

NIH National Institutes of Health Office of Behavioral and Social Sciences Research

The Future of Scientific Conferencing Proceedings



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Executive Summary

The National Institutes of Health (NIH) virtual workshop, "The Future of Scientific Conferencing," took place on June 6, 7, and 11, 2024 on the Labroots conferencing platform. Hosted by the Office of Behavioral and Social Sciences Research (OBSSR), with additional support from the Chief Officer for Scientific Workforce Diversity (COSWD), this event brought together multidisciplinary thought leaders to discuss the future of scientific conferences and meetings, with a focus on diversity, environmental sustainability, and technology-driven innovation.

Presentations were organized into four tracks:

- 1. Promoting diversity and inclusion—Strategies for overcoming barriers and fostering inclusivity in scientific conferences.
- Environmental sustainability—Efforts to reduce the carbon footprint of academic travel through online conferencing, hybrid approaches, and transformation of norms surrounding scientific conferences and meetings.
- 3. Networking, collaboration, and engagement—Enhancing engagement, collaboration, and scientific impact by understanding catalysts for convergence and applying techniques to improve interactions and engagement.
- Balancing participant needs and innovative technology—Navigating diverse perspectives and needs within the conference ecosystem and leveraging innovative technologies to bridge physical distance and improve the conference experience.

In addition to keynote and plenary speakers, the workshop featured 28 presenters with diverse perspectives on key aspects of scientific conferencing. Highlights from their presentations and panel discussions are summarized in this document.

An "Engagement Day" included several activities designed to promote networking and connection, from live poster presentations and Q&A sessions to 1:1 networking opportunities and multiple small group breakout discussions, led by workshop speakers and NIH staff. An online calculator was provided for participants to track carbon emissions saved by attending virtually compared to in-person.

Workshop attendance data and carbon calculation details are included in the appendices, along with discussion board summaries and a summary of considerations for equitable and effective scientific meetings.

Event recordings and other resources can be found on the OBSSR website: <u>https://obssr.od.nih.gov/news-and-events/events/future-scientific-conferencing</u>.

NIH Planning Committee

The following individuals were included in the workshop planning committee:

Jessica Gowda, M.S., OBSSR, NIH—Co-Chair
Sydney O'Connor, Ph.D., OBSSR, NIH—Co-Chair
Toccara Chamberlain, M.A., National Institute of Environmental Health Sciences, NIH
Theresa Cruz, Ph.D., National Center for Medical Rehabilitation Research/Eunice Kennedy Shriver National Institute of Child Health and Human Development, NIH
Cynthia Dwyer, M.A., Office of Extramural Research, NIH
Carlos Garrido, Ph.D., M.S., M.P.H., National Institute on Minority Health and Health Disparities, NIH
Kara Hall, Ph.D., National Cancer Institute, NIH
Beth Jaworski, Ph.D., All of Us Research Program, NIH
Amit Mistry, Ph.D., Fogarty International Center, NIH
Dana Greene-Schloesser, Ph.D., OBSSR, NIH
Jean Shin, Ph.D., Office of the Director, Chief Officer for Scientific Workforce Diversity, NIH
Erica Spotts, Ph.D., OBSSR, NIH

Welcome

Jessica Gowda, M.S., and Sydney O'Connor, Ph.D., OBSSR

Representing OBSSR, Ms. Gowda and Dr. O'Connor welcomed participants and acknowledged the NIH Future of Scientific Conferencing Workshop Planning Committee for their efforts in planning the event. The workshop's goals were to:

- Bring together multidisciplinary experts and apply evidence-informed approaches to explore barriers and opportunities in scientific conferencing.
- Enhance scientific conferencing, with discussion focused on:
 - o Upholding diversity, equity, inclusion, accessibility, and belonging (DEIAB) principles
 - o Promoting environmental sustainability
 - o Overcoming attendance barriers to build an engaged and diverse scientific workforce

Day 1 Welcome Address

Jane M. Simoni, Ph.D., Director, OBSSR

Dr. Simoni reviewed the history and purpose of OBSSR. Created in 1995, OBSSR is responsible for working within and beyond NIH to facilitate a synergistic integration of behavioral and social sciences with biomedical research so that discovery is accelerated and implementations to improve public health are equitable. Strategic priorities that will build better science include:

- Elevating OBSSR and its impact on collaborative research and sustainable adoptions
- Applying DEIAB values through equitable partnerships and bidirectional collaborations
- Fostering communications within the scientific community and with the public
- Building workforce capacity through broader diversity and reach
- Optimizing the generation of team science by fostering participation and hence creativity

Opening Keynote

Marie A. Bernard, M.D., COSWD

Dr. Bernard began her keynote with the fundamental concept that equitable scientific conferencing embodies the mission of COSWD. An analysis of 2.5 million scientific papers demonstrates that inclusion equals excellence. Collaborators with distinct backgrounds generated more widely cited research, leading to greater discovery.^{1,2} By sharing each contributor's limited perspectives, a multifaceted approach to build better science serves to instill research best practices, harness cultural change, offer flexibility in policies, and maintain action-oriented accountability.³

Notably, virtual experiences during the pandemic revealed that the virtual format improved the participation of underrepresented groups in conferences. For example, attendance data from the International 2020 Research in Computational Molecular Biology conference showed a marked increase in female attendees, Hispanic attendees, and attendees with African ancestry. By 2021, the NIH Office of Extramural Research (OER) Regional Seminar workshop experienced expanded attendance from 900 in-person attendees to 25,000 virtually. Meanwhile, reported participant satisfaction has risen to an average of 4.6 out of 5.

Virtual conferencing is perceived as effective in enhancing DEIAB, broadening universal accessibility, and making conference content and output readily available. At the same time, environmental impact is reduced, and cost savings are delivered to organizers and attendees. However, virtual meeting spaces present several challenges:

- Reduced opportunities for informal, spontaneous conversations that foster social connections
- Fewer visual cues, leading to increased cognitive strain
- Dependence on a stable internet connection, along with a learning curve for using various technologies

A hybrid solution offers the advantage of participant choice in how to attend. However, challenges can arise in bridging in-person and online contributors, balancing numbers across these two audiences, and maintaining focus on addressing on-site disability barriers. Dr. Bernard asked attendees to perform many-sided comparisons of in-person versus virtual experiences, with a focus on qualitatively assessing virtual benefits so that interactivity can be improved through human-centered design.

Summary of Presentations

Track 1—Promoting Diversity and Inclusion in Scientific Conferences and Meetings

Cultivating Inclusivity: Advancing Diversity and Inclusion in Scientific Convenings

Moderator: Marie A. Bernard, M.D., COSWD

Virtual conferences have increased diversity and reduced environmental impact compared to in-person events. Dr. Joseph from Harvard addressed structural barriers to global equity in conferences. Dr. Corona-Sobrino reviewed the inclusivity gains of virtual events, while Dr. Sarabipour presented a data-driven approach for monitoring conference setups.

Michelle Joseph, Ph.D., M.B.B.S., M.Sc., FRCS, Harvard Medical School, "Overcoming Key Structural Barriers in Equitable Scientific Conferencing"

Dr. Joseph proposed a pathway for equitable participation in global health conferences. To contribute and challenge the status quo, learners must first feel comfortable and included.⁴ Various "isms" and regional factors that shape conference dynamics, where diverse attendees rely on organizers to foster inclusion. Dr. Joseph stressed the need for organizers to ensure that diverse voices are present. Her team's <u>Conference Equity Project</u> helps implement inclusive practices.

A review of 36,000 conference attendees showed:

- 7.8% were from low-income countries (LICs), with most conferences held in high-income countries (HICs).
- Barriers included limited speaking slots and visa restrictions.
- Moving conferences to LICs increased LIC participation to about 50% without added support.

Data from organizer interviews and attendee surveys informed a conference equity framework, focusing on language, accessibility, and visibility. Dr. Joseph's team aims to spread the framework, encourage adoption by event planners, and create a conference equity index.

Carmen Corona-Sobrino, Ph.D., University of Valencia, Spain, "Monitoring and Assessing Gender Gaps in Events"

Dr. Corona-Sobrino introduced Monitoring and Assessing Gender Gaps in Events (MAGGIE), a tool for tracking gender imbalance in speaker representation, speaking times, and organizing committees. Based on the Analytical Hierarchy Process,⁵ MAGGIE helps organizers identify and close gender gaps in scientific conferences. The team conducted 13 interviews and two focus groups with gender dynamics experts before evaluating seven events on factors such as speaking time. Key performance indicators included female participation, organizational policies, and gender attitudes. Dr. Corona-Sobrino made recommendations for moving forward:

- Engage multidisciplinary groups to promote women as influential speakers and organizers.
- Address gender disparities throughout the conference life cycle, identifying and targeting the weakest areas for change.

The team aims to make MAGGIE adaptable across disciplines and for online events.

