



Embracing Change: IUPAC's Opportunities Moving Forward

by Javier García Martínez

The year 2024 marks the beginning of important changes at IUPAC, the result of a journey that began in 2019 and crystallized in some of the most important decisions for IUPAC's future in recent decades, adopted at our latest General Assembly in The Hague last August. In this column, I would like to talk about the many things we have accomplished together in recent years but most of all the future, about the many opportunities I see for IUPAC in the years ahead.

I would like to begin by mentioning that in recent months I have had the privilege of attending several meetings of the newly established Science Board and Executive Board. It is difficult to overstate the dynamism, enthusiasm, and ambition with which the people who are part of this new IUPAC structure are working. On the one hand, we are in the process of reinventing the structure of our Divisions and Committees. Until now, we have been organized according to the traditional areas of chemistry (organic, inorganic, analytical...) This traditional view of chemistry promotes silos and hinders interdisciplinarity. That is why we are already working on organizing ourselves around "topics" or "challenges" such as chemistry and energy, chemistry and health, chemistry and the environment, to foster interdisciplinarity and collaboration among our members. I want to emphasize that everyone will be heard in this process of rethinking the organization of IUPAC. I would also like to express my gratitude to the extraordinary individuals who serve on both our Executive and Scientific Boards. Thanks to their vision and hard work, I am confident that we will make IUPAC more effective, agile, and impactful.

Regarding the opportunities that I see for IUPAC in the coming years, the most obvious and perhaps most relevant is Digital IUPAC, an initiative to which we have given the highest priority, and to which we are dedicating resources, time, and focus. This is a collaborative effort involving all IUPAC Divisions and Committees

to provide standards and resources that facilitate the robust exchange and use of chemical information. Among the many activities involved, I would like to highlight the update of the IUPAC Compendium of Chemical Terminology, our famous Gold Book. This is one of the most ambitious projects we are working on, as it involves every single Division and Committee. Updating and expanding the terms in the Gold Book, which in its current version already contains more than 7,000 terms, and bringing all this information into a new, more user-friendly platform, will have a huge impact on the chemistry community and will greatly contribute to making all our efforts more valuable and the results of our work more accessible.

Similarly, artificial intelligence, machine learning, and especially large language models are transforming entire industries; and science is no exception. Thanks to these automatic learning techniques, machines are helping us look for patterns in the scientific literature and suggest the most effective experiments. As Andrew D. White recently titled his commentary in *Nat Rev Chem* 7, 457–458 (2023), the future of chemistry is language; and I would add that language is at the core of what we do at IUPAC. That is why we are increasing our efforts to create standards for the digital chemistry word. This is critical because, with the explosion of artificial intelligence and machine learning in chemistry, many different formats, standards, and protocols are being developed without any coordination, causing much confusion and problems in the management, sharing, and use of chemical data. In collaboration with the broader chemistry and data science communities, we are working to translate chemical communication standards into the digital domain, to align standards development and implementation with the FAIR (Findable, Accessible, Interoperable, Reusable) data principles. Coordinated by CODATA, and with the Research Data Alliance as a key partner, the WorldFAIR project will work through a series of case studies to advance the implementation of the FAIR data principles, particularly those for interoperability, and to develop a set of recommendations and a framework for FAIR assessment in a number of disciplinary or cross-disciplinary research areas. This effort is a key priority and an unavoidable opportunity to prepare FAIR implementation profiles appropriately adapted to each (cross)disciplinary area. (See <https://worldfair-project.eu/2023/09/27/iupac-worldfair-chemistry-managing-chemical-data-digitally/>)

We chemists are very good at making connections, but we have a much harder time coordinating with each other. The different organizations working for chemistry, associations, professional bodies, societies,



(Fig 1) HRH Princess Chulabhorn of Thailand refers to the IUPAC Top Ten Emerging Technologies in Chemistry at the PACCON2024 Conference in Bangkok, as an example of innovations that can help us build a more sustainable future.

