



IEEE in 2050 and Beyond A White Paper

2022 IEEE President & CEO K. J. Ray Liu

2022 IEEE Ad Hoc Committee on IEEE in 2050 Chair Roger Fujii

Foreword

The importance of future-proofing the organization

What will the future of the world look like? Everything in the world evolves. Therefore, IEEE also must evolve, not only to survive but to thrive.

How will people build communities and engage with one another and with IEEE in the future? How will knowledge be acquired? How will content be curated, shared, and accessed? What issues will influence the development of technical standards? How should IEEE be organized to be most impactful?

While no one has a crystal ball, predictions can be made based on evidence and trends. To start the conversation around these questions, I appointed the 2022 IEEE Ad Hoc Committee on IEEE in 2050. The committee chaired by IEEE Fellow Roger Fujii, is designed to envision scenarios looking out to the year 2050 and beyond to gain a global perspective of what the world may look like and what potential futures might mean for IEEE.

The committee explored plausible scenarios across IEEE's range of interests and scanned for drivers of change within existing and emerging technology fields. It also analyzed the role IEEE should take based on the identified potential futures and discussed next steps in IEEE's major areas of focus, including conferences, education, publications, standards, membership, sustainability, and governance.

For example, imagine that in 2050, your "cognitive digital twin" is constantly surfing the large volumes of research papers and data stored across open access repositories to find information directly relevant to your interests. It will also use its imaginative and creative logic to suggest new concepts and solutions for you. This platform will be driven by artificial intelligence, augmented reality, and virtual reality developed to help make you more productive and creative in your career. What is IEEE's role in this new environment?

Molding the IEEE of the future

As a global organization, a considerable challenge of IEEE is that it supports a broad community. This also presents a great opportunity to learn and pilot various models, services, products, and solutions to meet the diverse set of members' needs predicted for 2050 and beyond.

The technology generation of 2050 will likely be interested in solving mission-based issues such as climate change, universal access to health care, sustainable food sources, and ubiquitous energy generation and transmission. Thus, IEEE's mission—to advance technology for humanity—will still be relevant in the future. However, the way IEEE achieves its mission must and will change.

The future is multinodular and digital. IEEE will benefit from its status and reputation as a trusted, neutral provider of content and information. As a knowledge provider, IEEE has an opportunity to curate and deliver information to assist its constituents and the public in understanding the benefits and risks associated with several technology areas. Most importantly, IEEE can help with the deep integration of artificial intelligence and virtual reality

into a wide variety of everyday applications.

Adapting to an environment of constant chaos and change is essential moving forward. The ebb and flow of geopolitical tensions are likely to continue to increase—which will impact global organizations like ours. IEEE must become exceedingly nimble to address rapid changes in technologies and interdisciplinary needs, and attract a broader audience. IEEE will also need to rapidly respond to selected strategic changes and allocate funding for new approaches. IEEE's governance structure will need to be streamlined to meet the needs of many future scenarios that will require the organization to empower local entities to make decisions within their area.

Trust in IEEE must remain high if the organization is to maintain relevance and remain a credible source of information in the future. Now is the time for the organization to be thoughtful and bold, and take risks. IEEE cannot be afraid to break silos. Some activities will need to be terminated to make space for new ones. Products and initiatives should be evaluated regularly, and decisions must be made on a continuous basis.

Sound scary? Compounded by global warming, uneven demographic growth, and geopolitical challenges, the future likely is more uncertain than we realize. But often a crisis can be transformed into opportunity if we honestly face the unexpected and become prepared for whatever lies ahead. Adhering to IEEE's core principles—trust, growth and nurturing, global community building, partnership, service to humanity, and integrity in action—will serve the organization well into the future.

I sincerely thank Roger Fujii and the ad hoc committee members for their efforts. Their work will aid IEEE in devising long-term strategies to prepare for the future, to adapt, and to convert uncertainty into opportunity.

As I have shared, in an ever-changing and uncertain world, IEEE—your professional home—is always here for you, our members, as well as for humanity, and for our shared future. After all, serving our members well is our *raison d'être*.

By addressing the challenges and opportunities that lie ahead of us, IEEE can remain a vibrant organization with relevance both now and well into 2050. If IEEE remains true to its central values—fostering technological innovation and excellence for the benefit of humanity—I'm certain that the organization's future will be very bright indeed.

It has been my honor and privilege to work with and for you as IEEE president and CEO.



K. J. Ray Liu

2022 IEEE President and CEO

Executive Summary

The Ad Hoc Committee on IEEE in 2050 was appointed by 2022 IEEE President & CEO K. J. Ray Liu in January 2022. The objective of the committee was to look beyond current trends to discover the unanticipated and often surprising changes that may occur 30 years from today. Guided by a consulting team of futurists and



association executives, IEEE volunteers and professional staff with extensive organizational knowledge and a keen eye for the future worked very closely throughout 2022 to identify and recommend actions IEEE ought to consider today to maintain relevancy in the future.

The ad hoc committee used an adapted methodology from the University of Houston's best practices in foresight. This included interviewing a representative sample of eight futurists from around the world, building a base of knowledge from which to forecast potential futures, and exploring different worldviews that were dependent on the outcome of key uncertainties.

The committee's work concluded that [IEEE's mission](#) is highly likely to remain relevant in the future. However, **how IEEE achieves its mission must change**. IEEE's current structure, areas of interest, programs and services, and sources of funding may not align with the potential futures of the global environment.

IEEE's core principles of trust, growth and nurturing, global community building, partnership, service to humanity, and integrity in action will likely remain valid to the organization into the future. However, support of IEEE's core principles, delivery, and governing structures **must adapt to the organization's future needs**.



Now is the time for IEEE to be **thoughtful, bold, and take risks**.

IEEE leadership must be vigilant in watching for and addressing potential conscious and unconscious biases based on the organization's history and former processes. Expecting the future to be like the present overlooks subtle signals of change and misses important potential signs for the future.

