Cyberspace Offers Chance To Do 'Virtually' Real Science

As scientific meetings go, the neuroscience session at the BioMOO biology center was a success. Sure, the slide projector broke down once or twice, and some speakers couldn't be heard. But the discussion period featured a lively debate about the potential of gene therapy to promote nerve regeneration, and the surroundings—two floors of spanking new labs, offices, and meeting rooms in the midst of a pastoral wooded campus—were state-of-the-art. The participants especially liked how the meeting ended: Instead of packing their bags, heading for the airport, and spending hours in transit, and then making up for lost time back at work, they simply swiveled their chairs around and were back at their desks.

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—James Hutchins

How was that possible? Well, the BioMOO center doesn't really exist. It's a "virtual" facility—essentially just a big software program running on a computer at the Bioinformatics Unit of the Weizmann Institute of Science in Jerusalem. But thanks to the Internet and cyberspace—the virtual world of computer networks—BioMOO simulates a large and growing laboratory and office complex. Since its creation last November, BioMOO has become "home" to more than 300 biologists from three continents and dozens of fields who are communicating, collaborating, and designing electronic tools to do science.

BioMOO is the first major effort to use a virtual environment for day-to-day science and science communications. It owes its existence to an ad-hoc group of young working scientists, grad students, and postdocs who have adapted a special computer language, originally developed at Xerox's Palo Alto Research Center (PARC) for computer gaming, to the world of science. (MOO means Multiple-user dimension, Object Oriented; the 'M' originally stood for Multiple-user dungeon, referring to the computer version of the game "Dungeons and Dragons," from which the technology evolved.) The technology is not restricted to biology: A similar center is being created for astronomers, ecologists are laying the groundwork for EcoMOO, and there are even plans for an entire virtual university.

"We think MOOs are the right interface for the whole information infrastructure—what's often called the information superhighway," says Pavel Curtis, a PARC researcher who co-developed the MOO language and directs PARC's Social Virtual Reality project.

Beyond Internet. What MOOs offer scientists that other Internet resources do not is a "place" where they can meet other scientists, "talk" in real time, share data, research tools, and information, and showcase their own research. MOOs attempt to capture (within the limitations of words on a screen) the feel of the real world and real-world communications. You "walk" down a hall and into a lab, striking up a conversation with one of its occupants. Maybe they let you inspect and manipulate a model of their latest research project, a novel DNA transcription mechanism, for example.

Unlike e-mail and bulletin boards, MOO conversations take place in real time. Unlike Internet Relay Chat (another Internet tool for real-time communications), MOOs are focused on particular subject areas and let users show and share data and tools as they talk. And unlike videoconferencing, all a scientist needs to use a MOO is a computer and a bare-bones Internet connection.

The unique attraction of a MOO, Curtis says, is that it's a "shared, customizable environment that is, above all, persistent." Build a lab and put in data, notes, and tools, he explains, and they will remain there after you sign off. With your permission, collaborators can visit your lab and work with the data and tools while you are gone. And, he notes, "in the virtual world, space is cheap."

The advantages of MOOs are quite real for University of North Carolina neuroscientist David McKalip, whose research interests focus on esoteric aspects of the role of extracellular matrix and adhesion molecules in central nervous system regeneration and transplantation. Thanks to BioMOO, he's found another researcher with similar interests, neuroscientist James Hutchins of the University of Mississippi medical center, and the two are hoping to collaborate. McKalip finds BioMOO to be a valuable substitute for the conferences and meetings he must miss because of his long and unpredictable hours as a neurosurgery resident. Hutchins appreciates another feature of BioMOO: "Working in Mississippi," he says, "it is easy to feel a sense of isolation from the 'science centers' of the East and West Coasts. BioMOO brings me together with other biologists worldwide, in real time."

How it works. A visit to BioMOO begins with a telnet program or special MOO "client" software for logging onto the MOO via an Internet link.* Once logged in, you enter the BioMOO lounge, where you can study a MOO tutorial. Type "s" to move south into the Central Room, which tells you it is "a large circular room, its ceiling a transparent dome through which sunlight streams in." There you can search a research directory to find users with similar interests or check the jobs/postdocs board. Through one door are some four dozen labs, while other doors lead to offices, the library, the EMBnet Cafe, and seminar rooms. Down the hall are rooms for communications (Internet Gopher programs) and "transportation" to other MOOs. All the rooms can be explored, and most contain working research tools or demonstrations.