Sarvenaz Sarabipour, Ph.D., University of Connecticut School of Medicine, "Virtual and Hybrid Conferences: Towards Democratizing Science Communication"

Dr. Sarabipour's team studied how research culture affects conference inclusion, analyzing 270 multidisciplinary conferences involving 850,000 academics. Organized or sponsored by various entities (journals, societies, funding agencies), the team reviewed conference websites, compiling results into a central database. Findings revealed minimal mention of greening initiatives (6%), networking events (20%), career development workshops for early career researchers (38%), and diversity statements (22%), with public engagement and childcare almost absent. Despite the average conference cost of \$1,500 per attendee, conference funders spend \$1.3 billion on these meetings.

Virtual conferences offer cost savings and increased inclusivity:

- Early career researchers (ECRs) attend 3–10 times more than in-person events.
- International scholars face fewer visa issues.
- More diverse representation is seen across continents.

Dr. Sarabipour highlighted the need to improve research culture and policy by providing:

- Open-access science, conferences, and outputs
- New organizing principles and formats
- Sponsorships and career development for ECRs
- Meeting attendance statistics and meeting expenditure and revenue budget transparency
- Accessibility for persons with disabilities

Fireside Chat: Creating Inclusive Conference Environments Through Disability Inclusion and Accessibility

A fireside chat explored disability inclusion in scientific meetings, highlighting the need for accommodations and accessible facilities, and fostering a culture of respect.

Moderator: Theresa Cruz, Ph.D., National Center for Medical Rehabilitation Research, Eunice Kennedy Shriver National Institute of Child Health and Human Development

Panelists:

Lisa Meeks, Ph.D., M.A., University of Michigan Medical School Bonnielin Swenor, Ph.D., M.P.H., Johns Hopkins School of Nursing Jenny Mai Phan, Ph.D., Children's National Hospital Dr. Cruz posed a series of questions to the panelists, leading to the following key points:

1. Broad disability spectrum: The community includes people with various physical, cognitive, and sensory conditions, and immune suppression.

2. Defining "disabled":

- Different groups prefer different terms.
- A civil rights-based definition is useful, recognizing those protected by law.
- Some individuals covered by the Americans with Disabilities Act (ADA) may not identify as disabled.
- Normalize identifying as disabled and use person-first language. Ask, "How can we include you?" instead of "What do you need?"
- 3. Accessibility and inclusivity: Shift the focus from transactional accessibility to creating environments where disabled attendees can thrive. Consider cognitive and chronic conditions in scheduling, allowing breaks to reduce cognitive load.

4. Universal design:

- Benefits everyone, but its adoption remains limited despite 54 million Americans having disabilities.
- Resources for understanding universal design:
 - o <u>CAST</u>
 - o Ford Foundation Disability Inclusion Toolkit
- 5. Start small: Organizers should apply existing best practices from sources such as the ADA Info Center and Johns Hopkins University Disability Health.
- 6. Accessibility as a core principle: It's often treated as an add-on, leading to barriers.
- 7. Attitudinal and structural barriers: Organizers resist accommodations, and disabled attendees often feel othered. On-site representatives should provide quick, flexible solutions (e.g., noise-canceling headphones).
- 8. STEM diversity: Disability should be central to STEM diversity, not treated as an afterthought.
- 9. Opportunity costs: Missing sideline conversations or taking time for self-care can negatively impact career growth.
- 10. Limitations of the ADA and Rehabilitation Act: These laws are a starting point for equity, not the end.
- **11.** Hybrid conferences: Hybrid formats help accommodate caregivers and diverse minds but aren't a substitute for improving on-site accessibility.
- 12. Call to action: Apply team science principles to researching conference equity.

Key Topics of Discussion

The following topics were highlighted in Track 1—Promoting Diversity and Inclusion in Scientific Conferences and Meetings:

- 1. **Inclusive networking:** Formal and informal networking opportunities are often non-inclusive. Intentional approaches are needed to ensure that networking opportunities are accessible to all.
- 2. Gender balance and inclusivity: Equal gender representation correlates with women feeling valued in the scientific community. Reducing emphasis on academic titles and labeling collaborators as experts can increase participation.
- **3. Privacy and data sharing**: Opt-in/opt-out options, strict guidelines, and protecting contributor data behind logins are essential for privacy during recordings.
- 4. DEIAB policies and outcomes: More diversity statements are being communicated, but longitudinal data is needed to measure which policies drive equity. Diversity metrics, dashboards, and outcome studies are necessary.
- Conference format and inclusivity: Virtual meetings provide equitable access, especially for underrepresented groups, but in-person events can offer stronger connections if done thoughtfully. Hybrid meetings are costly but must ensure that virtual attendees receive an equivalent experience.
- 6. Continuous engagement: Individual networking should occur year-round, not just at conferences. Online platforms such as Slack and bioRxiv allow ongoing collaboration, while virtual events can enhance interaction, especially for ECRs.
- Disability accommodation: Hybrid formats often fall short of providing real equity for disabled attendees. Organizers should focus on accessibility beyond technical solutions, including financial support for disabled scholars invited to speak.
- 8. Sensory and energy limitations: Thoughtful event design, such as quiet rooms and clear signage, can help attendees with sensory limitations. Overstimulation from lights, noise, and crowds must be considered.
- **9.** Attending with disabilities: Physical conferences pose significant challenges for disabled attendees, leading to missed opportunities. Virtual formats help, but the burden of requesting accommodations often falls on the individual, which needs to change.
- **10.** Final thoughts: Conference planners must embed diversity, equity, and inclusivity into event design, ensuring that the needs of all participants are addressed. The conversation on accessibility is just beginning, and ongoing assessments are necessary to measure progress.

Track 2—Redefining Conferences: Innovative Formats for Sustainable Engagement

Sustainability in Motion: Charting a Greener Course for Academic Travel and Career Progression

Moderator: Sydney O'Connor, Ph.D., OBSSR

Traveling is a routine aspect of academic work, facilitating opportunities for research, networking, and collaboration. In this session, three experts, including Drs. Ben Ari, Whitmarsh, and Ackerman, discussed tools for measuring carbon footprints, the link between academic travel and career success, and ways to reduce the environmental impact of academic travel.

Tamara Ben Ari, Ph.D., French National Institute for Agriculture, Food, and Environment, "Determinants of the Carbon Footprint of Academic Traveling and the Pathway for Reduction"

Dr. Ben Ari discussed the Labos <u>1point5 program</u>, which helps research units (20 to 200 people) reduce the environmental impact of work-related travel. Her team developed a tool to measure greenhouse gas (GHG) emissions and suggest mitigation strategies.⁶ About 1,000 French research units, or one-third of the total, adopted the program. Data collected from these units highlight that air travel, especially for conferences, is a major contributor, with flights over 6,500 kilometers making up half the emissions. Shifting to train travel for short trips has had minimal impact, leading Dr. Ben Ari to advocate for alternatives to long flights.

A 2021 Labos 1point5 survey showed a disconnect between researchers' concerns about climate change and their behavior. Although 70% of respondents expressed concern, the same percentage had never canceled a trip for environmental reasons. The research community's awareness of climate change is high, but few units have taken steps to reduce emissions.

Key challenges include:

- Preference for individual eco-friendly actions over systemic changes.
- Lack of discussion around structural inequities.
- Few research units have implemented emission-reduction policies.

A potential reason for the reluctance to change is the correlation between frequent flying and academic success. Researchers who took more than 20 flights in 2019 had higher publication rates, suggesting the importance of exposure through conferences.⁷

Lorraine Whitmarsh, Ph.D., University of Bath, United Kingdom, "Walking the Talk: Does Climate Change Knowledge Influence Academic Behavior?"

Dr. Whitmarsh emphasized that climate scientists are more credible advocates for behavioral change when they lead by example.⁸ Conference travel, particularly by air, is often the largest source of carbon emissions,⁹ with wealthier nations responsible for most emissions but poorer nations suffering the consequences. However, environmental concerns alone don't predict climate change mitigation behavior.

Her team surveyed 1,400 academics across 30 institutions to explore whether climate change researchers fly more or less than other scientists. Despite their knowledge and concern, senior climate experts flew the most.

Key findings include:

- Environmental experts took 2–3 times more flights per year than other researchers.
- Senior professors emitted the most GHGs, possibly due to fieldwork.
- Researchers primarily fly for convenience and to build professional relationships.

In a follow-up study, 375 academics received either technical or environmental justice information to determine whether it affected their behavior. Results showed that those who flew for leisure also flew more for work, likely due to income. However, information and environmental values led to reduced intentions to fly, with 38% of experts choosing non-aviation travel in the past year, compared to 17% of non-experts. Yet, funding policies didn't incentivize low-carbon alternatives. Recommendations from 65 contributors from 50 institutions in 10 countries to reduce flying while enhancing inclusivity include:¹⁰

- Improving online collaboration methods
- Prioritizing land-based travel and factoring emissions into funding criteria
- Compensating for the time required to use alternative travel
- Redefining professional excellence beyond busyness

Visit No Fly Climate Sci for further resources and discussion.