Preparing stakeholders for the necessary changes ahead will present challenges. It is critical that **conversations around the future begin with IEEE leadership immediately** and expand carefully and thoughtfully across the wider IEEE community. The ability of IEEE to adjust to an

environment of constant change and potential chaos in a timely and appropriate manner is a **necessity moving forward.**

To adequately prepare for 2050 and beyond, now is the time for IEEE to dedicate the resources needed to explore the future. Necessary steps include, but are not limited to, piloting, prototyping, and experimenting with various models, programs, services, and solutions; monitoring and sharing results as appropriate; and continuing to track and report evolving trends that will continue to influence IEEE’s future.

Everybody stumbles across a golden opportunity at least once in a lifetime. Unfortunately, most people just pick themselves up, dust themselves down, and walk away from it.

Winston Churchill

By preparing for the future now, IEEE can seize its own “golden opportunity.” Whichever futures emerge at a particular time or place, IEEE can plan appropriately to meet the challenges of a changing landscape. By addressing the challenges and opportunities today, IEEE can remain a vibrant organization with relevance both now and in the future.

The following report entitled, “IEEE in 2050 and Beyond,” contains greater detail on the methodology used to explore 2050 and beyond, summarizes the committee’s work conducted in sub-groups to explore potential worldviews and what they mean for IEEE, and offers broad recommendations and considerations for IEEE.



IEEE in 2050 and Beyond

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Project Overview

The IEEE in 2050 Ad Hoc Committee Charge and Approach

The Ad Hoc Committee on IEEE in 2050¹ was appointed by 2022 IEEE President & CEO K. J. Ray Liu in January 2022. As per the ad hoc committee's charter, the committee explored plausible scenarios for the future across IEEE's areas of interest and scanned for drivers of change within existing and emerging technology fields. The committee analyzed the role IEEE should take given the identified potential futures for IEEE to achieve its desired role and next steps in its major areas of focus, including conferences, education, publications, membership composition, sustainability, demography, etc.

The IEEE in 2050 Ad Hoc Committee worked closely with Governance Directions, LLC and ForesightAlliance to closely follow a best practice, evidence-based framework for forecasting from the University of Houston's Master of Science in Foresight. The purpose of the framework is to provide a rigorous structure which facilitates forecasting with objectivity, data, and the discipline of foresight in understanding how change can take place.

The scope of the committee's charter required a broad and global look 30 years into the future to 2050. The scale of this project and the ability to leverage the extensive knowledge base of committee members offered a unique opportunity to scan for the future. The scope required an understanding of the issues and needs of 2050 at a holistic level to then make informed projections of how IEEE fits into the big picture and what it means for IEEE today.

Eight accomplished and reputable futurists from around the world participated in individual in-depth interviews with the committee to begin to illustrate global perspectives of what the world may look like in 2050. Each futurist brought a particular focus on the region of the world they represented as well as



¹ 2022 membership includes: Roger Fujii, Chair, Alex Acero, Johnson Asumadu, Lesleigh Campanale (professional staff), Paul Cunningham, Stephen Diamond, Karen Hawkins (professional staff), Harold Javid, Deepak Mathur, James Matthews, John McDonald, Maciej Ogorzalek, Roberto Saracco, Mary Ward-Callan (professional staff), Stephen Welby (professional staff)

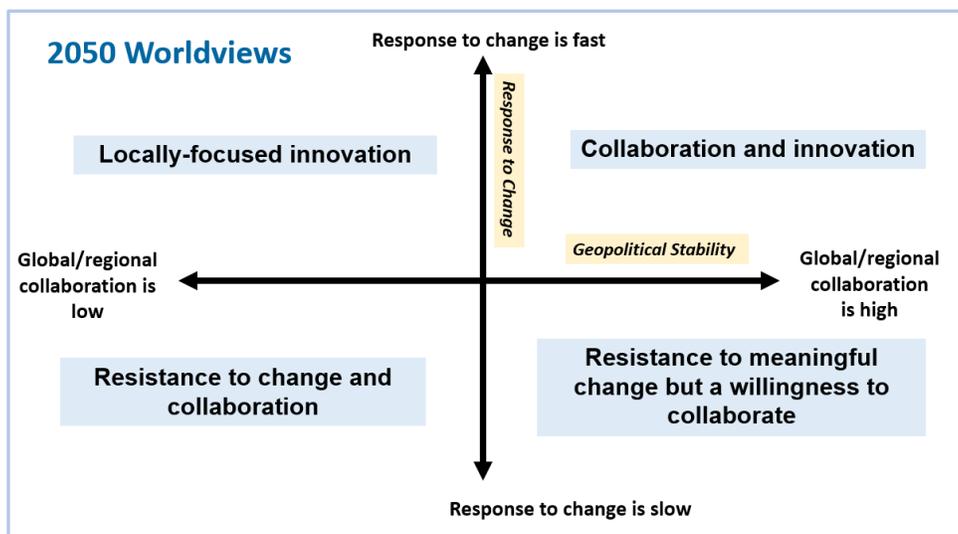
a unique range of perspectives and expertise on technology, social change, environmental awareness, and political changes.

Detailed notes were captured from each interview and findings were analyzed to identify 10 to 12 key highlights and themes for each futurist. These themes were assembled into a detailed knowledge base of information related to the futurists' forecasts containing data, further explanation, detail, concepts, and references. The database now includes more than 70 pages of themes, evidence, and resources.

During each of the eight in-depth interviews, futurists were asked to share **the two biggest unknowns or uncertainties** for their future view. Two prevailing themes in their responses were related to the **future of collaboration versus noncooperation** and **reaction to or adoption of change and innovation**. The state of collaboration and adoption of change will exist somewhere along a continuum with various nuances at the local, regional, and global levels.

