In the know

In big groups and companies, it's hard to track who knows what. So how can scientists share information and prevent work being duplicated? Philip Ball investigates one solution: knowledge-management software.

Someone, somewhere probably knows the solution to your problem — but how do you find them?

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It's a common frustration in scientific life: you have a seemingly simple query, but you aren't sure who can answer it. A basic experimental procedure, for example, might already have been mastered by someone else in the same building or company. Talking to that person could save you weeks of work — but how do you find them?

Researchers in small and specialized groups can simply ask around. But what about those in pharmaceutical companies that employ thousands of people around the world? Or scientists in multicentre collaborations? Asking individual colleagues would be far too time-consuming, and a single bulk e-mail would annoy many recipients.

Knowledge-management systems may be the answer. The software builds up a picture of who knows what in an organization, and uses the information to connect queries with answers. After a series of false starts, such systems have had some success in the pharmaceutical industry. And with electronic networking now embedded in scientific life, the infrastructure is there to implement knowledge management in new ways.

"Does the 25-person company need a knowledge-management system?" asks Eytan Adar, an information scientist at Hewlett-Packard Laboratories in Palo Alto, California. "Probably not. But would a 10,000-person pharmaceutical company, with researchers on both sides of the Atlantic, like to keep track of lab work to avoid duplicated experiments? There the answer is more clear."

Knowledge management is an organizational memory bank. Every problem that a staff member solves, from testing a candidate drug molecule to curing a glitch in computer code, adds to this memory. And if this treasure trove is accessible to others, the problem need only be solved once.

The longer a journal editor is in the job, for example, the more he or she relies on experience when choosing referees. There will be times when an editor knows that two researchers have fallen out, and should not review each others' papers. But how do others find that information? And how might this knowledge be preserved when the editor leaves?

Electronic memories

Keeping a record of everything is impractical, and useful information would be swamped in a sea of trivia. Often it is a chance remark at the coffee machine that becomes a crucial tip-off — it is peer-to-peer communication, not managerial fiat, that ensures important knowledge is passed on.

The first attempts at creating an electronic organizational memory sought to store and mine electronic data. One of the most influential was Answer Garden[1], developed in the late 1990s by Mark Ackerman, a computer scientist at the University of Michigan in Ann Arbor. This expert-finding system uses a database of employees' expertise, as volunteered by them, to find the right person to answer a question. Users are presented with a set of frequently asked questions (FAQs) that might avoid the need to consult another employee. If this fails to satisfy, they can be connected with an expert through e-mail, and the answer provided is added to the FAQ stockpile.

Other systems based on matching users with experts appeared around the same time, but promise gave way to disillusionment. Simon Masterton, a knowledge-management expert at the food and chemicals company Unilever, based in Port Sunlight in northern England, summarized the problem last year. "Very often there is a positive initial response to a new knowledge-management system," he wrote in a paper with colleague Stuart Watt, now at Robert Gordon University in Aberdeen, Scotland[2]. "Many people will try it out a few times. Unfortunately, more often than not the use of the system will begin to tail off pretty rapidly."

That's just what Ackerman found when academic groups and computer companies trialled Answer Garden[3]. "Things look great in theory," says one user. "Then when you get

to the specifics, it looks like more effort than it's worth. You really don't have the time."

There were other, more subtle, problems. Users found that useful knowledge could not always be decontextualized and stored. Some people were unwilling to share. And Answer Garden could not provide the incentives needed to compensate for the time and effort of sharing[4].

Tools for knowledge management in science also flowered briefly around the time of the first business-software projects. In the early 1990s, Eric Mandel of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, worked with Ackerman to develop a knowledge-management system for astronomers called ASSIST[5]. Astronomers often analyse many types of data with different, incompatible software packages. ASSIST embeds such software in a single electronic environment, containing advice and tutorials written and updated by users. Some users call it a living cookbook.

Astronomy cookbook

Within the first four months of its 1992 release, ASSIST was retrieved by more than 40 astronomical institutes, and was used on NASA projects such as the Compton Gamma Ray Observatory and the Advanced X-ray Astrophysics Facility (now called Chandra). Nevertheless, it did not catch on. Mandel says that it worked well, but lacked backing. "We really needed one large astronomical project to use ASSIST so that its truly innovative capabilities could be demonstrated in practice. But we never got one," he says. The NASA projects made limited use of ASSIST, and no one was willing to develop the tutorials needed to test the software, Mandel adds.

But scientific knowledge management is not dead. In fact, it is thriving, Ackerman says, but in a different guise. He points to arXiv, the physics preprint server hosted by Cornell University in Ithaca, New York, as a simple implementation of peer-to-peer sharing. "Scientists are not only lead users of knowledge-management techniques," says Ackerman, "they are inventing new techniques that are then incorporated into business practices."

Well connected: Mark Ackerman has devised programs to help researchers share their expertise.