Sara Ackerman, Ph.D., M.P.H., University of California, San Francisco (UCSF), "Transforming the Culture of Academic Travel"

Dr. Ackerman shared findings from the UCSF Study Project, which tested the idea that collective norms could override personal interests to reduce academic air travel. Without factoring in academic travel, the U.S. health sector is responsible for one-quarter of global health emissions. UCSF's annual sustainability report estimates that institutional travel contributes 15% of its emissions, which is likely underreported.

The 2020 project involved a focus group of 17 faculty members at various career stages, examining the benefits and burdens of work-related air travel.¹¹ While travel facilitates scientific collaboration, it disrupts home life and academic routines. Implicit pressure to travel for career advancement and success persists, with little reflection on whether these practices are necessary. Although virtual meetings improve global access, they often lack the social and networking benefits of in-person gatherings. Faculty members in the study expressed the need for clear guidelines on when travel is truly essential.

To lead by example, UCSF's senate has made sustainability a key focus, distributing carbon calculators and creating grants to support virtual conference attendance.

Their goals include:

- · Aligning travel policies with justice and sustainability conversations
- · Helping faculty and staff manage their carbon footprints
- Enhancing resources for hybrid meetings while improving attendee satisfaction

Redefining Conferences: Innovative Formats for Sustainable Engagement

Moderator: Toccara Chamberlain, M.A., National Institute of Environmental Health Sciences

Conference formats have differing implications for environmental impact, engagement, and accessibility. In this session, Dr. Meyer-Kahlen discussed the multi-hub format, balancing environmental concerns with the need for scientific collaboration. Ms. Tao detailed travel calculations for organizing hybrid events, while Dr. Raby highlighted the environmental benefits of moving an animal behavior conference online.

Yanqiu Tao, M.S., Cornell University, "Trend Towards Virtual and Hybrid Conferences May Be an Effective Climate Change Mitigation Strategy"

Ms. Tao discussed how the rise of video conferencing apps during the COVID-19 pandemic, including three of the seven fastest-growing apps, set the stage for today's sustainable virtual and hybrid conferences. She cited data from the European Astronomical Society annual meeting, noting that travel emissions from just one international conference can equal the annual CO₂ output of the Max Planck Institute and the per capita emissions of some developing nations. Additionally, 50% of travel emissions are tied to long-distance flights of over 5,000 kilometers.

Ms. Tao's team analyzed the environmental trade-offs of the 2020 Association for Computational Linguistics virtual conference, comparing a multi-hub format to an in-person event. The team created an attendee ecosystem encompassing factors such as travel mode, materials, utilities, and food and accommodations to evaluate the carbon footprint and cumulative energy demand. They considered the environmental impact of infrastructure, materials, and energy consumption, including fossil fuel use, metal depletion, water toxicity, and land and soil impacts.

Her team found that adding up to six conference hubs, located near major airports, could shift travel from aviation to car or train, stabilizing travel distances across participants. For 383 attendees who could be geolocated, the number and location of hubs were optimized based on attendee origins. They demonstrated that increasing virtual attendance to 50% could reduce the conference's carbon footprint by two-thirds. Moreover, using hubs decreased cumulative energy demand by 90%, largely by reducing air travel, while adding hubs reduced this energy demand by half.

Nils Meyer-Kahlen, M.Sc., Aalto University, Finland, "The Global Multi-Hub Academic Conference"

Mr. Meyer-Kahlen, a doctoral researcher in information engineering and virtual acoustics, questioned who benefits from traditional academic conferences, asserting that only those who can afford to attend them do. He shared an example of his academic colleague, Professor Richard Parncutt, traveling from Austria to Australia for a lecture tour without flying.

Emphasizing the urgency to cut emissions, Mr. Meyer-Kahlen noted that aviation contributes 5% to global warming, with one intercontinental flight equating to a year's worth of driving emissions.

In a survey of 13 colleagues, Mr. Meyer-Kahlen found that meeting new people and connecting with colleagues were the top reasons for attending conferences. Virtual events, while accessible, often lack social interaction and inspiration. The multi-hub global meeting approach offers a viable alternative, providing live event benefits with real interaction and rich content. The 2018 ICMPC15/ESCOM10 Conference, featuring four European hubs and additional satellites in North and South America and Australia, exemplified this model.

Key features included:

- A global foyer for chatting
- A homepage with times for all hubs
- Streams and recordings for all attendees

Survey results showed that 60% favored the hub approach, with La Plata, South America, having the highest satisfaction. This format increased attendance by 50% and reduced emissions per person by 70%.

Cassandra Raby, Ph.D., School of Biology, University of Leeds, "The Benefits and Challenges of Moving Conferences Online"

Dr. Raby presented a case study on the Association for the Study of Animal Behavior's online conferences, which have been held cost-effectively for about 10 events. The platform includes public and secure private pages and Zoom links, with open-source 3D animations resembling the in-person experience. In 2019, the in-person event drew 172 delegates from the United Kingdom (UK), European Union, and internationally. With 20 in London already, the other delegates traveled via train (102), air (43), and bus/car (7).

Data on environmental impacts showed that the 2019 in-person meeting's 417 attendees traveled 2,040,736 kilometers, producing 234.7 tons of CO₂. Virtual meetings have 17 times lower emissions and offer greater inclusivity and international reach.

Dr. Raby noted persistent interest in online events globally. However, in financially capable regions, virtual formats attract fewer participants compared to in-person gatherings. There is a belief that conservationists should lead by example in sustainable practices.

Key Topics of Discussion

The following topics were highlighted in Track 2—Redefining Conferences: Innovative Formats for Sustainable Engagement:

- Examples of successful academic air travel policies: A key UK health research funder, the Wellcome Trust, now requires researchers to demonstrate how they will consider sustainability in their proposals. While European universities have banned short-haul flights where alternatives exist, U.S. institutions face challenges due to large distances. NIH is leading by example with virtual committee meetings.
- 2. Research opportunities in methods and measurement tools: UCSF faced resistance to tracking carbon footprints due to software incompatibility. Many tracking tools are complex and data-intensive. An open-source tool from the Space Telescope Science Institute is available, but researchers in France struggle to access centralized emissions data.
- 3. Disassociating busyness from excellence: Behavioral habits drive excessive travel. The Tindall Centre for Climate Change Research has built a low-carbon culture with tools such as decision trees and carbon footprint rankings to combat this tendency; institutions could be encouraged to reward faculty who prioritize planetary health and incorporate sustainability considerations into their academic work and travel plans.
- 4. Linking environmental sustainability with global equity: Dr. Ben Ari's data show that 10%–15% of researchers produce 60%–65% of emissions, highlighting global and institutional inequalities. Wealthier regions and senior researchers contribute more to emissions compared to poorer countries and younger researchers. Balancing travel can spare up to 30% of GHG emissions.
- 5. Navigating individual travel decisions: The pandemic has made virtual meetings a norm, easing the reduction of travel. Europeans benefit from train routes, although they are slower and pricier. U.S. travelers can prioritize productive meetings and combine work with family visits to reduce environmental impact.
- 6. Challenges of organizing multi-hub events: Organizing multi-hub conferences requires careful planning and coordination. While technology is now user-friendly, improper hub placement can increase environmental harm. Mr. Meyer-Kahlen's paper offers guidelines for overcoming common challenges.¹²
- 7. Global foyers: Global foyers allow informal networking but have mixed results. Initial enthusiasm can wane, so structured approaches during agenda slots tend to be more successful.
- 8. Encouraging car travel for distances over 500 km: Ms. Tao's study recommended car travel for distances over 500 km, but rules and preferences vary.¹³ Alternative transportation, such as buses or ferries, can sometimes replace flights.
- **9.** Scholarly societies and conference revenue: Unlike firms that depend on conference revenue, scholarly associations rely on membership fees and publications. Online conferences have low costs, reducing financial concerns.
- **10.** Advancing conference sustainability beyond travel: Other environmental impacts include hotel stays, food, and utilities. Ms. Tao's research highlights additional factors, and Mr. Meyer-Kahlen notes the lack of popularity for vegan food and carbon offset payments.

Day 1 Plenary Session

Lucy Gilson, Ph.D., Dean, Peter T. Paul College of Business and Economics, University of New Hampshire, "How To Be an Effective Conference Presenter and Attendee in the New World of Virtual/Hybrid Work"

Dr. Gilson reviewed the history of virtual collaboration, noting that researchers have long sought to bypass geographical constraints. By 1980, computers could read hyperlinks, and the internet launched in 1983. Despite this, Dr. Gilson's team found limited research on virtual teams—only 93 studies and 47 articles by 2004. Their review¹⁴ revealed that as tasks became more complex, virtual team performance declined, but having at least one face-to-face interaction improved outcomes.

By 2015, research on virtual teams had expanded to over 1,000 articles,¹⁵ with findings showing that decisionmaking took longer but was more effective, and communication remained task-focused rather than planning, or teamwork focused.