These two phenomena were plotted on a 2x2 quadrant map (below), creating four unique quadrants or plausible futures that the committee then used to forecast to 2050. Plausible futures are futures that **could or may happen; but will not necessarily happen**. Exploring these alternatives enables an organization to **understand the range of options** that may unfold and prepare for multiple futures. The quadrants are:

- **Top left:** Locally focused innovation is embraced, but without collaborative effort
- **Top right:** Both collaboration and innovation coexist
- **Bottom left:** There is resistance to change and resistance to collaboration
- **Bottom right:** There is resistance to meaningful change but there is a willingness to collaborate



The committee was placed in four sub-groups; each was assigned one quadrant or worldview to explore. The sub-groups met over a period of four weeks, synthesizing and discussing their perceptions of the ideas surfaced by the futurists, as well as the research in the knowledge base relating to the environment the respective sub-group was assigned.

For purposes of discussion and analysis, a consistent methodological approach was adopted. The sub-groups explored their assigned worldview using a standard set of worksheets to guide them. These worksheets enabled the groups to explore 2050 at a macro or high-level, drilling down to how society functions in each quadrant and what their future scenario means for IEEE's areas of interest and to IEEE as an organization.

Each sub-group devoted a significant amount of time in discussion and thought to explore their assigned worldview (quadrant). They were then asked to provide a story that illustrated their respective worldview and to name their quadrant. Each sub-group was also asked for their thoughts, recommendations, and any learnings to share with IEEE leadership. This came from a robust discussion of their assigned worldview coupled with the deep experience of IEEE awareness by members of each sub-group.

Both the nature of the worldview each sub-group was assigned and expertise of the team members served to create varying narratives and voices.

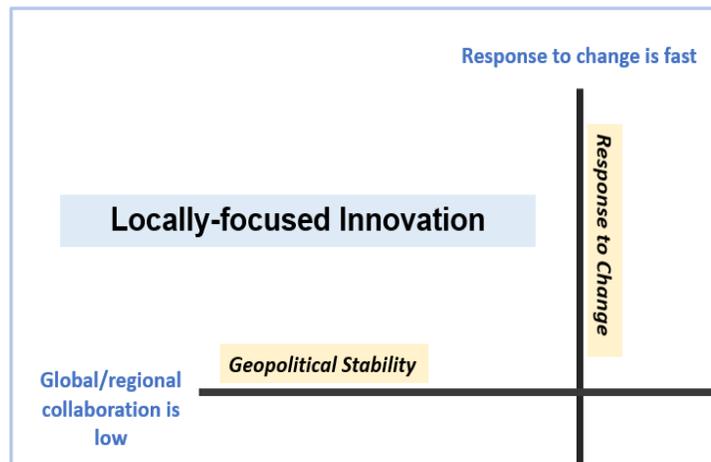
Worldview Scenarios and their Potential Implications for IEEE

The following is a summary of each sub-group's report and their key learnings. The sub-groups were each asked to create a story for their quadrant based on its main characteristics. Each story illustrates how IEEE might interact with the wider world. These worldviews can be global or local and can exist at different times for different regions or areas. Collectively, they represent a broad perspective of potential challenges and opportunities going into the future.

Top Left Quadrant: Locally-focused Innovation

Group's Chosen Name: *The Fast and Furious*

This subgroup tells the story of a fictional character, Fredericka Terman, who has just been recognized for her contributions to and leadership in the development and commercialization of innovative technology applications to agriculture and food production. Her great accomplishment is facilitating the sweeping dissemination of technology that is easily implemented in diverse environments with extreme variability in temperature, rainfall, and length of growing season.



There is great inequality in Fredericka's time. Lucky for her, she comes from a family with resources and was able to attend a highly select and rare in-person university offering an interdisciplinary education. Fredericka's outstanding academic performance qualified her to attend an in-person IEEE conference. A corporate sponsor paid for her travel via high-speed train, and local electric-powered public transportation with power generated by renewable energy sources. Fredericka enjoyed IEEE's new option of collaboratively working with non-IEEE societies and forming new groups like technical councils to steer research and technical activities in rapidly evolving interdisciplinary fields.

Scientific and technical literature created in-country and by a handful of other geographies was free to read in the IEEE Xplore online library, but literature from other countries was inaccessible to Fredericka and her classmates. Papers from outside the national firewall could sometimes be accessed by special request via government channels. Papers published by IEEE were trusted to be objectively peer reviewed and assessed for data quality and reproducibility.

Traditional membership in IEEE is just 200,000 individuals, but corporations support the organization through membership fees and sponsorships. Employees of corporate members

access information resources as needed, and new content and data sets focusing on practical applications predominate.

IEEE Publications uses a platinum business model, free to read with the costs of development and dissemination borne by companies or governments.

Countries with internationally relevant information and data access may collaborate with IEEE as a conduit to facilitate other countries or geographies to obtain and benefit from these resources without direct contact.



Highlights

- There is a high response to change, but collaboration with or among other countries or regions is low. Countries rapidly innovate and implement to preserve a competitive advantage.
- Competition and inequalities are extremely high; access to resources is uneven across the globe and within local regions.
- Technology is implemented unevenly due to political and military power and resource imbalances.
- Shareability of content and information may be determined by nations or regions – alliances will form among regions focused on specific issues and capabilities.
- Geographically separate communities may be “frenemies,” similar to competing companies, collegial and willing to share up to a point, but still striving for economic advantage.
- Local technical communities will develop, connecting around shared interests (for example, supply chains).
- Academia in many countries and regions will be unable to move fast enough to meet demand.
- Low birth rates in regions will cause the retirement age to increase and potential taxation to prevent industrial migration.
- Climate change will likely continue unabated in areas with no collaboration and high in innovation inequality.

