Visions of the Future

A Day in the Life of a Scientist

Earlier this year *Science* asked readers to imagine what life would be like in the year 2050. As one of a four-part series in December, we present the second installment of these fictional essays.

A Day in the World Science Alliance

by JILL TREWHELLA AND DON M. PARKIN

Monday, January 24, 2050
The satellite radio alarm woke me up at 5:30 a.m.

with the International Public Radio newscast anchor announcing that Patrick Leyland, leader of the World Science Alliance, would hold a press conference today in Brasília. He would report on the success of our Amazon River watershed reforestation project. I snuggled under the covers and stole a few extra minutes to enjoy the moment, letting my mind drift back over the decades. I reflected on the day I accepted one of a small number of distinguished fellowships the WSA was offering in order to attract young scientists to work on scientific and technological solutions to world problems. I had no clue at the time about the journey I was beginning.

By the year 2020, economic globalization and environmental crises had focused the political agenda for most nations on issues of climate change, energy efficiency, and sustainable economic development. The WSA was formed that year during the brief period in U.S. history when a third-party government won the presidency running on a global political agenda. When I began my career in the WSA in 2030, no one could have predicted that this still-small, idealistic worldwide alliance would grow into what it is today; a $200-billion international agency charged with providing scientific and technological resources to solve world problems. The WSA now also has responsibility for developing the science and technology base upon which its political counterpart, the New United Nations, develops international policy aimed at avoiding future catastrophes such as the Asian agricultural disaster that led to world economic market instabilities and drained the capacity of international aid agencies in 2017.

It was 5:45 a.m. and I could not delay getting out of bed any longer. I had to be in the family communication center and ready for my video conference by 6:00. My Canadian colleagues were in the same time zone, and it would be midafternoon for the Europeans. However, it was late evening in Australia, and my colleagues there would be wanting to finish up work for the day. I threw on a coverall and quickly combed my hair and went downstairs. As I walked into the communication center, stumbling over the antique *Star Wars* action figures left on the floor by Jason, the 2-meter by 2-meter flat panel display lit up with a message asking if I was ready for the live video conference.

I said yes, and the voice-activated control switched to a split Canadian/European/Australian screen. Everyone was there. "Good morning all—we have reason to celebrate! The reforestation project has been an outstanding success, and the press coverage has been more than generous."

"Yeah, g'day everyone. I don't think we could have asked for better," came the response from Rob down under.

"This is going to help us tremendously when we go in for our budget review," remarked Jenny from Edmonton.

"Not if we don't have the right experiments lined up and a convincing demonstration that we can transfer the technology to the Asian sites that need regenerating." Heinrich, always the realist, brought us quickly to the topic we were here to discuss.

Our success in South America had been built upon our discovery of a novel metabolite in a rare species of native tree. This discovery led us to characterize a new regulatory pathway that we were then able to engineer genetically so that the carbon and nitrogen cycles were decoupled. The engineered trees grew rapidly, fixing higher-than-normal amounts of carbon from the atmosphere under conditions of marginal nitrogen availability. Thus, we were able to regenerate forest without using environmentally damaging fertilizers. The long-term impact on reducing carbon dioxide in the atmosphere was predicted by the climate models to be finite and beneficial just from the South American project alone.

To have the sort of global impact desired, however, we needed to get the same sort of results elsewhere, especially in Asia. The prob-

lem we faced was the high concentrations of industrial toxins in the soils of the Asian wastelands. Any biotechnology solution would require combining the approach that was successful in the South American project with additional measures to deal with the toxins.

One approach we were considering was to do additional genetic engineering to make toxin-tolerant trees that would not only fix and metabolize the toxins but also volatilize the products as harmless species. As an alternative, we were considering an approach combining bacteria and plants. We were working on the natural bacteria in the soils, seeking candidates to engineer so that they would take care of the toxins before we introduced our trees. Both approaches had their problems, but we had recently seen some preliminary data from a plant biologist in Beijing that led us to believe that the dual-purpose, toxin-sequestering and fast growing, tree might be possible. One purpose of the conference call was to discuss bringing the Beijing group into the collaboration. We also needed to hear reports from each location about the results of this past week's experiments.

By 8 a.m. everyone had reported on their latest results, and we had a consensus that we would invite the Beijing group to an exploratory workshop in Hawaii. We were already planning our annual retreat there for early December, and it would be easy for us to arrive a few days early for the workshop.

We said our farewells, and I signed off, heading back upstairs to rustle the children out of bed and to have my shower. I needed to be at headquarters and ready for a meeting with my local research team by 10:00. While overseeing the breakfast and departures of the kids for school, I managed a quick call to Nevada to find out when Jack would be home from his field trip to the Neutron Research Center. His helijet would land at the WSA Denver satellite pad at 8 p.m., and he would get the maglev shuttle home. We could have dinner together after the kids were in bed.