The MOO environment is real-time, with users "speaking" to each other as if they were in the same room. Typed responses are processed immediately and can include descriptions—called emotes—of gestures, facial expressions, and other non-verbal conversational cues that users choose with typed commands. "After a short time in conversation in MOO space, using emotes becomes natural," explains University of North Carolina biology postdoc Victoria McGovern. "You nod at a colleague's comment, scoff, laugh, smirk, 'high-five.'" Meetings can be open to all or moved to special rooms that are restricted to specified users.

At the moment BioMOO is strictly a text-based environment, meaning you can talk only as fast as you can type and graphics must be reproduced in ASCII characters. But the PARC researchers are putting the finishing touches on the next generation of MOO, called Jupiter, which will offer full-color graphics, windows, audio, and even video. Gustavo Glusman, a Weizmann Institute graduate student who founded BioMOO who and now co-administers it, says graphics will soon be added to BioMOO.

Those limitations haven't stopped scientists from finding lots of uses for words alone.

* To visit BioMOO, telnet to: bioinfo.weizmann.ac.il 8888 or 132.76.55.12 8888. At the BioMOO welcome screen, type "connect guest". Some telnet programs may require that the space between the address and the 8888 port identifier be replaced with a pound sign (#); others require the address to be followed by `` /port=8888''. BioMOO can also be reached by Gopher (port 70) at bioinformatics.weizmann.ac.il.

Martin Leach, a graduate student at Boston University school of medicine, has developed a prototype tool that allows BioMOO users to send gene sequence data (which they can store in their BioMOO lab or office) to major sequence databases to search for matches. Although scientists can run similar software from their own computers, not all have such programs or want to put them on their own machines. With BioMOO, such tools are always there for all to use.

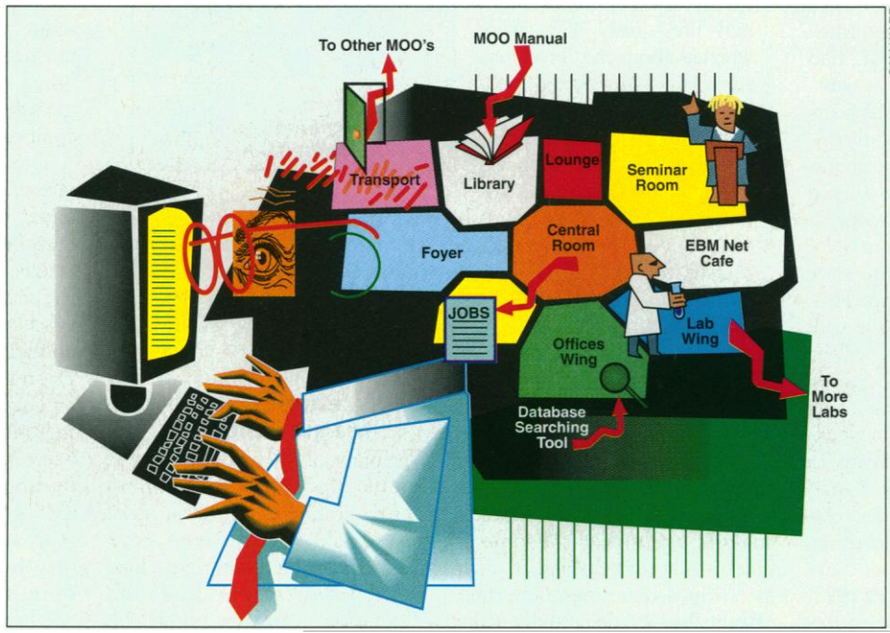
Glusman and BioMOO co-administrator John Towell, a bioinformatics postdoc at the University of Northern Illinois, have written tools that allow several authors to work on a paper collaboratively, sharing the same draft on-line. Indeed, the two, who have never met in real life, are writing a paper together on using MOOs to teach chemical modeling.