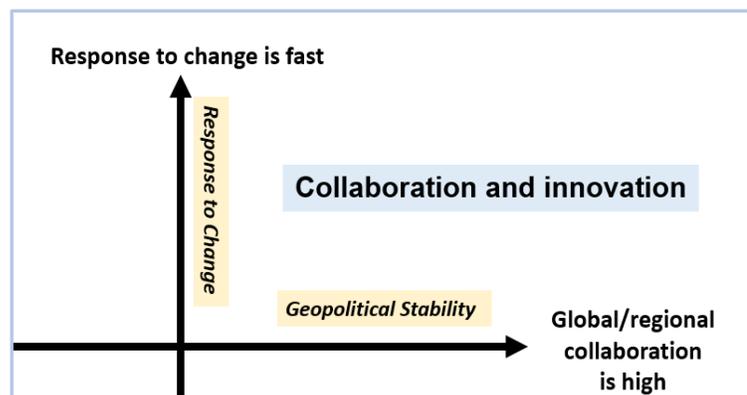
Potential Implications for IEEE

- IEEE may engage new audiences such as those in the arts and social sciences, the entertainment industry, medical industry, and others who apply technology in their professions. Short-term, pay-to-play, and corporate memberships may rise.
- IEEE may need to localize access to products and services, based on local rules. IEEE’s governance and decision-making processes will need to address the hyper-local, rapidly changing environment.
- Climate-consciousness, cost efficiencies, and geopolitical concerns will combine to drive demand for online education at all levels.
- IEEE may offer certifications (stackable) and remote education, perhaps in partnerships with universities.
- Pre-university educators may turn to IEEE for specialized education, especially in places where the local system is small and/or poorly funded.
- New IEEE Societies and Councils will develop in response to the emergence of interdisciplinary communities.
- Standards may increase in importance, but IEEE’s processes must evolve. IEEE may offer “pre-standards” as an alternative. Regional standards may also be offered but challenges in competing with national standards development organizations (SDOs) will need to be addressed.
- Hyper-local regional independence could drive support to local or regional technology-focused organizations and damage support for the IEEE’s international mission and influence. This would create an existential threat to IEEE.
- Opportunities for IEEE to be the unifying organization to help solve larger global problems and to recapture industry and government members interested in the larger global picture are likely to exist.

Top Right Quadrant: Collaboration and Innovation

Group’s Chosen Name: *Chaotic Utopia*

This sub-group tells the story of hopeful times after recent unprecedented transformation. In the dark years of the 2020s, humanity was emerging from a global pandemic; war was raging in eastern Europe; and economic and political divisions were deepening with nations taking hard lines. However, brighter times have come.

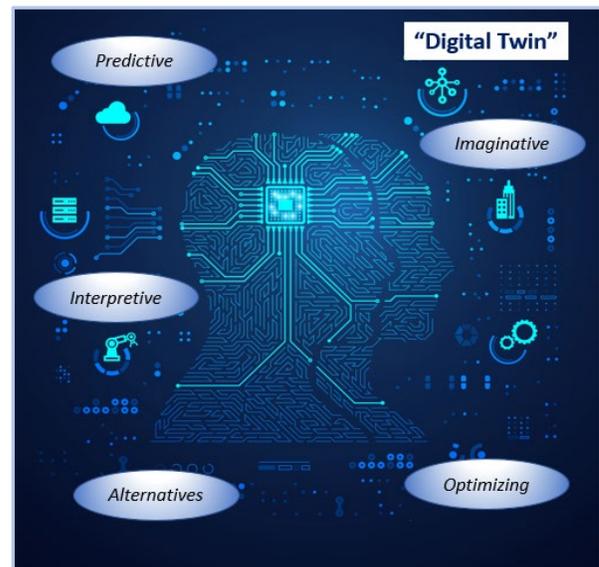


The trend toward world interdependence led to increasing cooperation between peoples as the growing suffering of humanity led nations to believe that the wellbeing and happiness of the population depended on it. In this worldview, people travel for pleasure more than work, enjoying differing cultures and beautiful resorts; and it takes less time than in the past to reach their destination. Although climate remains a challenge, progress has been made.

Most people are living in the metaverse, a continuum that consists of both digital and physical entities, perceived as a single space because the co-presence of the digital and physical is seamless. Our eyes and mind's eye can roam both. Barriers still exist in the physical space but often these can be overcome through the digital space.

Students finishing university have grown their cognitive digital twin (CDT) throughout college and academia. Like a curriculum vitae (CV), the CDT retains a record of what has been learned in a form that can be used and even transferred.

If in the past the connection with IEEE was in the form of a membership providing access to the IEEE knowledge base, now it is a subscription to IEEE's knowledge services. By subscribing to IEEE (as to other knowledge providers), a person can empower its CDT with access to the knowledge provider. The CDT can negotiate services with the knowledge provider, such as being notified of changes in the knowledge base.



Highlights

- The world is responding to change through innovation, and global collaboration is high.
- Significant progress has been made in responding to climate change because of increasing cooperation.
- Technology exploration and development is barrier-less.
- Change has come through significant and incremental investment in software, particularly in Artificial Intelligence (AI).
- We are living in the metaverse – a continuum of both digital and physical entities; barriers in the physical space can be overcome through the digital space.
- Nations respond to other nations' needs; global thinking and local action dominate.
- Virtual and physical life is seamless; access to virtual travel will be completely immersive in real cities.

- By subscribing to IEEE (a knowledge provider), a person can empower their CDT to negotiate services with their knowledge provider/IEEE – to make “sense” of the outside knowledge space and acquire parts that are of interest.
- Demand is for instant, “customized” information.
- Information comes from everywhere; the focus will be more on how to retrieve information rather than learning and memorization.
- Personalized education is targeted to areas where a person has not already mastered a topic.
- Project-focused communities will form quickly for a specific purpose.
- Birds of a feather, whether philosophical, cultural, or technical, will become the gathering points with or without boundaries.
- Gathering at the local level can add social and technical elements to enrich communities.