and federations hardly coordinate their actions, and share their resources and information. That is why the Presidents' Forum—which was a recommendation of the IUPAC Structure Review and which inaugural session was held in August 2023 during our General Assembly in The Hague—is such a great strategic opportunity for IUPAC. See page 41 for a report on this activity. This is a meeting of the presidents of all chemical societies and federations with the objective of sharing information, coordinating actions, and serving as a high-level global platform for chemistry. More than 40 representatives responded to our call. I am convinced that the Presidents' Forum is a strategic initiative for IUPAC and a great opportunity to act as a convener for the international chemistry community to work together for the common goal of better serving the chemistry community worldwide. In the coming months, we will be launching a Presidents' Forum website on the IUPAC website with resources, information, and joint activities to serve as a meeting place for the entire international chemistry community.

I am convinced that the integration of the International Younger Chemists Network (IYCN) into the IUPAC structure is one of the most obvious, even inexorable, opportunities for our organization. Not only will we bring talented early-career scientists into our

structure, but we will also have access to hundreds of dedicated volunteers in more than 70 countries around the world. IYCN and IUPAC have worked together for many years. Successful activities such as the Periodic Table of Younger Chemists, ChemVoices, or the Global Conversation on Sustainability are the result of our collaboration, but the effective integration of IYCN into IUPAC will take the impact of our activities to a whole new level. It will also allow us to improve our diversity, and inclusiveness. It will also significantly increase our representativeness, as IYCN is present in many countries, including Latin America, Africa and the Middle East, where our membership is significantly lower. This is one of the most significant and transformative changes in recent IUPAC's history.

Our global initiatives, such as the Top Ten Emerging Technologies in Chemistry, are another great opportunity for IUPAC. This activity is an extraordinary example of how we can raise awareness of some of the most important scientific discoveries of our time while promoting chemistry. Through this global initiative, IUPAC is projecting a modern, forward-looking image, helping to improve the public perception of chemistry and connecting the laboratory with industry and society. In addition, this initiative is part of a call we make every year for anyone in the world to propose a technology

Past President's column

to our international panel. In 2024, we'll be celebrating the sixth edition of the Top Ten Emerging Technologies in Chemistry, which continues to grow in popularity and reach year after year. Media from many parts of the world, prestigious journals and scientific congresses have picked up on the technologies we highlight at IUPAC and have become a sign of recognition and support for chemical technologies that can shape our future and contribute to a better, more sustainable future for all. (See Figure 1 and <https://iupac.org/what-we-do/top-ten/>)

Another of our most successful global activities is the Global Women's Breakfast. By promoting inclusivity, the GWB creates a platform for dialogue and collaboration to address diversity and leadership challenges in chemistry worldwide. This is a highly visible initiative that IUPAC organizes each year and that place our organization at the heart of the efforts to improve diversity and inclusiveness in science worldwide. I cannot thank Laura McConnell and Mary Garson, co-chairs of the Global Women Breakfast, enough for making this annual event such a great success. In 2022, we reached over 30,000 people from 78 different countries at 407 individual events, and in 2023, we held over 380 events in 75 different countries, with Morocco, Rwanda, Slovenia, Sudan, Tanzania, the United Arab Emirates, and Vietnam participating for the first time. This global activity not only helps raise awareness of the need to

increase diversity and inclusion in science around the world, but also gives IUPAC additional visibility and helps us reach out to communities where we have very little presence. The 2024 Global Women's Breakfast on February 27, "Catalyzing Diversity in Science," demonstrated once again how IUPAC can help promote a more diverse and inclusive science worldwide.

Our commitment to diversity, inclusion, best practices, and respect for others has crystallized in the Committee on Ethics, Diversity, Equity, and Inclusion (CEDEI). I could not be more proud of this important committee and the work it has accomplished in just a few short years. In this regard, I would like to highlight the IUPAC project entitled *Guiding Principles for the Responsible Practice of Chemistry* (see project 2022-034-3-060), which they are leading. This initiative aims to produce a set of guidelines that will provide a framework for transparent, responsible, and ethical behavior in all aspects of the chemistry enterprise. These Guidelines will be developed in line with the mission statement of the IUPAC Strategic Plan, and it represents an outstanding opportunity, as IUPAC should also make recommendations regarding best practices, ethical use of chemistry, and the promotion of diversity, equity, and inclusion in chemistry. CEDEI is therefore a strategic opportunity to consolidate IUPAC's international leadership and the fundamental role of our organization in emerging areas of increasing importance.