New knowledge-management software has also emerged in recent years. Employees of the pharmaceutical company Aventis are using one new system, called KnowledgeMail. In 2001, for example, a researcher at DG Thrombotic Diseases and Degenerative Joint Diseases, a research division of Aventis based in Frankfurt, Germany, needed to figure out how to culture and sort the macrophages — a type of white blood cell — he was working with. He suspected the information was out there, but knew it could take weeks of searching to track it down.

With about 5,000 research staff and 75,000 employees, there was a good chance that someone in Aventis had already solved these problems. KnowledgeMail quickly found two researchers in the company's US division at Bridgewater, Massachusetts, who could supply the information.

Mail mining

The software, produced by Tacit of Palo Alto, California, develops an expertise profile of users based on words and phrases extracted from their e-mails. Crudely put, if one researcher gets a lot of e-mails about macrophages, the system assumes that they are an expert on the topic and sends appropriate questions their way. This allows expert profiles to be generated with little effort by users. Tacit's software has also been used by drug company AstraZeneca and technology firm Lockheed Martin; and KnowledgeMail has now evolved into a product called ActiveNet.

Over a three-month trial in 2001, Aventis estimates that KnowledgeMail saved the company 7.8 person months. More than 80% of the 435 trial users in Germany, France and the United States asked for the software to be retained. Aventis is now extending use of the system, and other pharmaceutical companies are exploring similar packages.

But systems such as KnowledgeMail are not problem-free. "The issue with creating detailed profiles is the need for a guarantee that user privacy would be maintained," says Adar. Allowing users access to their profiles seems one way of addressing such concerns.

Adar and his colleagues have designed Social Harvesting of Community Knowledge[6], software that builds up expertise profiles using e-mail scans, information on web pages visited and documents viewed. Users can also list their interests and skills in a self-declared profile, and can edit their profile or prevent certain sources from contributing to it. This facility was important to trial users, even though it may compromise the need to maintain unbiased profiles — people's self-image is often far from realistic.

If systems such as Adar's can continue to iron out such problems, new knowledge-management software could overcome the barriers that defeated early packages. Within certain research environments, they have the potential to cut down on tedious literature searches. And if they can do so without invading users' privacy or placing too much of a burden on their time, knowledge-management software could join the suite of computer programs that we cannot imagine living without. ■

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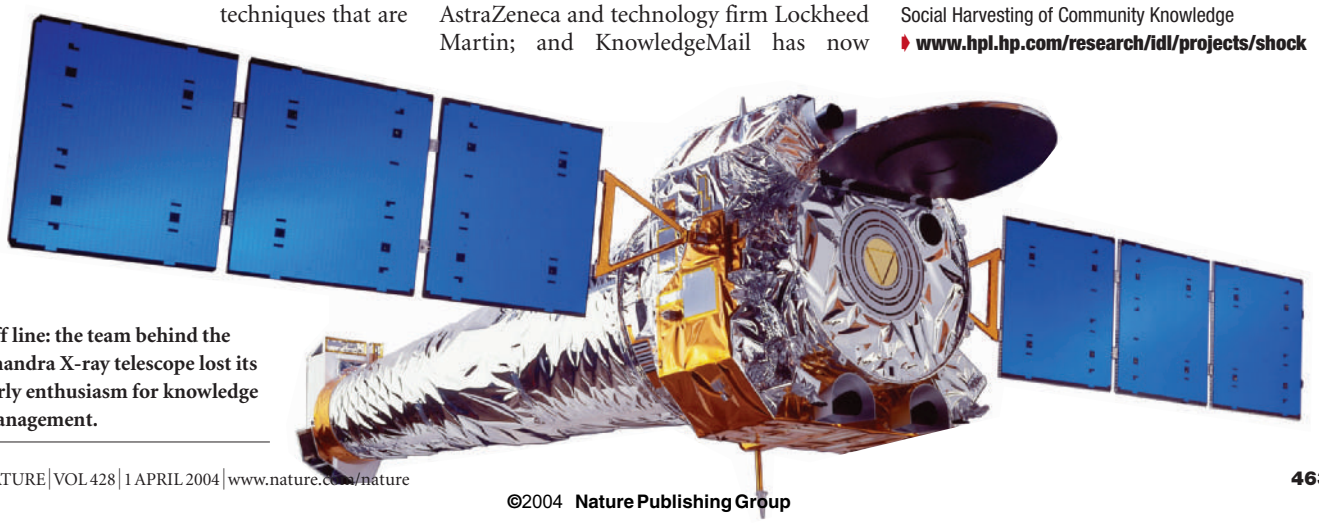
KnowledgeMail
www.mindsharesolutions.co.uk/products
Social Harvesting of Community Knowledge
www.hpl.hp.com/research/idl/projects/shock



CHANDRA X-RAY OBSERVATORY

Off line: the team behind the Chandra X-ray telescope lost its early enthusiasm for knowledge management.