Potential Implications for IEEE

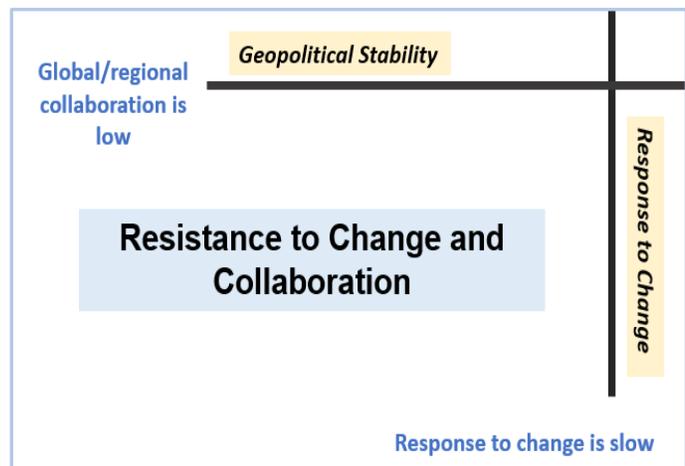
- Expand the value proposition of the IEEE brand as a trusted source of technological information and discovery. For example, reach beyond large companies to include small businesses, startups, freelancers, and hobbyists.
- Revenues will come from the services that are able to search, acquire, and make sense of the large volume of research and technology data scattered across many different repositories. Also, correlation to meaningful datasets provides validation of the theory to those interested in applied engineering/science of technology.
- The pace of change will lead to an overwhelming amount of data which will create chaos; only those who keep their eyes focused beyond the horizon and change rapidly will lead in the future (IEEE competition may come from non-traditional players to disrupt IEEE business models).
- Artificial Intelligence, Augmented Reality, and Virtual Reality (AI/AR/VR) application software will be the tool for making sense of the large research data and IEEE, in partnership with application developers, should be a major provider of those services.
- Content needs to be continuously updated. IEEE should consider charging for search of “AI-summarized” information.
- IEEE should be a smart repository of executable knowledge that will take the form of software “pills.” Software libraries will keep expanding as the low code/no code becomes part of many industries. Access to these “pills” will also be fostered through the availability of virtual labs supporting research (academia) and interoperability.
- IEEE should evolve user profiling to facilitate development of a personal (or organizational) Digital Twin. This can be used to both provide better customized services and as a service itself, and then can be offered (at a price) to both members and companies.

- Broaden IEEE’s sources of information – partner or merge with other societies and include all information outside IEEE’s walls.
- Create new and diverse models for conferences and gatherings – break the mold.
- Aid technologists’ ability to imagine, cooperate, think critically, understand how to use foresight, and ask good questions.

Bottom Left Quadrant: Resistance to Change and Collaboration

Group’s Chosen Name: Challenged

This sub-group highlights a time of hyper-focus on local needs and resistance to collaboration. Disruptive changes in countries may be induced by political, environmental, and humanitarian conditions. Resistance to change and collaboration may also be initiated and led by individuals or groups of influence opposing scientific innovation, new technologies, changes in the workplace, denying climate changes, or based on any other kind of opposing reasoning.



There will be few if any global opportunities and thus no global strategy will work. This will require different strategies tailored for each region or country. If enough people in a country push in a direction contrary to governments or groups’ opposing vision, there may be a revolution in the country.

Government may control and even completely block access to outside channels of information. Networks and communities will need to be built from the bottom up regardless of the resistance from the top and may be invisible globally.

We expect there will be tension among young people who prefer to collaborate nationally and globally to support change. Travel will be extremely limited to within each individual sub-group for many people.

Funding for universities will be reduced, and it is likely that investment will be directed toward the status quo rather than change. Under such conditions, IEEE may become a battleground in which regional restrictions and technology regulations divide IEEE. The demand for IEEE membership will decline.

Everything will be done locally and at a lower scale than today – convening, joining, idea sharing, etc.

Highlights

- There is resistance to change as well as collaboration with other countries and regions.
- Focus is on maintaining the status quo and priorities that meet needs.
- Countries focus on their individual power with no collaboration with other countries and have little influence over one another.
- Regional or country opportunities will require different strategies for each region or country.
- There will be “quiet” collaboration among pockets of people within local groups who wish to collaborate.
- If enough people in a country push in a direction contrary to the government’s vision, there may be a revolution within the country.
- Unofficial back-channel communications and collaboration may spring up amongst selected geographic regions or nation states.
- People retiring from the workforce will be replaced by people from within the country, and not by importing people from other countries.

Potential Implications for IEEE

- Current IEEE core values are not relevant in 2050.
- IEEE will likely exist as a much smaller and fragmented organization.
- There is a smaller market for IEEE membership.
- Training or education will be tailored to local needs.
- IEEE could have potential success with interoperability with “quiet” groups aiming to collaborate.
- IEEE can seize the opportunity to be the global collaboration and integration voice on critical topics.
- Standardization on a global scale will not be needed and will be on a local level.
- IEEE should look at the market of intelligence providers: sell services related to technology knowledge “distilled” from its databases, including automated AI based-consultancy services.
- The role of those born in the 2020s through 2040s must be considered.
- There will likely be a risk of “fake” virtual reality within sub-groups or at the national level to please the masses. Virtual reality will be imaginative, but access will be limited to each sub-group, with no sharing across sub-groups.
- There will be more emphasis on in-person learning rather than virtual or remote learning.



