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More Scientists Treat Experiments as a Team Sport

Massive Collider, a Global Collaboration, Has a Bumpy Start; but Sometimes the Work of Crowds Yields Wisdom

By ROBERT LEE HOTZ

If all goes well, researchers Friday may power up the Large Hadron Collider -- a $6 billion particle accelerator near Geneva. The atom smasher is so large that a brief status report lists 2,900 authors, so complex that scientists in 34 countries have readied 100,000 computers to process its data, and so fragile that a bird dropping a bread crust can short-circuit its power supply -- as occurred earlier this month.

Far from trouble-free, the proton accelerator is resuming operations after a catastrophic breakdown in 2008 that triggered a year of repairs and recriminations. Its large research teams operate on such an elaborate scale that project management has become one of science's biggest challenges.

Around the world, scientists are cutting across boundaries of place, organization and technical specialty to conduct evei more ambitious experiments. Inspired by such cooperative enterprises as Linux and Wikipedia, they are encouraging creative collaborations through networks of blogs, wikis, shared databases and crowd-sourcing.

Once a mostly solitary endeavor, science in the 21st century has become a team sport. Research collaborations are large more common, more widely cited and more influential than ever, management studies show. Measured by the number authors on a published paper, research teams have grown steadily in size and number every year since World War II.

To gauge the rise of team science, management experts at Northwestern University recently analyzed 2.1 million U.S. patents filed since 1975 and all of the 19.9 million research papers archived in the Institute for Scientific Information database. "We looked at the recorded universe of all published papers across all fields, and we found that all fields were moving heavily toward teamwork," says Northwestern business sociologist Brian Uzzi.

As research projects grow more complicated, management becomes a variable in every experiment. "You can't do it alone," says research management analyst Maria Binz-Scharf at City College of New York. "The question is how you put it all together."

The key is bringing the people together in the first place, which has sped technological advancements that often benefited the rest of us. The ease of global business and social networking today owes much to the World Wide Web, which was designed to aid information-sharing between scientists. It was invented at the European Organization for Nuclear Research (CERN), the home of the Large Hadron Collider.

New online science management experiments are underway. Last year, the National Science Foundation started a $50 million project to map all plant biology research, from the level of molecules to organisms to entire ecosystems, so scientists can swoop through shared data as if they were using Google Earth. Last month, U.S. computer experts launched a $12 million federal project to create a national biomedical network called VIVOweb to encourage

collaborations.

Scientists are experimenting with the new technology of teamwork even in mathematics, where researchers customarily work alone.

Last January, British mathematician Timothy Gowers invited volunteers to work on a problem in combinatorial research called the density Hales-Jewett theorem, which he posted at his Polymath Project blog. By brain-storming together online, two dozen volunteers solved the problem in 37 days. "This way of doing research led to our finding the proof much more quickly than otherwise," says Dr. Gowers at Cambridge University.

Other scientists team up out of frustration. Biology students created an online collaboration called OpenWetware to share technical tips about cell lines, enzymes, protocols and screening assays. "This stuff is never published," says Sriram Kosuri at the Harvard University Institute of Genetics, who was among its organizers. "We wanted to get this information into the open."

Since 2005, the project has grown into an online collaborative of 7,000 registered users on five continents and 65,000 Web pages -- all with little or no direct management. "Everyone uses it for their own purposes and it grows organically," says Dr. Kosuri.

In that spirit, paleontologist Michael Taylor at the University College London recently set up the Open Dinosaur Project, encouraging volunteers to create an online database of dinosaur bones from collections world-wide. "The whole nature of the scientific engagement is changing dramatically and quickly," Dr. Taylor says.

By many measures, the Large Hadron Collider is the largest machine in the world. It is designed to smash together proton beams to test ultimate theories of matter. Its science teams, drawing on independent researchers, resources and funds from 150 universities and dozens of government agencies, already transcend the physics of conventional management.

Strictly speaking, no one is in charge.

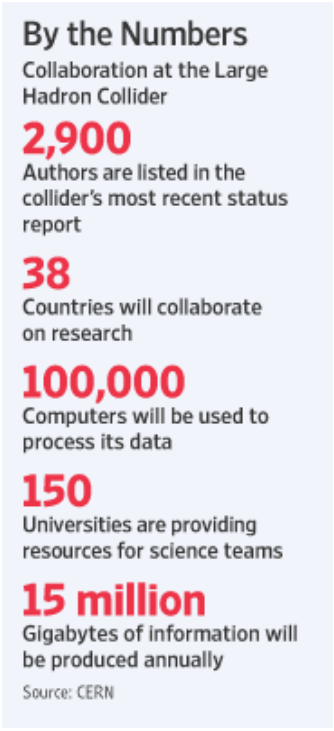
Consider Tejinder Virdee, who occupies the top spot in the organizational chart of the collider's Compact Muon Solenoid detector -- an intricate 12,500-ton device the size of a medieval cathedral. At least 3,600 people from 183 institutes in 38 countries are involved. Ordinarily, Dr. Virdee might exercise considerable executive authority. Instead, he carries the misleading title of "spokesperson." He was elected by researchers to negotiate with other groups on their behalf.

He has no power to order or insist, only to cajole and persuade. "I cannot direct anybody to do anything that they do not want to do," Dr. Virdee says. "All decision-making is by consensus." Yet, he is more or less the boss -- at least of this component.

All around the collider, research groups organized themselves in democratic cooperatives, arranged in an anti-hierarchy. All deliberations are open -- and exhaustive. Everyone gets their say no matter how long it takes. "It is bottom-up and not top-down," says Markus Nordberg, who is the resource coordinator -- essentially the chief financial officer -- for the collider's ATLAS detector. The ATLAS detector weighs as much as the Eiffel Tower and is among the largest collaborations ever attempted in the physical sciences.

"None of them can do the research without each other," says Barbara Gray, a management analyst at Pennsylvania State University. "No one can play with the Large Hadron Collider unless they all play together."

In one sign of trust, the scientists who designed the systems relied on technologies that did not yet exist, delaying key decisions as long as practicable in the expectation someone would invent a way out of the problem. "There is enough confidence in the community that the technical problems will be solved at the last possible affordable moment," says Dr. Nordberg. "That is not the way industry works."



If all performs as planned, research teams will equally share the data and the credit.

For all their skill, the scientists starting up the Large Hadron Collider have encountered any number of operational glitches this year and, perhaps, one unique obstacle. The accelerator is expected to unleash forces so fundamental -- even a black hole, some fear -- that a few physicists fret the universe may be sabotaging the project to protect itself.

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