I just managed to catch the 9:30 maglev shuttle from the neighborhood stop and arrived at WSA headquarters 10 minutes later. I was relieved that there were no delays this morning due to the unseasonable high temperatures that had been causing problems with the room-temperature superconductors that levitate the train. I had enough time to stop by the canteen and get two dozen donuts—a fuel still required by young research minds at group meetings.

Our meeting this day focused on our latest animated holographic dynamic simulation that integrated all of the structural and dynamic information we had on the molecular network. We wanted to identify our best candidate to engineer for toxin tolerance and fixation. We had NMR and crystal structure data on the molecular components from the teams in Edmonton and Hamburg. The Sydney group had given us the biochemical data defining the sequence of the component interactions. Our own mutagenesis experiments and neutron contrast variation studies revealed structural details of the component interactions. After integrating the data and developing the network model, we gave it to the computer graphic artists. While viewing the results of their efforts, we were all awed a little by what they had done in taking our data and rough images and converting them into high-resolution dynamic holographic sequences that are invaluable for planning our molecular engineering strategies.

It gave me some satisfaction to reflect on how the prestige and financial power of the WSA has been able to pull the talent that once was concentrated in the Hollywood entertainment industry into the scientific simulation and analysis revolution.

We finished our meeting with a discussion of how the new Beijing data could help direct us to the right species for the Asian project, and we roughed out a preliminary agenda for the proposed exploratory workshop in Hawaii.

I hurried out of our meeting room and took the elevator to the penthouse executive dining room. My Division Director was waiting (a little impatiently) for me. While we were served lunch, I reported to him on our latest progress and told him about the Beijing connection we wanted to make. We will need Division Office support to bring them in, because it will increase our budget. When I explained that it could bring the project to field-test status years earlier, it was clear that we will have what we need.

With my meetings over for the day, I headed down to my laboratory. It was cool and quiet there, except for the hum of my teraflop desktop computer crunching away on several dynamic molecular network simulations that I had launched Friday afternoon to run over the weekend. This is my favorite place to be at work. I enjoy the society and pace of international team science, but it is these quiet times that are the best. I can sit undisturbed for several hours, poring over the results of my calculations, evaluating them against new experimental data, and adjusting the simulations as needed.