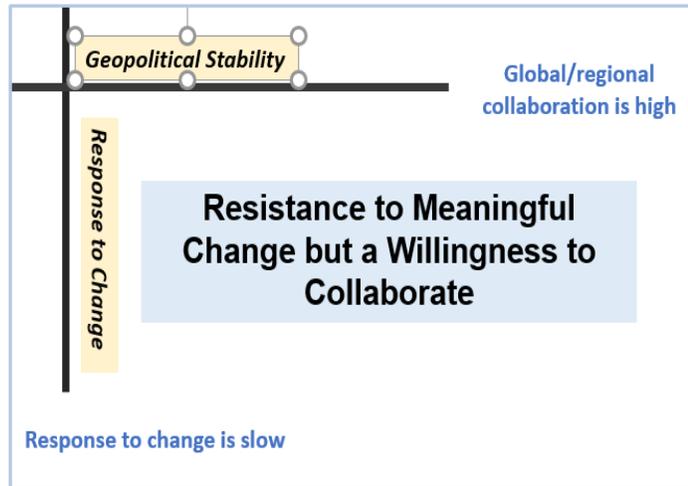
- Educational focus will be on how knowledge can be applied in the real world, rather than a more traditional academic/theoretical education. IEEE has the opportunity to team up with industry and governments to address such education needs.

Bottom Right Quadrant: Resistance to Meaningful Change but a Willingness to Collaborate

Group's Chosen Name: Consensus Builder

This group's main character is the fictional Charlotte, a 97-year-old with over 75 years of experience in IEEE.

Charlotte will join colleagues to contribute to a moderated participatory plenary session at her first hybrid IEEE conference of the year. This week-long flagship community event in Amsterdam utilized pan-European carbon-free travel with autonomous electric vehicles including surface and air ride-shares, trains, and short- to medium-range ships.



The world is much better in some ways today than it was 30 years ago. Overall air quality, quality of life, and access to basic human rights, including clean water, communications and connectivity, energy, education, food security, and healthcare has improved. There are still social inequalities as well as national, regional, and global consequences of climate change.

Charlotte plans to share her perspective on the importance of IEEE evolving to become a mission-driven, diverse, and interdisciplinary community, and its continued critical contributions to societal challenges, including stabilizing and reversing climate change. She will personalize this by sharing how different generations of her own family have been empowered and enriched in both their personal and professional lives by consuming and contributing to on-demand, multi-modal, internationally recognized, and certified STEM-related education, which was facilitated by IEEE. She will also discuss the role IEEE continues to play in facilitating ethical, purposeful discovery and application of technological innovation to address societal and economic needs.

Highlights

- The quadrant operates on the basis of discussion and collaboration to create consensus.
- While change steadily takes place, it can be slow.
- Sudden or major change is rare – adoption of new approaches and technological innovation is incremental.
- Fewer brick and mortar universities will exist in 2050, meaning more concentration in fewer places and a greater focus on online or virtual education.
- Information sourcing and distribution will continue to move towards accessing digital and virtual knowledge repositories, with an expectation that basic information is available free of charge with the ability to pay for added value processed information.
- Younger employees may want better work life balance than today, with older employees bridging the workforce gap as medical advancements enable people to work longer without the current physical, cognitive, or other traditional consequences of aging.

Potential Implications for IEEE

- Education programs may evolve to flexible and modular life-long learning – corporations play a role in defining the evolving application education space.
- Knowledge acquisition, curation and sharing, multi-modal delivery, joint qualifications, and stackable certification (including micro-certification) will all be important for IEEE to explore.
- Re-imagine IEEE organizational and cost structures as well as staffing needs.
- Flexibility to appropriately respond to needs of different key stakeholder groups around the world is important.
- Evolve from narrow disciplines to interdisciplinary applications and coordinated action addressing societal needs.
- Improve impact through better integration of all IEEE activities (geographic, technical, education, standards, and humanitarian).
- Embrace an approach to support a variety of relevant applications and toolsets.
- Education will be more student and group centric rather than teacher centric in delivery.



- Certification will become ever more important as a means to document continuous learning activities based on a changing workplace and requirements to upskill or reskill to keep up to date.
- Bigger tendency is to have a bifurcated educational structure. People who maintain the infrastructure and others who advance and innovate the tools. (This is an opportunity for IEEE).
- IEEE community members in 2050 will not be limited to professionals with technical degrees, and a greater proportion will have both broader and interdisciplinary backgrounds.

Meaning for IEEE

This section builds on the sub-groups' work reported above, focusing on IEEE's mission, governance and structure, core areas of interest, and funding opportunities.

Mission

Most of the sub-groups independently concluded that IEEE's mission will likely be relevant into the future but that *how* IEEE achieves its mission must change. IEEE's current structure, areas of business, programs and services, and sources of funding are not likely to align well with the potential futures of the global environment.

IEEE's core principles of trust, growth and nurturing, global community building, partnership, service to humanity, and integrity in action will likely remain valid to the organization into the future; however, the ways in which these values are supported, delivered, and governed must adapt to future needs.

If IEEE remains true to its central values, to foster technological innovation and excellence for the benefit of humanity, the organization's future will shine bright

Based on the findings from the interviews, validated research, and work of the sub-groups, absolutely nothing was learned that should diminish the need to remain focused on IEEE's core purpose. Regardless of the future environment, structure, and services IEEE provides, if IEEE remains true to its central values, to foster technological innovation and excellence for the benefit of humanity, the organization's future will shine bright.

Governance and Structure

Governance includes the systems that are used to ensure the association meets its goals and objectives. This includes a focus on how a Board serves the organization and how the organization is structured; how it is systematized and organized.

The future is often described as volatile, uncertain, complex, and ambiguous (VUCA). In this environment, success requires agility, flexibility, and speed. These characteristics will be required by the IEEE Board of Directors and all subsequent IEEE Boards and Committees, regardless of the state of the future. A potentially chaotic future means it is critical for the Board to be prepared for multiple scenarios; fluidity of structure and systems to prepare for any future is key.



The IEEE Board of Directors must be a future-focused, nimble, and deliberative process body focused on envisioning and discussing strategy. The Board should discuss internal governance

structure of the organization such as Board size, competencies relative to serving on the Board, direction (such as moving from a top-down structure to bottom-up), and the structure of committees.