The COVID-19 pandemic provided a real-world test of virtual collaboration. Dr. Gilson now suggests that researchers focus on integrating familiarity, relationships, and feedback into technology-enabled spaces. Her team emphasizes that effective virtual teamwork requires careful planning, leadership, and clear norms. Recommendations for applying DEIAB principles in conference planning include:

- Setting clear goals for all participants.
- Conducting cost-benefit analyses to select the best technology, leveraging algorithm potential for democratic participation.
- Building community and engagement, encouraging help-seeking and help-giving.
- Addressing mental strain and diverse learning styles.
- Facilitating information processing and retention.
- Recognizing and mitigating gender and age-related biases through the use of virtual settings.

Day 2 Welcome Address

Michael Lauer, M.D., Deputy Director for Extramural Research, Office of the Director, NIH

Dr. Lauer shared that his first scientific conference experience was as a child with his father, who enjoyed connecting with colleagues. Over time, Dr. Lauer grew to value the social aspect of large cardiology meetings. Today, the Office of Extramural Research (OER) is expanding through virtual meetings, which are more time-efficient and accessible, allowing participation from those who otherwise couldn't attend. Besides hosting its main conference online, OER is introducing smaller pre-conferences and spreading events to reach wider audiences. Dr. Lauer concluded that while the format has evolved, the enjoyment of conferences remains unchanged.

Day 2 Plenary Session

Andy Burnett, M.Sc., Managing Director, Knowinnovation Ltd., "Oh, That's What You Mean"

Mr. Burnett highlighted that his company transitioned to fully virtual conferencing before Skype even existed. His team focuses on the psychology of creativity, which is essential for innovative discussions. He questioned why some organizers and attendees revert to face-to-face meetings despite the effectiveness of virtual ones. A director mentioned in-person meetings allowed immersion away from emails. Burnett responded that if social activities are crucial, conferences should be redesigned to address this need.

He cited a study that used Spotify playlists to map musical tastes and connect people across locations. Similarly, conferences could use cluster maps to enhance dialogue. Burnett also proposed a broader conferencing vision that includes externalized thinking and cross-disciplinary collaboration. He suggested using simulation models to:

- Develop models that reflect a dynamic world and compare them with real observations.
- Encourage presenters to use simulations for engaging presentations.
- Present the resulting ideas as conference outputs.

Summary of Presentations

Track 3—Networking, Collaboration, and Scientific Innovation in Conferences and Meetings

Networking, Collaboration, and Scientific Innovation in Conferences and Meetings

Moderator: Dana Greene-Schloesser, Ph.D., OBSSR

Preliminary research suggests that meeting modes and features affect opportunities for and experiences with networking and collaboration. In this session, Ms. Wenger discussed perceptions of virtual academic conferences among university staff and professors. Dr. Zajdela shared her modeling of virtual and in-person meetings, showing that orchestrated encounters boost collaboration. Drs. Gutwill and Allen emphasized the need for new social norms to guide virtual networking.

Ariane Wenger, Doctoral Student, ETH Zurich, "Factors Influencing Networking Efficiency During Virtual Conferences"

Ms. Wenger shared insights from her ETH Zurich thesis on perceptions of virtual academic conferences, highlighting the importance of conferences for visibility, reputation, and funding through networking and collaboration. ETH professors and staff, initially skeptical of virtual conferences, grew more positive post-pandemic, citing a reduced carbon footprint and lower costs as benefits of virtual conferences.

Challenges included a need for inspiration, particularly among staff. Virtual settings were found to be more effective for formal presentations and small-group discussions than for informal conversations. Staff appreciated the availability of recordings and the inclusivity of virtual conferences, while professors valued the reduced stress and time commitment.

The success of virtual networking relies on individual characteristics, speaker training, technical support, group dynamics, and organization. Feedback from ETH respondents noted that virtual conferences can be effective in conveying scientific knowledge but lack the routine breaks of in-person events.

Ms. Wenger posed key questions for future conferencing:

- Does online versus in-person create a two-class system?
- When should streaming versus mingling be prioritized?
- What are the financial implications for organizers?

She urged replacing outdated in-person norms with new virtual standards and encouraged participants to reassess their conference expectations.

Emma Zajdela, Ph.D., Princeton University, "We Need Scientific Collaboration to Achieve a Sustainable Future"

Dr. Zajdela highlighted the United Nation's sustainability goal 17, "Building Bridges—Partnerships in science to address health, environmental protection, and peace," which underscores the need for collaborative science.

Recent trends show a significant rise in collaborative research. From 1960 to the mid-2000s, publications and patents increased by over 80%, with team sizes doubling. Among scientists located in different cities, one-sixth of these met at conferences.

Dr. Zajdela's team developed a nonlinear model to predict the likelihood of new collaborations based on factors such as interaction profile, time spent together, and interaction intensity. They tested this model over eight years with 12 in-person and six virtual workshops using data from the Scialog conferences. Participants were assigned to discussion groups and then formed teams to develop research proposals. With over 20,000 possible pairings, participants at each conference would produce 20 to 30 proposals, 5 to 8 of which received funding.

Key findings included:

- Participants who collaborated spent 95% more scaled time together.
- Opportunities for collaboration in mini sessions increased sevenfold.
- The model outperformed the null model in seven of eight workshops.
- Live conferences and virtual conferences had similar outcomes in terms of team formation, but live conferences were more effective at connecting communities.

Future plans involve:

- Publishing the Scialog data for public use.
- Modeling team formation to enhance equity and diversity in scientific discussions.
- Analyzing granular data, including hundreds of hours of video and in-person conversations for deeper insights.

Dr. Zajdela encouraged engagement with her team's model and its settings.

Sue Allen, Ph.D., and Joshua Gutwill, Ph.D., Clean Conferencing Institute, California, USA, "Improving Informal Networking Using Platforms, Activities, and Social Norms"

Dr. Allen introduced the Clean Conferencing Institute, a nonprofit organization dedicated to enhancing virtual conferencing through innovative technologies and strategies to combat the climate crisis.¹⁶ Their research focuses on platforms, activities, and norms, using social network analysis to visualize attendee connections.

Dr. Gutwill showcased spatial apps and artificial intelligence (AI) tools that improve digital interactions. Avatars representing users can navigate virtual rooms and connect with others based on proximity and shared interests. AI can facilitate large sessions in the absence of a live host and prompt discussions during small-group breakout sessions.

Key recommendations include:

- Plan facilitation carefully, including conversation starters and leadership roles.
- Introduce and reiterate expected social norms and guidelines.
- Ensure participants understand the technology, tech support options, and privacy policies.

Organizers should select appropriate tools, align activities with conference goals, and develop clear participation guidelines.

Catalysts of Innovation: Exploring the Impact of Scientific Convenings on Knowledge-Sharing and Idea Diffusion

Moderator: Jean Shin, Ph.D., COSWD

Scientific conferences and meetings allow for knowledge-sharing and idea diffusion. In this session, Dr. Hansen highlighted how conferences act as marketplaces for converting scholarly output into credibility, and that this process often disproportionately benefits more established researchers. Dr. Teplitskiy suggested that in-person conferences serve as commitment devices that enhance engagement with scholarly papers. Dr. Baruah found that virtual-team brainwriting sessions are more effective for idea generation than video calls, while an AI-driven smart meeting assistant could further support team creativity. Dr. Brucks observed that virtual settings hinder creative idea generation but enhance focused idea selection.

Thomas Trøst Hansen, Ph.D., Danish Council for Research and Innovation Policy (Doctoral Student, Aalborg University Copenhagen, 2016–2020), "How Do Scientific Events Have Academic Impact?"

Dr. Hansen described academic impact as a ladder with milestones, including arguments, data, staff, equipment, funding, publications, and recognition. This model is circular, allowing for various starting points.¹⁷ Conferences act as marketplaces for converting scholarly output into credibility, often benefiting those with more established reputations. Access to these benefits varies by event type, whether broad congresses or specialty conferences, but the conversion process is consistent across disciplines.

Dr. Hansen's team developed a framework to evaluate conference types and their impact based on participant and event factors. In the context of climate change, physical events must justify their environmental costs by fostering community and addressing relevant issues.

Misha Teplitskiy, Ph.D., University of Michigan, "In-Person Conferences as a Commitment Device for Learning"

Dr. Teplitskiy suggested that in-person conferences serve as commitment devices that enhance engagement with scholarly papers. While papers are accessible online and inexpensive, reading them depends on personal motivation. In contrast, attending a paid conference with travel plans commits attendees to engage with the content. The norms at live events further encourage participation, offering benefits such as:

- · Access to preliminary or sensitive findings
- Curated collections of papers in specific areas
- Increased content absorption
- Two-way communication with feedback to improve papers

Using the Confer scheduling app, Dr. Teplitskiy's team analyzed data from 25 computer science conferences over six years. Attendees could "like" papers, generating around 90,000 likes. Analysis showed that attendees who accessed conference presentations were 63% more likely to cite liked papers. Additionally, chance attendance of non-liked presentations increased citation likelihood by 125%. Dr. Teplitskiy raised the question of whether virtual conferences as currently designed can serve as effective commitment mechanisms.