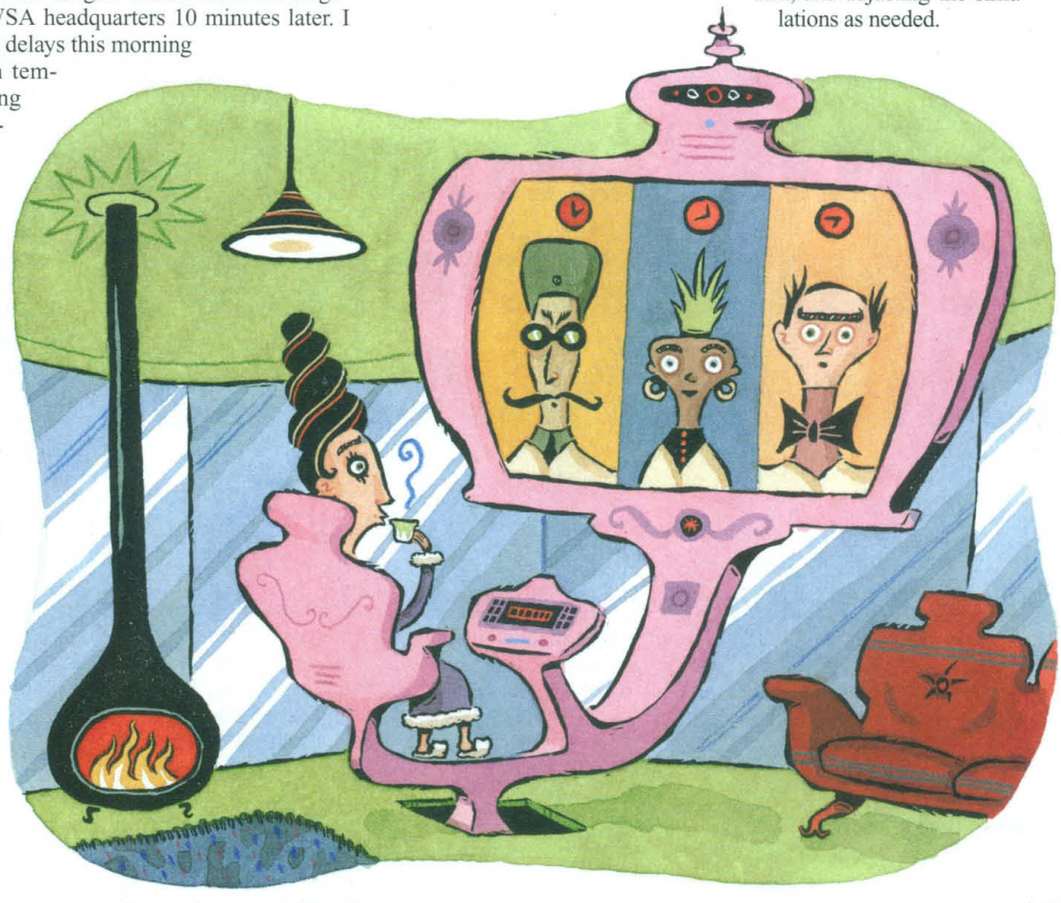

ILLUSTRATION BY ADAM MCCAULEY

While reviewing the simulated molecular trajectories in the holographic visualization chamber, I selected a set of targets to input into our Molecular Design Toolbox. The Toolbox searches all the molecular databases and gives me a set of possible strategies to modify specific enzymes in the network in order to change their substrate specificity so they will act on one or more of the toxins present in our test site. I prioritized the strategies and readied them for distribution to my research teams for evaluation. The time passed quickly, and I suddenly realized that I must be at the school in 15 minutes to meet the children.

I arrived at the school by 4:30 p.m. to meet the kids, and we caught a maglev shuttle home. The overloaded car was noisy, and Jason was anxious to be home in time to see the next episode of the original *Star Trek* TV series that was still in perpetual reruns. His older sister Karen listened patiently to his prattle about Tribbles and such. After getting the kids some dinner and talking about their respective days with them, I settled them down in our communication center to work on their homework while I logged into the WSA library. I checked my log to see if there were any hot E-scripts published that day. It had been a relatively quiet day for science publishing: only 5000 manuscripts submitted to the network and only a couple of them flagged by my E-Sentry as important. We all finished early enough for Jason to watch *Star Trek* before it was time for him and Karen to get ready for bed and reading time. Their father arrived home in time to say good-night before they were asleep.

Over a late-night supper, Jack told me about his trip to Nevada where he was trouble-shooting for the U.S. Nuclear Energy Commission. The NEC came into being soon after the United States signed the international treaty requiring all nations to reduce their emissions from fossil fuels by 80%. They established our West Coast nuclear power reactor network in Nevada. Soon after, the Neutron Science Research Center was sited there with its facilities for reactor materials development, neutron scattering, and medical applications. Jack's contract was to find out what was wrong with the cold neutron source enhancement project at the research center.

His success would be a boon for our project. We were always hungry for more neutrons for our structural studies. Jack had good news for me—it seemed we might be doing experiments using the new cold source within the year.

We went to bed, and I enjoyed the feeling of being tired from a good day. I drifted asleep wondering where my journey might take me from here. We have the team and the tools to make the Asian project really go, and our success would have a huge impact for the future. I looked forward to being a part of making it happen.

The authors, a husband-and-wife team, collaborated on this project from the glorious mountains of Northern New Mexico. J. Trewhella arrived in the USA 20 years ago from Australia, and is a biophysicist. D. M. Parkin is from Utah, where he began his journey in condensed matter physics and went on to specialize in radiation effects. J. Trewhella, Mail Stop G758, and D. M. Parkin, Mail Stop K765, Los Alamos National Laboratory, Los Alamos, NM 87545, USA. E-mail: jtrewhella@lanl.gov and dmp@lanl.gov

This essay is a work of fiction. Names, characters, places, and incidents either are the product of the authors' imaginations or are used fictitiously. Any resemblance to actual persons, living or dead, events, or locales is entirely coincidental.

Address to the 40th Annual Convention of the U.N.A.A.S.

by PAUL K. WOLBER

(Scene: A packed, windowless auditorium. A buzz of conversation fills the room, but individual voices are indistinct. A casually dressed, nut-brown man of indeterminate age walks to the podium and clears his throat. The crowd quiets, and the speaker begins ...)

Speaker: Colleagues and friends, welcome to the 40th annual convention of the United Nations Association for the Advancement of Science. I thank the meeting organizers, both real-presence and virtual, for inviting me to deliver this opening address. Today, I would like to review the eventful first four decades of our history and then discuss the challenges which I believe will shape our next 10 years.

Many members of today's audience witnessed the sad events that caused the American Association for the Advancement of Science to transform into a truly international organization. I will not dwell on the tragic excesses of the international conspiracy of unemployed scientists that held the world hostage during the first 6 months of 2009, nor will I join the endless argument over whether the ultimate response of Hillary Clinton's administration was excessively brutal. Suffice it to say that one piece of good that emerged from those tragic times was the founding in 2010 of the U.N.A.A.S., an international scientific organization committed to policing the world's scientific communities and representing the interests of scientists of all nationalities.

The first challenge facing the U.N.A.A.S. was the formidable task of reversing the conditions that had produced such an ample supply of unemployed, disaffected scientists and engineers. The task was complicated by funding problems: the governments of the world found it difficult to muster the political will to provide the