The Board must empower organizations that reflect both a local and global focus to participate in decision-making processes. “Glocal” governance models are at the early stage of emergence and are continuing to evolve. Glocal organizations exist globally but successfully integrate local culture, language, socioeconomics, and environmental issues into their systems. Glocal groups within IEEE should uphold the IEEE brand yet incorporate local cultural norms and traditional elements into their organization structure and events.

IEEE should consider other unique models that may suit their organizational requirements and future needs. It will be important to stay abreast of new models that will emerge and to continue to find ways to pilot them in the future.

IEEE’s Core Areas of Interest

Technology is and will continue to be even more integrated, implicitly or explicitly, in all program areas and industries. Technology integration and technology adoption (even in worldview scenarios slow to adopt change) presents many opportunities for IEEE and its core areas of interest. With technology becoming more interdisciplinary, IEEE programs, services, and solutions will evolve to reflect the needs of a much broader range of strategic partners. The IEEE community members in 2050 and beyond will not likely be confined only to professionals with technical degrees. A greater proportion could have both broader and more diverse backgrounds and seek programs that IEEE could provide.

Technology convergence will likely continue to pose both opportunities and challenges, with potential implications requiring greater collaboration with adjacent communities (e.g., mechanical engineers, chemical engineers, power generation, bio-pharma groups, agriculture and food production, sociology, legal, and ethics) to solve societal problems. IEEE programs, services, and solutions will likely continue to evolve to allow the organization to be a leading player and have a seat at the table with others who are also focused on solving similar problems and issues.

IEEE has an opportunity to curate information to assist its constituents and the public in understanding the benefits and risks associated with several technology areas, most importantly, the deep integration of artificial intelligence (AI) and virtual reality (VR) into a wide variety of everyday applications. IEEE standards could contribute to a global initiative to define how AI is designed and used. For example, associated training is necessary to avoid intended or unintended bias in algorithmic models that influence activities such as autonomous cities, political processes, and medical decisions, to name just a few.

The vision for IEEE’s role in 2050 will allow the organization to expand or adjust existing programs, in addition to creating an entirely new array of programs available to both the technical community and broader public. The need for new programs, services, and solutions

will require IEEE leadership to be vigilant in routinely monitoring and identifying IEEE legacy programs that may need to be eliminated.

Engagement

In all worldviews, the association’s “membership” models are likely to look very different than today, if they even exist at all. The massive shift will be in the relationship between IEEE’s audiences of interest and their engagement with IEEE and will trickle through all of IEEE’s core areas of interest having impact in each. Level of connection to IEEE, reasons for connecting with IEEE, and cost involved with IEEE are all currently unknown.

In all potential scenarios for 2050, IEEE’s constituents are likely to be more diverse than they are today. Continued evolution and growing importance of technological innovation over the next few decades (even in the worldviews slow to adopt innovation) means it is likely that IEEE will expand the range of disciplines it supports, as the application of technological innovation becomes more interdisciplinary. Public sector organizations will likely become a very important constituency for IEEE.



Some aspects of how engagement with IEEE looks in 2050 is reliant on what worldview(s) are present. Each quadrant has unique characteristics that contribute to who will engage with IEEE and how.

In quadrants with low collaboration, only those who are geographically local to the organization may be permitted to engage with IEEE while other regions may have a broader array of engagement models available, including paying for services.

In some regions, engagement and adoption of change will be very strong. Using enabling technologies to host and organize meetings (including virtual meetings) will create more opportunities for engagement within the various new membership models. IEEE ought to investigate the adoption of Digital Twins and Personal Digital Twins as tools to establish a strong tie with its membership and attract new participants, while avoiding organizational disruption.

Content/Information

IEEE is likely to continue to benefit in the future from its current role and reputation as a trusted, neutral provider of content and information. The volume of journal articles published will potentially peak in 2030 and lay flat thereafter. How content and information is curated and delivered will likely look very different. The business models and audiences for IEEE content are also expected to evolve.



To become more relevant to private and public sector and other broader audiences, IEEE's knowledge base should have a much stronger focus on how knowledge can be applied (e.g., in industrial or public service delivery related processes). This is also referred to as "executable" knowledge.

User resources developed from content will likely be a compendium of articles, data, algorithms, videos, and other media – not all of which will be archived. Integration and curation of these may also be offered to content creators for a fee.

In some future scenarios, especially those in which collaboration and cooperation is low, the availability of access to and the ability to publish in reputable scientific and technical sources may narrow; a current trend that is growing. Content from outside a local (either country or regional) firewall might sometimes be accessed by special request via government channels.

Content published by IEEE will continue to be trusted to be objectively peer reviewed and assessed for data quality and reproducibility by IEEE. However, the initial vetting of submitted content will likely be partially to fully automated. An intensive time commitment for volunteers may still exist in the additional layers of assessment.

Convening/Community Building

Convening and community building are expected to remain high in importance in 2050 and beyond. However, there are several factors that will affect how and why people convene and build community.

New technologies will make interaction between people easier and more convenient, even in worldview scenarios that are slow to adopt change. In 2050, IEEE can expect that most or all meetings and gatherings will likely incorporate both AR and VR.

The growth of AR and VR is based on expanding hardware/software capabilities (including how mobile devices and technology implants are used) and expanding applications of the technology.



Format of meetings will likely be driven by the need to transmit information in different ways and at differing speeds as well as the need to foster discussions in new technical areas. The choice of some technical areas may be location-specific but there are likely to be various geolocations that will select similar technology focus areas.

Currently, events typically held in-person are starting to split into virtual components for paper delivery and discussions with some new creative ways of engaging people on a more asynchronous basis. The integration of in-person and virtual engagement should be seamless by 2050, resulting in many opportunities for varying formats and delivery methods.

If geopolitical conditions limit collaboration around the world, events might solely be accessible on a regional basis (even virtual events). Inter-regional discussions may take new forms and formats with heavy government interaction. It is also possible that engagement may become more informal and less visible if government involvement becomes too great.

