+ different countries improve their shared profession. During his career, Dr. Laker started a semiconductor company, served on several corporate boards, and authored patents at Bell Labs, now AT&T. He also served his country as a captain in the United States Air Force.

His stories and laughter filled every room he entered until his passing, and he will forever fill the hearts of his family and friends, especially Mary Ellen, whom he married 55 years ago. His three sons, three daughters-in-law, and four grandchildren - John and Alice, Melanie and Jack, Chris and Jacqueline, Brian and Karen, Georgia and Lucia, and the extended family and friends he loved so much.

We will truly miss how he always fully embraced life with unyielding positivity and are grateful for all his many contributions to IEEE-HKN. May he eternally rest in peace. 

Become an IEEE SIGHT Member!

Join a global network of 43,000+ individuals partnering with underserved communities and local organizations to leverage technology for sustainable development.

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IEEE SIGHT

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Free, New E-Book and Audiobook from IEEE-USA for Members Now Available: An Audiobook on Making the Most of One-on-Ones with Your Manager; Fourth E-Book in Career Transitioning Series Explores Building Your Personal Brand

Georgia C. Stelluto



No Surprises! Making the Most of One-on-Ones with Your Manager

Do you have a one-on-one coming up soon with your manager? Whether your answer is yes or no, you should consider getting IEEE-USA's new audiobook *So, How Are Things Going? Making the Most of*

One-On-Ones With your Manager, by Paul. J Kostek. In the audiobook, Kostek discusses why more is better when it comes to one-on-ones. He outlines the types of issues you should consider addressing during your meetings and what actions you need to take afterward.

While more and more companies are requiring these meetings two or three times a year, Kostek suggests ideally you should have a meeting of no more than 30-minutes once a month – or even more frequently. "Immediate feedback about the fit of an assignment, performance on a project, and issue(s) with working conditions... need to be addressed sooner rather than later."

Kostek believes that regular one-on-one meetings can improve productivity and help employee retention, which is increasingly important in tight job markets.

Preparation for these meetings - deciding what you want to discuss and in what order - is key. Areas for discussion include:

- Assistance needed with problems or projects
- Additional resource needs
- Available training the manager might suggest
- Changes coming to the organization
- Skills you need to develop to move up to the next level in the organization

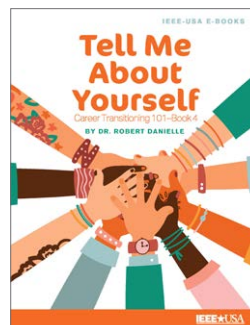
Kostek urges the reader to be specific. Don't go into a meeting expecting to say you need assistance or resources without giving details as to what assistance or resources might look like. Preferably, lay out options for your manager.

The author notes that when the meeting ends, your work is not over. "Take notes at the meeting. Use your notes from these meetings to build a plan to respond to any issues. Make your case for change and ask for it to be included in your annual review." The notes should serve as a starting point for your performance review; mention the meetings in your self-appraisal and the actions you took because of them. If regular meetings have occurred, "there should be no surprises" when the annual review comes.

Listening to this book can help you better prepare for and get more out of your one-on-one meetings (or encourage you to schedule one if there is not one already on your manager's calendar). You can easily listen to this audiobook in the car, at the gym, or while relaxing at home.

Members – Download your free audiobook at: <https://ieeusa.org/product/so-how-are-things-going-making-the-most-of-one-on-ones-with-your-manager/>

Paul J. Kostek currently works at Base 2 Solutions, a Bellevue, Washington consulting firm. He is a long-time IEEE volunteer, having served as IEEE-USA President, on the IEEE Board of Directors, and as President of the IEEE Aerospace and Electronics Systems Society. He has also chaired the American Association of Engineering Societies, the IEEE Intelligent Transportation Systems Conference, and the AIAA/IEEE Digital Avionics Systems Conference. Kostek has a B.S. in Electrical Engineering Technology from the University of Massachusetts Dartmouth. He is currently an adjunct professor in the ECE Department at Seattle University.



New IEEE-USA E-Book, Fourth in Career Transitioning Series, Explores Building Your Personal Brand

In the new IEEE-USA E-Book, *Career Transitioning 101—Book 4: Tell Me About Yourself*, Dr. Robert Danielle focuses on your personal brand: why it is important; its benefits; and how

to build and maintain your brand. He provides insights, tools, tips, and anecdotes to help you plan, design, and create your own brand. As he writes in the introduction, "Your personal brand is a combination of your reputation and the value you bring to current and future employers," and "it is the tool and fuel that helps drive professional growth and career success."

Danielle feels a strong personal brand allows you to respond confidently (whether at a cocktail party or in a job interview) to the prompt, "Tell me about yourself."

The author outlines the many benefits of a strong personal brand:

- Differentiating you from the crowd
- Giving you more control of your career
- Establishing you as an expert
- Increasing your perceived value
- Attracting new opportunities
- Turning your "fans" into promoters
- Providing a career safety net

Danielle suggests using the three Cs of branding when building your personal brand: Clarity, Consistency, Constancy.


- **Clarity** - Strong brands are concise, powerful and clear.
- **Consistency** - Brand messaging needs to be consistent everywhere: on social media, your LinkedIn profile, websites, bio and resume, business cards, communications, presentations—even your introductions at meetings.

As Danielle notes, "The more consistent the message, the more the message is learned and reinforced."

- **Constancy** - A consistent message is critical, but just as in advertising and marketing, the message must be heard repeatedly by the right people.

Members—Download your free e-book at: <https://ieeusa.org/product/career-transitioning-101-book-4-tell-me-about-yourself>

Dr. Robert Danielle is an expert in the areas of career transitioning, leadership development and change management. He currently works as Manager, Learning Solutions for Amazon Mechatronics. He has held strategic roles in the media, technology, government/military, higher education and e-commerce.

Danielle holds a Doctorate in Higher Education and Organizational Change; a Master's degree in Information Systems Management; and an undergraduate degree in Leadership. He is a certified Performance and Career Coach. 

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