(Fig 2) Workshop on System Thinking in Chemistry Education held here in Cairo during the African Conference on Research in Chemistry Education (ACRICE).

A few weeks ago, I had the honor of representing IUPAC at the closing ceremony of the International Year of Basic Sciences for Sustainable Development (IYBSSD) at CERN, Geneva, Switzerland. See page 44 for a short report on this meeting. It was a celebration of all that we can achieve together and of the importance of knowledge, evidence, and international collaboration in achieving the Sustainable Development Goals. Now, in 2024, we have a new opportunity with the start of the Decade of Science for Sustainable Development (DSSD), declared by the UN General Assembly on 25 August 2023. It will certainly be a challenge to fill an entire decade with activities and content, but at IUPAC we have many global initiatives, such as the Periodic Table Challenge, ChemVoices, the GWB, and the Top Ten Emerging Technologies in Chemistry, that can grow much more thanks to this International Decade. Undoubtedly, if we seize the opportunity, the Decade of Science for Sustainable Development (DSSB) will allow us to build and explain how chemistry can help us address some of the major challenges we face and accelerate the achievement of the Sustainable Development Goals.

The involvement of such major international initiatives as the IYBSSD and now the Decade of Science are great opportunities to strengthen our relationships and collaborations with other international scientific organizations such as UNESCO, Academies of Sciences, other Scientific Unions, and the International Science Council. To achieve our goals and to ensure that IUPAC can better serve the scientific community, we must strengthen our relationships with the major international scientific organizations that share our goals. (See <https://iupac.org/iybssd2022/>)

One of my great heroes, Nelson Mandela, used to say, "*Education is the most powerful weapon (I would say tool) you can use to change the world.*" That is why we at IUPAC are working hard to reimagine the future of chemistry education. In particular, systems thinking offers an extraordinary opportunity for a more relevant and contextualized chemistry education, giving students the tools to connect the molecular description of the problems we face with their solution. IUPAC's various projects to design, implement, and disseminate System Thinking in chemistry education have given us great visibility and placed IUPAC at the center of reimagining the chemistry education of the future. These kinds of efforts, which make IUPAC the engine of change in chemistry and a key player in the future of our profession, are a unique opportunity and a key

priority that we should take advantage of also in other areas such as chemical entrepreneurship, the transfer of discoveries to the marketplace, and university-industry relations.

I have always been aware of the extraordinary work done by our staff and volunteers, but my time as IUPAC President gave me the opportunity to see this work firsthand. I cannot begin to describe the titanic work that Tammy, Enid, Fabienne and Greta do. Just four people who take care of the logistics and coordination of all IUPAC activities. They are the real Fantastic Four. I am deeply grateful for their commitment and dedication, which goes far beyond the call of duty. Please, if you have time, send them a note and talk to them the next time you see them to let them know how much you appreciate their contributions as well. But the heart of IUPAC's work is done by our volunteers. Hundreds of people from around the world who give generously of their time and talents so that we can serve the chemical community. Personally, and on behalf of the entire organization, I would like to express my gratitude to each and every person who contributes to our work, from the recently appointed members of the Executive and Scientific Boards to the volunteers who help us organize the Global Women Breakfast in hundreds of cities each year.

The last few years have not been easy; disease, climate change, and war are threats to our survival. Our best defense against these existential risks is science and international cooperation. That is why organizations like IUPAC are needed now more than ever to build a better world together, with evidence-based action, diversity and respect for others, and with ethics at the heart of everything we do. After a process of reflection and change that began with our Centennial, we are now ready to realize the ambitious but achievable commitment that defines our mission: "*The application and communication of chemical knowledge for the benefit of humankind and the world.*" What a wonderful goal to work toward.

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