Developing interpersonal relationships might still be largely an in-person activity. Despite this growth in virtual gatherings, there will still be value in physical participation in local and global gatherings. In scenarios where change or innovation is resisted, sub-optimal, or adopted slowly, in-person could be more desirable and prevalent. Tech curiosity will continue to drive learning about others across a worldwide paradigm but the ability to deliver this may be gated by government restrictions. If the world remains open, then the in-person component will drive networking and debate of technical topics, application areas, new emerging areas, and the softer side of technology such as ethics, privacy, etc.

Technical societies of the future might look similar to today, and in some scenarios might even increase in importance, bringing needed harmony in a world of rapid technological change. The membership demographics of these groups, how, when, and where groups convene, and what community means will depend on which worldview(s) persist.

People will likely organize around synergistic topics of interest, which may actively include broad topics like social or environmental issues, in addition to purely technological topics. These groups will likely be broad in composition including those who align on technical interest, those from governments and Non-Governmental Organizations (NGOs), educational institutions, corporate researchers, students, and other related audiences such as user communities and tech-curious communities. In all scenarios, it is likely that gatherings of special interest groups will be formed and dissolved quickly to address broader needs, reducing the need for extensive governance models.

Developing and Promoting Technology Standards

IEEE's reputation as a trusted technology partner should mean IEEE can remain relevant and a trusted partner in standards development in 2050 and beyond in all scenarios. As technology innovation continues to evolve at rapid speed (even in quadrants slow to change), standards activity is likely to remain important as technology advances. However, in worldview scenarios where collaboration and cooperation are low, IEEE standards activity will have to adjust to local needs.

An accelerated approach to development of standards that are living and evolving processes, responsiveness to addressing rapidly changing technological-advancement is important. Standards processes will need to become faster and more modular to maintain relevance.

As the geopolitical issues begin to influence the development of standards, it is imperative to address hyper-local and regional differences and needs. Countries with more extreme isolationist positions will most likely focus on national standards development and refuse to engage with international Standards Development Organizations (SDOs). Corporations, however, will likely still appreciate the value of standards that can be adapted easily and offered across national boundaries to maximize revenues. Corporations may be willing to pay substantial amounts to participate in standards development. The output is open-source standards freely available to end users and adaptable for local use. Traditional standards development cycles and processes are too slow for these companies.

Education and Career Support

Generation Z are digital natives who grew up with constant internet connectivity, and they are the first generation to have a touchscreen-centric approach to computing devices. They have grown up relying on tablets and smartphones as their primary interface device, with personal computers only used as a secondary device. Their immersion in online digital culture gives them high expectations for frictionless interfaces, which can lead to impatience in the face of legacy technology platforms and challenges. IEEE must prepare for this generation and beyond.



Acquiring information is key to the future and building structures that allow people to get what they want quickly is important. IEEE educational resources should continue the shift to be offered digitally and in multi-modal formats.

As IEEE further incorporates AI tools into their operations, the organization will likely be able to anticipate an individual's needs upon or even before their first engagement with IEEE. A constituent's engagement will be more of a "Broadcatch vs. Broadcast" approach, allowing members to choose what they want, when they need it, and in a medium or format that best meets their needs. Broadcast is the more traditional method of sharing knowledge, where timely information is distributed in a predefined manner at periodic intervals. IEEE will make use of specialized AI (with human insight) to filter and prioritize information that matters most to its constituents thereby avoiding information overload, or a narrowing of unrecognized options. Human insight can be a key value add to "commodity" AI.

IEEE will be able to support the educational and capacity building needs of end-users of STEM related products, services, and solutions through the on-demand provision of multi-modal modules to facilitate different learning approaches that are stackable and internationally recognized in terms of credentials, level (e.g., foundational, intermediate, advanced), and objective (e.g., cross-disciplinary or interdisciplinary). The predominately service-oriented offerings will be delivered as microlearning opportunities (learning snippets) with a learning path to create credentials for competency assessment to drive personal growth.

Education resources should support large and small countries or regions, businesses of all sizes, academic institutions, technology professionals across a range of disciplines, and potentially the general public. IEEE ought to continue to create a forum to facilitate the development of applications for new technologies as they continue to evolve.

IEEE Funding Opportunities

There are several potential funding models that could support IEEE, including but not limited to membership subscriptions, education and skills capacity building modules, certification recognition, sponsored activities, and donor directed philanthropy.

Several sub-groups anticipate membership related income is more likely to be from a subscription type model. Others felt that individuals or corporations would support IEEE based on their alignment with the mission.

Shifts in traditional IEEE funding sources need to be closely monitored. Conversations with corporate sponsors, particularly those with an international focus, should be explored. In addition, IEEE should continue to explore non-dues revenue, including monetizing the applications relative to data-collection and analysis.

Disruption regarding the revenue generated from standards setting is likely. It will be important to strategize and address this quickly to minimize the disruption.

Closing

The goal of this project was to envision opportunities and risks that the future could hold. The in-depth discussions combined with the futurists interviews and supporting research better prepares IEEE to work toward its optimal future, to maximize new opportunities while minimizing disruption.

Some of the recommendations in this report might align with the intent of existing IEEE programs or services. Many of these initiatives will need significant further research and consideration. IEEE should consider piloting test models to make incremental changes to minimize organizational disruption. Regardless of the quadrant or quadrants that IEEE experiences, to prepare for 2050, significant change must occur.

The commitment of resources for this project was notable. The IEEE Board of Directors should be commended for proactively pursuing this exploration. The interviews with the futurists and the research provide an enormous source of ideas and opportunities that IEEE can explore. By addressing the challenges and opportunities, IEEE can remain a vibrant organization, with relevance both now and in the future.



Additional recommendations related to the work of the IEEE Ad Hoc Committee on IEEE in 2050 are available upon request. Please email ieeein2050andbeyond@ieee.org with your inquiry.

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