Thinking systematically about the online academic experience

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Two months into the coronavirus pandemic, most university and laboratory staff have been asked to work from home. We are fortunate that while most physical work has been on pause, research, scholarship, and teaching can continue via teleconference calls and collaborative online workspaces. Even as universities and labs attempt to partially re-open in the summer and fall, online scholarship will likely have to continue as students and staff struggle to return to campus due to travel and visa restrictions, and parents have to stay home due to school and daycare closures.

Now is the time to brainstorm what work still needs to be done to create useful and productive virtual spaces for academics and research scientists—both amidst the pandemic and afterward. In this commentary, I will first discuss the need for a systematic approach to physical resources for online academic work. Then I will discuss the organization and operation of the larger academic gatherings.

Physical resources for online engagement

Perhaps the most-challenging aspect of scholarship and teaching in an online world is—paradoxically—physical resources. To date, we have not been very thoughtful about metrics relevant for productive online scholarship, despite our general proclivity toward metrics in other aspects of our jobs [1]. In contrast, gamers have long obsessed over metrics related to hardware and internet connections needed for a high-quality online experience: frames per second (FPS), connection latency, and specific benchmarks for various video games. We should adopt a similar mentality for remote scholarship.

We can track the latency and uptime of our internet connections and sound and image quality of videoconferencing tools, holding our service providers to high standards—and provide students and staff extra support if these metrics cannot be met. For example, we need sufficiently low latency to achieve a speech delay of less than ~150 ms, which is necessary for effective spoken communication [2] as well as for annotations and joint editing of online documents. We should similarly scrutinize the quality of the audio, aiming to be closer to the standard of music recordings (44 kHz at 16 bits/sample) than conventional phone quality (8 kHz at 8 bits/sample)

In remote collaboration and especially teaching, we often experience the loss or rapid degradation of an internet connection in the middle of a video call—or during a live lecture [3]. Worse yet, many people still do not have broadband access at all: for example, in 2019, this included a shocking 28% of the rural population of Wisconsin [4]. Even as broadband coverage expands, it is likely that many will still lack the rock-solid connections needed for remote scholarship. Can this be addressed in the near term? Though they are not very commonly used, hardware- and software-based link aggregation (or channel bonding) techniques that combine multiple network connections may be able to stabilize intermittent or low-bandwidth connections [5] [6]. It would undoubtedly be beneficial for some students working remotely to, e.g., have their cell data plan "reinforce" an unreliable WiFi connection without using too much cellular data.

Another important consideration is input and output interfaces. Many of us work remotely on small laptop screens, even though multiple monitors or one large monitor can substantially improve productivity and

satisfaction [7]. This is especially the case when a lot of screen real estate is taken up by a videoconferencing application.

An ideal setup for remote work and collaboration likely includes a high-performance computer, a reliable and fast internet connection, two monitors, a high-resolution camera, a separate tablet for drawing and marking up documents, and high-quality audio—including a headset with excellent noise cancellation, given that background noise can meaningfully reduce productivity [8] and many students may sharing a small living space with their families or roommates. It may be useful for institutions to implement checklists [9] for faculty, students, and staff to ensure that all physical resources—including broadband internet and, if necessary, link-aggregation technology—are in place for effective remote scholarship.

Who is responsible for these physical resources? The physical resources described above are likely far out of reach for many students and other stakeholders in the science and academic enterprise. If a substantial amount of work is expected to be done remotely, we should perhaps expect institutions such as universities and research labs to foot the bill for at least a significant portion of these expenses. Though this would be a substantial departure from current practices, there is precedent for such an arrangement: for example, software licenses for Matlab and AutoCAD are too expensive for individuals to purchase, so they are purchased in bulk by institutions. We should treat physical hardware and infrastructure for remote work the same way—as a business or academic expense. For students paying tuition, this price may be included in the cost of attendance (like room and board), negotiated down by purchasing in bulk, and be included in financial-aid calculations.

Technical gatherings

Even as universities and research institutes begin to open their laboratories and smaller classes, it is likely that larger gatherings will continue to be online for the foreseeable future. It is worth considering what additional innovation is required to make these a success by looking at two examples: thesis defenses and academic conferences.

I recently attended my first remote thesis defense, and it was the first time when I felt that the online experience has already eclipsed its in-person counterpart. Defenses are typically just presentations with slides and a Q&A, and seem to work just fine over a simple teleconference. Unlike in-person defenses, the online format makes it possible for friends and family to participate in real time from anywhere in the world and makes it trivial to add committee members from other institutions. I am not sure it is necessary to go back to in-person defenses, though it would be nice if the celebration afterward were still in person. That said, I would not recommend hybrid defenses or similar events—where some people participate in person, and others remotely. The hybrid approach can create an imbalance where the online contingent is usually considered secondary and reduces the incentive to ensure a quality online experience.

Conferences. The world of conferences flipped on its head as the pandemic advanced. This March, physicists from all over the world have already begun to arrive in Denver for the APS March Meeting—the largest annual physics meeting in the world—when the meeting was abruptly canceled [10]. Almost overnight, virtual sessions began to pop up on YouTube and elsewhere, a trend that has accelerated into massive online conferences within the next two months. For example, the Optical Society's flagship CLEO conference (co-sponsored by the IEEE Photonics Society and APS) just concluded with 4× the participants than the usual in-person event). Several months earlier, our Photonics Online Meetup had a five-hour block of live talks and a poster session held over Twitter, which was viewed at the time as an exciting experiment [11] [12].

Following this experience, we can be confident that online conferences can succeed: they attract larger audiences than in-person events, obviate the need for visas, reduce travel cost and CO_2 emissions, and make it easier to attend while meeting family obligations. However, there are also many aspects of conventional gatherings that online events still struggle to replicate: audience attention and engagement, serendipitous encounters with collaborators and friends, and opportunities to grab a few minutes of time with a potential future advisor or employer.

What can be done to endow online conferences and other large events (and even large classes!) with these more-nebulous but important aspects of physical gatherings? One possibility is to schedule unstructured time (like coffee breaks), for example creating video rooms for small groups of people. Another approach is to create a parallel space for communication outside of the typical confines of presentations and formal Q&As; for example, at several recent conferences I was able to engage some participants on Twitter. An intermediate possibility is the creation of a conference workspace with channels using tools like Slack or Discord, for less-structured text and voice interaction among the conference attendees. Another possibility, though difficult in a pandemic, is hybrid virtual-physical events, where some local in-person activities mix with the online event; for example, at the January Photonics Online Meetup, we had ~50 "hubs" at a variety of universities and organizations that created a communal experience [11].

One intriguing possibility is the use of virtual reality (VR) or video-game type environment that can mimic or go beyond physical spaces. VR conference spaces have been attempted recently, for example at the IEEE VR conference which used the cross-platform Mozilla Hubs [13]. At the second Photonics Online Meetup in June, we are planning a small-scale poster session using the same platform. It seems likely that VR spaces will eventually be effective and immersive enough to become commonplace, with innovation rapidly accelerated by surging demand. It is worth keeping an eye on these developments, so we can help steer the development of VR technology to enable effective and accessible online scholarship.

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