Jonali Baruah, Ph.D., Psychological Sciences, Tarleton State University, "Development of an Al-Driven Smart Meeting Assistant to Facilitate Team Ideation"

Dr. Baruah's team is developing a machine-learning prototype, the Smart Meeting Assistant, to improve idea generation in virtual meetings. This tool monitors speaking time, facilitates turn-taking, categorizes discussion topics, and offers feedback to boost equity and productivity. However, Dr. Baruah highlights that group creativity and productivity in virtual settings are influenced by the communication modality and the participants' psychological and physiological responses.

Dr. Baruah's team conducted an experiment comparing brainstorming in video meetings with virtual brainwriting sessions. Video meeting groups produce more feasible ideas despite a high risk of production blocking. Brainwriting groups, however, surpassed video-based brainstorming groups by generating a greater quantity of ideas, as well as more original ideas. While perceived functional diversity of the group members was linked to increased originality during the decision-making phase, it was associated with decreased originality during the idea generation phase.

Another experiment comparing video-based and text-based group brainstorming showed both were effective for idea generation. However, text-based brainstorming produced better-quality ideas due to fewer distractions and less fear of judgment. Moreover, the opportunity to refine selected ideas significantly improved their quality in the text-based condition, particularly when group members remained anonymous.

In small group brainstorming sessions, Dr. Baruah's team utilized the Smart Meeting Assistant to track participants' speaking time, idea contributions, the number of topics discussed, and the number of ideas generated within each topic. They applied a machine-learning-based topic modeling approach to categorize ideas generated in virtual

brainstorming sessions. The system demonstrated 90% similarity to human categorizing, validating its reliability. Furthermore, a comparison of structured versus unstructured virtual group creativity sessions using topic modeling produced consistent results between machine-learning and manual coding. Thus, topic modeling showed great potential for efficiently coding and analyzing brainstorming communications, reducing both time and human effort. Future plans include expanding the Smart Meeting Assistant's capabilities to predict screen fatigue and its association with cognitive performance in video-based meeting groups.

Melanie Brucks, Ph.D., Columbia Business School, "Virtual Communication Curbs Creative Idea Generation"

Dr. Brucks highlighted the pervasive role of virtual communications in various aspects of life, from education to telehealth and social interactions. She questioned how this shift to virtual environments might affect idea creation, noting that innovation often comes from teamwork, where diverse contributions come together to form a complete idea.

Dr. Brucks' team examined how the physical versus virtual environment impacts thinking scope and focus by studying 301 pairs tasked with brainstorming new uses for a flying disc or bubble wrap. The study found that virtual pairs generated half as many ideas as in-person pairs but selected higher-scoring, more creative ideas with lower decision error. A similar pattern was observed with engineers in a large telecom workshop, where virtual and in-person groups exhibited the same trends.

Additionally, Dr. Brucks conducted an experiment to test if virtual and in-person pairs noticed unexpected props in an office setting. Face-to-face pairs observed and drew several objects in the room, while virtual pairs either drew minimal objects or none at all. Eye-tracking analysis revealed that face-to-face partners scanned their surroundings, whereas virtual pairs focused their gaze primarily on their partner and the task.

Key Topics of Discussion

The following topics were highlighted in Track 3—Networking, Collaboration, and Scientific Innovation in Conferences and Meetings:

- 1. Applying social network analysis to enhance virtual events:
 - Improving opportunities for networking and social interactions can make virtual events as effective as, or better than, in-person events.
 - Social network analysis may be used to foster connections among attendees. Other technologies, such as radio frequency identification-enabled name tags, may also be employed to enhance the networking experience.
- 2. Making norms explicit in virtual spaces: Clearly define expectations for first-time attendees and during meeting openings. Ensure that formal communication structures are in place to facilitate engagement and interaction.
- **3.** Balancing networking and global reach: Online meetings with over 10,000 attendees see increased participation and diversity. Technology alone may not match the networking efficiency of in-person events, but virtual and in-person experiences can inform and complement each other.
- 4. Addressing the two-class system in hybrid events:
 - Hybrid formats can create disparities between on-site and virtual attendees.
 - Intentional design may help to mitigate these disparities.
 - Scientific associations are alternating between virtual and in-person meetings to mitigate this issue.
 - Hybrid events that seek to duplicate the in-person and virtual experience may not always be cost-effective or logistically feasible.

5. Differences by career phase: Perceptions of virtual conferences vary by career stage, with faculty often less positive about virtual formats.

6. Privacy and data collection challenges:

- The ethical collection and use of data are critical. Attendees should be informed about how their data is used.
- Exploring alternative data sources, such as Google Scholar for identifying authors and references, could be an option.

7. Integrating AI for virtual idea generation:

- Research is exploring how AI can enhance group performance and creativity by monitoring engagement and predicting screen fatigue.
- Future studies will focus on the mental and physical aspects of virtual interactions to improve meeting effectiveness.

8. Credibility and the presentation of formats:

- The credibility of research findings might not be significantly increased by in-person presentations.
- Teplitskiy's research suggests that prior engagement with papers can increase their impact, regardless of the presentation format.

9. Creating opportunities for collaboration:

- More research is needed to understand the effects of virtual versus in-person conferences.
- Organizers should frame session goals clearly to improve the impact and outcomes of conferences.

10. Enhancing virtual ideation:

- While virtual settings can introduce certain inhibitors, diverse voices and perspectives are still crucial.
- New tools and strategies should focus on inclusiveness and accessibility for participants with disabilities.

Track 4—Balancing Participant Needs and Technology for Engaging Conferences and Meetings

Building Bridges: Navigating Diverse Viewpoints and Needs to Optimize the Conference Experience

Moderator: Kara Hall, Ph.D., National Cancer Institute

The conference ecosystem is diverse, and each individual or group may have competing viewpoints and needs. In this session, Dr. Pokharel noted that, while virtual formats as currently designed don't fully meet professional networking needs, hybrid conferences can be financially prohibitive. Dr. Standaert recommended allowing a meeting's objective to drive modality and limiting the duration of virtual events. Dr. Kuehne emphasized the need for more data to make conferences more accessible and engaging. Dr. Kidd recommended developing options that meet the diverse needs of constituents.

Jessica Pokharel, Ph.D., ITHAKA, New York, USA, "Financial Models for Virtual and Hybrid Meetings"

Dr. Pokharel, representing ITHAKA (the nonprofit publisher of *JSTOR*), presented her team's analysis of meeting formats and costs in 2022 and 2023. She outlined key models:

- Fully in-person: High cost, often half of a society's budget, but generates revenue
- Hybrid: Most expensive due to needing both in-person and tech support
- · Hub and spoke: Based on watch parties, can delegate organization to chapters
- Distributed: Shared spokes with no central hub
- Multidisciplinary summit: Like this event, where societies share costs around a common theme

Dr. Pokharel highlighted the unsustainable travel costs for in-person events, rising fees, and challenges with employer reimbursements post-COVID. Small societies often partner with larger ones, and conference owners monetize presentation recordings. Reviewing 80 STEM societies, membership dues ranged from \$149 to \$650, with event fees for members typically adding costs. Full in-person registration had a median fee of \$535, while virtual registrations had a median fee of \$250, with a top price of \$620.

Willem Standaert, Ph.D., HEC Liège, Management School of the University of Liège, "How Shall We Meet?"

Dr. Standaert's research centers on business meetings with five to ten participants, examining how meeting objectives shape the choice of virtual formats. He noted that while companies recruit talent with collaborative tools and attractive facilities, the purpose of the meeting (i.e., the task) remains the key factor driving the use of virtual meetings. Standaert identified three primary conferencing modes, each with varying costs and communication capabilities:

- · Video conferencing: Visual interaction with screen-sharing
- Audio-only: Challenges in identifying participants and fostering engagement
- Telepresence: Immersive setups that mimic physical team meetings

Based on multi-year research, he outlined four key reasons for meetings:

- 1. Information exchange: Sharing routine details, ideas, and clarifications
- 2. Decision-making: Solving problems, negotiating, and gaining consensus
- 3. Communicating sentiments: Expressing opinions, giving feedback, and reinforcing authority
- 4. Relationship-building: Developing trust, assembling teams, and resolving conflicts

Standaert emphasized that meeting organizers should first determine the necessary capabilities to meet their objectives before selecting a modality. His research, covering nearly 2,000 real-life business meetings in three global industries, revealed that relationship-building requires more complex, high-end tools, while simpler tasks, such as information exchange, may need only audio and screen-sharing. For effective meetings, he advised:

- Let objectives drive the choice of mode.
- Limit the number of attendees and meeting length.
- Adjust modalities for different segments or consider a series of shorter meetings.
- Use different formats based on meeting frequency, such as audio for weekly updates and in-person for annual gatherings.