Eric Mercer, a Caltech postdoc researching transgenic mice, is developing a colony of virtual mice that can be anesthetized, dissected, inspected, and sutured as an inexpensive and simple way to teach dissection and handling. It's not as fancy as CD-ROM–based multimedia simulations—dissection simply reveals pre-programmed descriptions of the tissue and organs in the area under inspection—but it is available to all for free. If MOOs become virtual universities, these kinds of shared teaching tools could be their foundation. "I'm hoping to build a complete animal training facility," Mercer says, "which could mean fewer live animals wasted and less time spent on training by experienced personnel."

Others have used BioMOO's tools to build demonstrations of their research open to all users. The idea is to create what amounts to a permanent electronic poster session, with working models as well as descriptions. For example, University of Toronto molecular biology graduate student Blake Smith has constructed a model of the biological system he is researching, the role of a "heat shock factor" protein in gene transcription. Others have constructed interactive biochemical models, including a walk-in model of the Epstein-Barr virus and a "hands-on" demonstration of DNA replication, in which the user directs genetic reproduction by manipulating nucleotides, enzymes, and other cellular machinery. In the works are statistical analysis tools, more database searching, and advanced communications facilities that allow researchers to use BioMOO as their home base for general Internet surfing.

Multidisciplinary MOOs. Whatever their origins, science MOOs are now sprouting on their own. McKalip is planning a neurosurgery MOO, and zoologist Pat Lorch of the University of Toronto is helping to start EcoMOO, a virtual learning center that will be used to simulate field work for first-year ecology students in classes too large to carry out real field work. At MIT's Media Lab, MediaMOO has become a thriving research center for scientists studying computer communications strategies.

Scientists who are particularly intrigued by the educational potential of MOOs are developing Diversity University, described as a "virtual institute for innovative education." And a non-profit "virtual corporation" has been incorporated in Texas to create a fully accredited virtual university known as the Global Network Academy. "The beauty of teaching in a virtual classroom is the computer screen does not make judgments regarding race, sex, disability status, or age," says Mississippi's Hutchins.



Imagine that. Just a few keystrokes away from your own computer terminal, BioMOO is an ambitious attempt to create a virtual reality research center on the Internet, complete with labs, offices, meeting rooms, and even a cafe.

Another new MOO-based application for scientists is AstroVR, a virtual environment for astronomy and astrophysics researchers now being developed by Curtis and Caltech astronomer David Van Buren. In the AstroVR prototype, one of the rooms "contains" the Infrared Astronomy Satellite (IRAS), which finished its 1-year star survey in 1983. "You can walk into the room and say, 'Point IRAS at the Andromeda Nebula,' and 20 seconds later four images appear on your screen showing the Andromeda Nebula in infrared," Curtis says. Other rooms contain interactive data plotting packages and allow access to a variety of astronomical and bibliographic databases.

Although the IRAS data are also available through other means, such as e-mail or CD-ROM, says Van Buren, the advantage of AstroVR is that it's immediate and doesn't require any special hardware other than an Internet connection. Best of all, it allows collaborators to view the data simultaneously, discussing the images in real time with typed comments or through a voice link. Van Buren and Curtis have also given it the capacity to find an object without specifying its location. Compared to traditional analysis methods, says Van Buren, AstroVR "buys you convenience and ease of use."

The AstroVR collaborators want existing collaborations of respected space scientists to use and help develop the program as a way to spawn interest among working scientists. "We've been warned not to let this become a place used by a lot of grad students," says Curtis, "because then senior researchers will think it's just a toy."

The BioMOO creators worry about that, too; so far, nearly half of those on BioMOO are graduate students and postdocs, and many spend a good deal of time chatting or simply playing with the technology. But BioMOO's increasing sophistication is beginning to draw more university faculty and research associates, who now account for nearly 20% of the BioMOO membership. The virtual center has already hosted several "journal club" meetings, with as many as 30 participants each, to discuss key articles in subjects from ecology to neuroscience.

"I see the BioMOO as a refuge for the serious biologist on the Internet," says Toronto's Smith. Curtis says the virtual center can't yet simulate animals or reagents, "but we can give you the environment that glues the scientists together and allows them to collectively plan the experiment, do the analysis, write the papers." In other words, he says, MOOs allow for "the real work of doing science."

–Christopher Anderson