Lauren Kuehne, M.S., Omfishient Consulting

Ms. Kuehne introduced the Evaluating Conferences for Diverse Engagement (ECODIVE) project, aimed at increasing participation from nonprofit organizations, Tribes, government agencies, consulting firms, nongovernmental organizations, and Historically Black Colleges and Universities at environmental science conferences. ECODIVE, a collaboration of researchers, advisors, and ecology societies, also focuses on career development for early career researchers and promoting DEIAB values.

Kuehne highlighted the role of ecologists and conservationists in addressing societal challenges, such as climate change, by engaging with the public, advocating for progress, and informing global policy, as part of the Social Contract movement in science.

The ECODIVE team seeks to understand how virtual conferences can improve access for key participants outside of academia. Preliminary data from recent Ecological Society of America meetings show that academia still dominates, with most participants attending only once. The ECODIVE team is currently implementing their Task II, which is a survey of environmental scientists working in state and federal government, Tribal organizations, industry/consulting, and a range of academic institutions. So far, their systematic identification (in 12 of a planned 25 states) reveals that non-academic participants are more represented in the field than at these conferences.

Nancy Kidd, Ph.D., Reactor Comments

Dr. Kidd highlighted that there's not a single answer to the question of how to navigate diverse viewpoints and needs to optimize the conference experience. A wide range of variables, such as attendee cost, environmental impact, and organizational resource availability should be considered in determining what kinds of meetings make sense in different contexts. Research can be done to understand attendee preferences and barriers to entry. Each society can then seek to develop a package of options from which all constituents can find at least some satisfaction.

Dr. Kidd cited the American Sociological Association as a model. The association did a lot of research, including a member survey and a carbon analysis. Based on their findings, they decided to focus their main conference primarily on intellectual content and distribute other activities, such as governance meetings, across the year virtually. They also decided to have a mini virtual conference a few months in advance of each annual major conference and to hold the major conference virtually every three years. This approach underscores the importance of using data to balance diverse perspectives and improve the overall conference experience.

Virtual Frontiers: Transforming Conference Experiences With Immersive Technologies

Moderator: Beth Jaworski, Ph.D., All of Us Research Program

Dr. Queiroz advocated for immersive technologies, such as virtual reality (VR), to create meaningful connections and improve learning outcomes in scientific meetings. Dr. Ahn emphasized VR's potential to bridge physical distances, while Dr. MacIntyre highlighted how hybrid models can enhance networking interactions.

Anna Queiroz, Ph.D., Stanford University, "Meaningful Connections in Computer-Mediated Communication"

Dr. Queiroz examined how new media and computing tools enhance real-time communication. Computer-mediated communication involves creating, exchanging, and perceiving information via technology, with modalities such as email, social media, and VR conferencing acting on scales of immersion and synchronization. Enhancing the digital experience can replicate the feel of face-to-face interaction.

Dr. Queiroz's research on 4,000 video conferencing users found that shorter sessions with smaller groups fostered higher connectedness, while Zoom fatigue set in for larger groups, longer sessions, and more frequent meetings. In VR environments, learners using headsets—providing focused, narrated content—displayed physiological responses akin to real-life experiences, felt a sense of presence, and exhibited greater creativity in answering open-ended questions. Interaction with digital objects improved retention, although excessive movement reduced the recall of narration, which is a key consideration for VR task design. VR also positively influenced behavior change when communicating about climate change, driven by increased risk perception and a sense of control over learning.

In 2020, Dr. Queiroz's team implemented a beta VR platform for Stanford's <u>Very Virtual Conference</u> and later expanded its use. While mediated technology makes virtual content more engaging, her team supported hardware compatibility, trained participants, and provided orientation materials. Dr. Queiroz recommends that for successful VR integration, planners consider audience needs, infrastructure, and thorough preparation for speakers and attendees to use the technology effectively.

Sun Joo (Grace) Ahn, Ph.D., The University of Georgia, "Bridging Physical Distances With XR"

Dr. Ahn explored the challenges and successes of using extended reality (XR) to overcome geographic limitations through interactive communication. Virtual formats reduce perceptual information, making relationship-building slower due to the absence of social cues, especially in time-limited conference settings. However, advances in XR aim to close these gaps by allowing users to see, hear, feel, and move as if they were interacting in person. XR achieves this by:

- Mapping natural gestures into avatars
- Enabling solo users to interact with multiple avatars
- Supporting compatibility with commonly used devices

Dr. Ahn shared a case study on military families separated by deployment. Using Converged XR, families reconnected through virtual homes they could access anytime, complete with a game room and yard. Over eight weeks, families visited these 3D homes two to five times, with average visits lasting 37.5 minutes. Families reported high levels of shared reality, resulting in stronger cohesion and reduced anxiety. Interviews showed increased use of "we" and positive descriptions of family life.

The Institute of Electrical and Electronics Engineers' (IEEE) <u>VR 2020 conference</u> provided a testing ground for fully digital modalities, using <u>Mozilla Hubs</u> to recreate meeting rooms and allowing attendees to join from computers, headsets, tablets, or mobile devices. Twitch was used for live streaming, and participants connected via Slido and social media for real-time feedback. Findings showed:

- Attendees were skilled and motivated to use the technology.
- Twitch was the preferred platform for remote engagement.
- Although 60% of users had headsets, only one-third used them.

Remote attendees felt more present and were less apprehensive about joining discussions. They also appreciated the democratization of networking with senior scholars. Future plans include:

- Adjusting event schedules for shorter, more engaging sessions for remote participants
- Offering VR literacy training
- Providing a quiet room for tech checks

Blair MacIntyre, Ph.D., Global Head of Immersive Technology Research, JPMorgan Chase and Co., "Hybrid Conferences With Immersive Technology"

Dr. MacIntyre, an academic on leave in a business role at JPMorgan Chase and Co., shared insights on implementing immersive hybrid conferences. In his corporate setting, conference attendance is seen as an honor and reward, with employees showing great enthusiasm for both internal and external events.

At the Association for Computing Machinery User Interface Software and Technology (UIST) <u>2019 conference</u>, Mozilla Hubs were used to stream talks and facilitate remote interactions. Dr. MacIntyre noted that attendees responded positively to a simultaneous small-group poster event, which replicated some of the value of in-person poster halls. Insights from UIST 2019 informed the design of a hybrid event for IEEE VR 2020. That event became fully remote because of COVID-19, using a combination of video streaming, Mozilla Hubs for immersive spaces, and Discord for chat. Insights from VR 2020 included:

- The total cost of running IEEE VR 2020 as a fully virtual conference with immersive spaces and video streaming was comparable to just the audiovisual cost of the in-person conference.
- The hybrid format allowed attendees to organize collaborations and social gatherings via Discord.

For DEVUP 2023, Dr. MacIntyre's team experimented with how to connect remote and in-person participants in a hybrid conference format with approximately 500 in-person attendees. The digital environment fostered interaction through photo sharing, scavenger hunts, and networking, with remote participants feeling present and in-person attendees feeling connected to their virtual counterparts. Many followed up on connections made during the event.

Dr. MacIntyre highlighted that VR technology enables fully symmetric hybrid conferences across multiple locations, suggesting that gaps in the agenda can be used for social experiences for remote attendees. He advised planners to be deliberate in connecting on-site and virtual participants to avoid isolating any attendees.

Key Topics of Discussion

The following topics were highlighted in Track 4—Balancing Participant Needs and Technology for Engaging Conferences and Meetings:

1. State-of-the-art VR haptics and hardware:

- Dr. Ahn's data shows that VR headset adoption at conferences remains low. Although headsets will become lighter and more user-friendly, widespread use at conferences is unlikely for the next 5–10 years. VR technology currently lacks the realism seen in movies such as *Ready Player One*. Users still face challenges in mapping real-world interactions to virtual environments. VR's role in conferences will shift from high expectations to incremental improvements.
- Concurrent sessions are becoming feasible with platforms such as Quest's Windows integration and Vision Pro's iPad support. However, VR adoption remains low compared to laptops. VR technology currently struggles with replicating face-to-face interactions and multi-person conversations effectively.
- For a more practical digital approach, extending conference experiences over several days, such as Dr. MacIntyre's pre-conference virtual meetings and Discord channels, might be more effective.
- 2. Digital literacy challenges for immersive technology: Digital literacy for immersive tech involves individual, contextual, and structural challenges. Effective training, including tutorials and customization options, is essential. Users across different time zones need training that is aligned with their schedules, and integration issues with hardware and software must be addressed.
- 3. 2D versus VR spatial conferencing: GatherTown offers movable 2D avatars and spatial cues, which are suitable for ad hoc social interactions but lack VR's depth. VR provides finer cues, although full facial expressions are still limited. 2D platforms might decline as VR becomes more intuitive and accessible, potentially eliminating the need for headsets in the future.
- 4. Modality decisions for conflicting objectives: When conference goals conflict, planners should prioritize objectives and choose suitable modalities. For instance, face-to-face interactions might be chosen for networking while digital formats are used for routine information exchange. Alternatively, splitting modalities or opting for a conference series may be effective.
- 5. Underexplored virtual meeting formats: Virtual meetings still fall short of in-person standards. Non-English speakers benefit from online modalities that allow for preparation and less spontaneous communication. Future meetings could explore better support for these users.
- 6. Conference attendance motivators: Attendance often hinges on grant or funding requirements. The role of conferences in career advancement and their benefits need more quantitative research. Participation costs are a key factor, and assumptions about conferences' value should be tested.
- 7. Perceptions of power in professional societies: Younger scholars feel overshadowed by influential, well-funded members. Societies need to communicate constraints and explore data-driven approaches to conference models. A large-scale project with standardized questions could help develop a broader understanding.
- 8. Overcoming resistance to change: Younger generations favor virtual options, but leadership may resist. Advocates must present objective data showing that virtual options meet participants' needs and sustain the society's model.

- 9. Conference size impact: Early ECODIVE research suggests that conference size affects repeat attendance. Societies of various sizes are studied, and data sharing might help understand how size impacts engagement.
- **10.** Organizer costs and registration fees: Virtual meetings have lower costs compared to hybrid events, which are expensive due to the need for syncing physical and online components. Hybrid formats often lack real-time engagement and require significant funding and technical learning.
- **11.** Conference recording and privacy: Opinions on sharing presentation recordings vary. While some see it as an opportunity for wider reach, others oppose it due to privacy concerns.
- 12. Transitioning conference formats: Canceling hotel contracts is costly, so organizers often wait for contracts to end before changing formats.
- **13.** Meeting language and audience needs: Generative AI can enhance personalization and participation for diverse conference attendees.

Engagement Day

The workshop "Engagement Day" featured innovative virtual learning and interdisciplinary networking approaches. Participants were encouraged to engage in live poster presentations, small group discussions, and one-on-one networking opportunities. The virtual poster hall featured on-demand recorded presentations and live discussions with poster presenters. A networking lounge was open throughout the event, and attendees were encouraged to schedule one-on-one meetings during a structured networking time. Small group discussions on various topics were facilitated by workshop speakers and NIH staff. A summary of live poster presentations and small group discussions is included below.

Poster Sessions

Alex Buatois, University of Gothenburg, Sweden, and Valentin Lecheval, Humboldt University of Berlin, Germany, "Designing Inclusive International Conferences: Insights from Animal Behaviour Live (ABL)"

Mr. Buatois highlighted that in-person conferences have economic and environmental costs, and often exclude diverse voices from the research community. Fully virtual events also pose challenges, including participants' technology learning curves and motivating engagement and networking.

His team at ABL Online, now in its fifth year, organizes inclusive events with four key design principles:

- Developing broad communication strategies
- Using a geographically balanced, blind abstract selection process with objective scoring
- Offering free events with common internet and social tools
- Surveying participants and adapting conference design accordingly

Kiana Winslow, Global Health & Social Medicine, Harvard Medical School, "Optimizing Access for Low- and Middle-Income Countries (LMICs) Participants at Global Health Conferences"

Ms. Winslow's poster presentation focused on a consensus exercise aimed at identifying barriers and facilitators to global health conference access for participants from LMICs. Key parties included conference organizers, governments, and related entities. Data from the Conference for Public Health in Africa helped shape DEIAB principles into a consensus statement with key recommendations. Major issues included visa and passport delays, funding challenges, lead times, and government involvement. Winslow emphasized the need for equity metrics to assess and improve participation in global health conferences. Her team is finalizing recommendations to create a Conference Equity Index, as part of the broader Conference Equity Project, detailed by Dr. Joseph in a related talk.¹⁸

Sodiq Mojeed, M.Sc., Santa Fe Institute of New Mexico, and African Institute of Mathematics, Ghana, "Scialog: An Antidote to Homophily Effects and Scientific Collaboration"

Mr. Mojeed presented data on selecting diverse collaborators from the Scialog workshop series, organized by the Research Corporation for Science Advancement (RCSA) to foster cross-disciplinary research. Prior to the threeday event, 50 early-career fellows were surveyed on their awareness of each other. They were initially grouped by algorithm and then self-organized into smaller teams to develop research proposals. Longitudinal data from four annual conferences used network connectivity coefficients to analyze how fellows connected with those of different attributes. Visualizations revealed that gender, academic discipline, and research methods had little impact on collaborator choices.

Small Group Discussions

Global conference equity: Bringing the global research community to the table

Facilitator: Michelle Joseph, Ph.D., M.B.B.S., M.Sc., FRCS, Harvard Medical School

This discussion focused on barriers, challenges, and potential solutions to improving access to global health conferences. Key barriers discussed include obtaining visas to enter the United States and other countries, which requires time, fees, and in some cases luck. Registration fees are also a barrier; possible creative solutions include providing scholarships to early-career researchers, lotteries, and generally increasing funding for participants from low- and middle-income countries (LMICs). Documentation from host country governments may greatly facilitate conference attendance and participation. Local partners are also important for international organizations. In addition to increased funding for meeting attendance, funding is also needed to improve infrastructure in some settings around the world to ensure there is sufficient internet access to enable participation in virtual meetings.

Thinking outside of the box: Designing effective, engaging, and innovative scientific meetings

Facilitator: Andy Burnett, M.Sc., Knowinnovation

This discussion explored innovative meeting models and formats designed to enhance social connections while considering factors such as time, access, and attention span. A few unique suggestions that were discussed include quiet lounges and artificial intelligence meeting catch-up features. Additionally, this group emphasized the importance of addressing the need for fostering psychological safety in virtual conferences, especially when attendees are unfamiliar with one another. To facilitate this, it is empowering for individuals to manage their own level of privacy and confidentiality, such as through chat options. Implementing strategies such as integrating speed networking earlier into the main agenda or establishing conference buddies may help attendees become familiar with each other and enrich the overall conference experience.

Family-friendly academic conferences: Barriers and resources for parents and caregivers

Facilitator: Kristin Dupre, Ph.D., National Institute of Neurological Disorders and Stroke

This discussion was centered around prioritizing family considerations when planning conferences. Scheduling breaks into the agenda is essential to accommodate all attendees' needs. Leaders should set examples for attendees by prioritizing family-friendly arrangements, such as bringing children to events, and only attending if accommodations are available. Diverse conference planning committees are necessary to address various attendees' needs, such as lactation and quiet rooms. Potential barriers for the target audience (e.g., early-career scientists or caregiving responsibilities) should always be considered during planning. There is also a nuanced concern about weekend events, particularly for single parents, as they may be more convenient but there are no compensations for working on the weekend. Configurations for attending conferences, for those with or without children or caregiving roles, should always be accepted.

Leveraging your roles and connections to improve virtual conferences

Facilitators: Josh Gutwill, Ph.D., and Sue Allen, Ph.D., Clean Conferencing Institute

This discussion focused on using our unique roles to move toward more inclusive and environmentally sustainable virtual conferences. The facilitators emphasized that changing the conference ecosystem requires understanding the key players within that ecosystem. Conference and meeting organizers and planners can prototype and test out ideas for innovative ways of meeting and connecting. One example of this is BarCamps, which are virtual, open, participatory workshop events in which the content is generated by participants. Attendees can be empowered to make their voices heard and express their preferences whenever possible, for example by contacting the conference or meeting organizer to ask for a virtual option and by sharing feedback. Exhibitors generally prefer in-person formats, as virtual formats provide less return on investment. However, exhibitors could embrace the virtual format to foster more personal connections with attendees. Funders may have a high degree of influence on the improvement of virtual conferences. Organizations such as the Wellcome Trust have recently incorporated sustainability into their evaluation of scientific activities. Meeting platform providers can offer useful features (such as translation into multiple languages and Al-enabled meeting minutes) to make the virtual experience more effective, enjoyable, and accessible. And finally, researchers can develop the evidence base for the benefits and drawbacks of virtual conferences by studying the impact of a variety of conference formats on metrics of conference effectiveness and inclusion.

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Appendix A: Attendance and Carbon Calculation Data

Conference Attendance Data

Of the approximately 700 conference registrants, one-third resided outside the United States, with the greatest number of international registrants residing in Mexico and the United Kingdom. Attendees included researchers, professors, students, and technicians.

Carbon Calculator for Emissions Savings

Upon logging into the Chati Event, users received a browser notification asking if they allowed the event page to access their current location. If they consented, the Chat Event Carbon Calculator widget displayed their estimated individual emissions savings, the overall event emissions savings, and the number of trees needed to absorb the saved emissions. Users who declined location access did not see individual calculations but could view the overall event savings and have the option to enable location services for future impact calculations.

Twenty-two attendees opted to calculate their carbon emissions savings. While domestic attendees saw modest savings, international participants saw more significant savings, ranging from 269 to 762 kg of CO₂, reflecting the travel emissions saved by holding the workshop virtually compared to in-person at the NIH main campus in Bethesda, MD.

The Chat Event Carbon Calculator calculated emissions savings based on the distance between the attendee's location (via IP address) and the event site (Bethesda, MD) following guidelines from the U.S. Environmental Protection Agency:

- For locations within 150 miles, calculations are based on passenger car travel.
- For locations over 151 miles, calculations are based on air travel, divided into short-haul, medium-haul, and long-haul tiers.

Once an individual's emissions savings were calculated, they were included in the total event savings. Chati did not retain any location data for privacy reasons, storing only the calculated emissions savings and the presumed mode of travel (car or air).

Appendix B: Discussion Board Comments

Discussion Board 1—What do you enjoy most about scientific conferences and meetings?

Responses included:

- Inspired by colleagues' work, meeting new people, and making new connections and friends.
- Joining my scientific community, enjoying presentations by established researchers I've read about.
- Observing how new scientific breakthroughs and practices are communicated. Effective communication must be tailored to the target audience, as presentation styles vary between Europe and the United States.
- Seeing presenters spark conversations among attendees, with energy and excitement that was missed during virtual events, where interactions were limited to chats and awkward Zoom meetings.
- Meeting new people and exploring future collaboration opportunities.
- Catching up with colleagues, stepping away from the routine, and immersing in topics of interest.
- Learning about field advancements and networking with new people.
- Attending oral and poster presentations, searching for engaging sessions.
- Meeting heroes in the field and finding them to be kind, open, and encouraging.

Discussion Board 2—What do you enjoy least about scientific conferences and meetings?

Responses included:

- Focusing solely on the topic, but this incurs the cost of missing other activities.
- Multiple simultaneous in-person sessions with no recordings or slides for missed ones.
- Hybrid formats are equitable, but managing "two conferences in one" is challenging for nonprofit organizations.
- Difficulty in connecting with people and staying engaged through a screen.
- Planning time away from family and work is challenging, especially for in-person meetings.
- The cost of being away from family and sometimes missing timely work projects.
- Limited knowledge sharing, high costs, and a preference for hotels over universities or public centers for scientific events. Slides and poster PDFs can be shared post-meeting.

Discussion Board 3—What resources/approaches have you found helpful for improving scientific meetings?

Responses included:

- Alternating between in-person and virtual formats each year allows professional communities to benefit from both.
- Providing physical space for reflection at on-site conferences enhances the experience.
- Frequent breaks and prompts to stretch and hydrate improve the attendee's experience.
- For both formats, it's important to provide:
 - o Clear guidelines for presenters (e.g., font size, color usage, e-handouts)
 - o A code of conduct for all participants and vendors to ensure respect
 - o A direct way for attendees to request accommodations in advance and receive confirmation
- Tools such as SpatialChat and Gather Town offer 2D spaces where attendees can navigate as avatars and interact with those they approach.
- Mobile apps help attendees find resources and plan their conference schedules.
- Published abstracts in scientific journals add value.
- The MozFest model, with selected participants as co-facilitators and conveners, made the conference more democratic and thematically cohesive.

Appendix C: Considerations for Designing Equitable and Effective Scientific Conferences and Meetings

Planning and hosting scientific convenings requires navigating a broad range of options and decisions. To determine the most appropriate format and design, event planners should carefully contemplate the target audience, meeting objectives, technology capabilities, and desired outcomes. This document compiles key insights and questions from the Future of Scientific Conferencing presentations, offering practical guidance for designing meetings. It can be adapted to suit events with varying audiences and goals.

Diversity, Equity, Inclusion, and Accessibility

Audience Considerations

- Consider the intended audience and the anticipated speakers for your event.
- Aim to include representation from diverse cultures, regions, identities, and abilities.
- To encourage broader engagement, innovative outputs, and the generation of collaborations, reach beyond disciplinary silos.
- Intentionally create opportunities for individuals of varying career stages (e.g., early-career researchers, mid-career professionals, and senior academics) to participate and learn from each other.

Global Reach and Access

- Involve a diverse universe of participants in shaping conference policies and practices to ensure a variety of perspectives.
- Broaden access and facilitate attendance through translators, scholarships, open conference materials, and transparent attendance statistics.
- Consider holding virtual events to broaden access, or hosting events in low- and middle-income countries.

Gender Equity and Representation

- Regularly evaluate conference planning practices to identify and address areas lacking in gender equity.
- Utilize tools to track gender balance among speakers and attendees.
- Reduce gender bias and scientific discipline silos by surveying attendees and algorithmically assigning discussion sessions.

Disability and Accessibility

- Create a supportive environment for attendees to identify as a person with a disability and to seek accommodations without hesitation.
- Provide a confidential email address for accommodation requests and adopt a proactive approach by asking "How can we include you?" instead of "What do you need?"
- Identify and address potential barriers with practical solutions, such as on-site support and assistive technologies such as noise-canceling headphones or light-filtering glasses.
- While hybrid formats help to provide flexibility for individuals with disabilities and those with caregiving responsibilities, they are not a substitute for improving on-site accessibility.

Conference Formats and Design

Virtual Conferences and Meetings

- Recognize that virtual meetings produce lower carbon emissions, broaden accessibility and inclusivity, and reduce travel costs.
- Organize successful online conferences using open-source technology, public access, and structured agendas that approximate the in-person experience.
- Leverage virtual tools to better engage non-native English speakers in English-speaking events, and to better support and engage neurodivergent individuals.
- Mitigate "Zoom fatigue" by planning shorter, more engaging sessions and providing asynchronous components.

Hybrid Conferences and Meetings

- Assess the financial and logistical impacts of different conference models.
- Depending on the context, consider incorporating at least one face-to-face meeting to enhance performance, especially for complex tasks where decision-making can benefit from direct interaction.
- Consider a hybrid format with multiple hubs to enhance social interactions while reducing energy demand (e.g., air travel).
- Present simultaneous programming across hubs, ensuring live audience participation and interactive global foyers to bridge the gap between virtual and in-person attendees.

Design Principles

- Apply universal design principles and embed diversity, equity, inclusivity, and accessibility into event design to create an accessible experience for all attendees.
- Anticipate barriers such as technology challenges and differing learning styles.
- Enhance virtual experiences with thoughtful design, utilizing tools such as spatial apps and artificial intelligence for connections, and providing structured guidance for participants.
- Regardless of format, design your meeting for sustainability. Design creatively to maximize engagement and effectiveness while reducing environmental impact.
- Ensure privacy and confidentiality are respected. Offer opt-in/out choices for recordings and data sharing and protect sensitive information with login constraints and session guidelines.

Conference Objectives

Matching Modality to Meeting Needs

- Align conference formats and modalities with organizational goals and participant needs while balancing costs and logistics.
- Prioritize key goals when objectives conflict. For example, face-to-face interactions might be chosen to optimize networking, while digital formats may be relied upon for routine information exchange. Alternatively, splitting modalities or opting for a conference series may be an effective approach.

Networking and Collaboration

- Effective virtual collaboration hinges on thoughtful planning and clear communication and messaging, ensuring that both presenters and attendees can engage meaningfully despite physical distance.
- Maximize the effectiveness of collaboration and connection through strategic team formation, polling, and small group discussions.
- Establish social norms for technology use to facilitate interactions.
- Use pre-conference surveys to boost engagement.
- Use spatial apps and artificial intelligence (AI) to encourage mingling and connections.
- Provide participant guides and structured facilitation to navigate interactions.

Idea Generation and Diffusion

- Leverage in-person conferences and live interactions as a way to stimulate scientific advancement and maximize idea diffusion.
- Use anonymized brainstorming methods to reduce bias and improve idea quality.
- Implement Smart Meeting Assistants and machine-learning algorithms for better idea generation and equity in discussions.
- Implement participant mapping, akin to Spotify's preference mapping, to spark deeper conversations.
- Foster discussions with communication models designed to support critical thinking.
- Integrate co-modeling activities and AI simulations to inspire innovative thought.

Environmental Sustainability

- Recognize the environmental impact of academic travel. Aim to reduce long-distance flights while enhancing online collaboration.
- Acknowledge the perception that frequent academic travel is linked to career advancement. Reward faculty for prioritizing sustainability in career advancement and reduce the emphasis on "busyness" as a measure of success.
- Implement organization-wide initiatives, such as distributing carbon calculators and aligning travel policies with environmental justice discussions, while offering resources for virtual and hybrid experiences.
- Provide tools for intentional travel decisions, such as decision trees and carbon footprint rankings.
- Incorporate sustainability considerations into funding criteria and compensate and recognize academics for time spent on low-carbon alternatives.
- Acknowledge that many researchers are concerned about climate issues and would like to reduce their academic travel, but that structural influences may impede progress.

Technological Innovations

- Integrate emerging technologies such as virtual reality (VR), mixed reality, and extended reality (XR) to enhance conference experiences and bridge physical and virtual participation.
- Use VR to enhance creativity and learning recall, with added training for users.
- Be mindful of XR limitations but anticipate future improvements in sensory and interaction capabilities.
- Enhance networking and collaboration through immersive, shared 3D spaces.
- Use AI to manage discussions when live facilitators are unavailable and to summarize content in place of notetakers.

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