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Degrees of Separation Are Likely More Than 6, Especially in E-Mail Age

By KENNETH CHANG

Socially, it may be a small world, but it's hard to get from here to there.

In the current issue of the journal Science, researchers at Columbia University report the first large-scale experiment that supports the notion of "six degrees of separation," that a short chain of acquaintances can be found between almost any two people in the world. But the same study finds that trying to contact a distant stranger via acquaintances is likely to fail.

The "six degrees of separation" notion came from an experiment in 1967 by Dr. Stanley Milgram, a social psychologist, where a few hundred people tried to forward a letter to a particular person in Boston by sending it through people they knew personally. About a third of the letters reached their destination, after an average of six mailings.

Dr. Milgram's experiment inspired a notion that the billions of people in the world, widely separated by geography and culture, actually form a close-knit network of social acquaintances, that you are a friend of a friend of a friend of a friend of a friend of anyone anywhere.

Until now, few scientists have tried to confirm Dr. Milgram's findings, which some scientists find unconvincing because of the small number of participants and other shortcomings of the experiment.

The advent of the Internet enabled the researchers to more carefully explore the problem, which is part mathematical -- the structure of the network -- and part psychological -- what motivates people to participate or not, and how do people decide whom to send the message to? The answers are of interest both to computer scientists studying the ebb and flow of information on the Internet and sociologists studying the spread of gossip and cultural trends.

In this global study, more than 60,000 people tried to get in touch with one of 18 people in 13 countries. The targets included a professor at Cornell University, a veterinarian in the Norwegian army and a police officer in Australia. Despite the ease of sending e-mail, the failure rate turned out much higher than what Dr. Milgram had found, possibly because many of the recipients ignored the messages as drips in a daily deluge of spam.

Of the 24,613 e-mail chains that were started, a mere 384, or fewer than 2 percent, reached their targets. The successful chains arrived quickly,

requiring only four steps to get there. The rest foundered when someone in the middle did not forward the e-mail.

As in most social networks, it is not just a question of who knows whom, but who is willing to help.

"Just because President Bush is six degrees from me doesn't mean I'm going to be invited for dinner at the White House," said Dr. Duncan J. Watts, a professor of sociology at Columbia and senior author of the Science paper. "You can ask a friend of a friend for a favor, but that's about it."

Of the people who received an unsolicited e-mail message in the experiment, 37 percent sent it on, a relatively high participation rate. But with nearly two-thirds of the recipients not forwarding the message at all, the number of continuing e-mail chains dwindled quickly with each successive step.

When the researchers asked people why they did not participate, less than 1 percent replied that they could not think of anyone to send the e-mail message to, suggesting that most simply did not want to be bothered.

Thus, the researchers assumed that many more of the e-mail chains could have been completed. They calculated that half of them would have been finished in five steps or less if the first sender and the target lived in the same country, and seven steps otherwise.

"That sounds like we're pretty connected," Dr. Watts said. But the 98 percent attrition rate "would suggest we're really not connected," Dr. Watts said. "It all depends on what this attrition rate is."

Dr. Mark Granovetter, a professor of sociology at Stanford who wrote an accompanying commentary in Science, said the similar findings of Dr. Watts and Dr. Milgram suggest the phenomenon of close links in social networks is "pretty robust."

Dr. Judith S. Kleinfeld, a professor of psychology at the University of Alaska who has described "six degrees of separation" as an "academic equivalent of an urban myth," said the conclusion was not warranted.

"Instead of showing we live in a small world, it really shows the opposite," she said. "Ninety-eight percent of people can't reach anybody. What do they conclude? `Hey, we're all connected.' What? All I'm saying is his study didn't prove it."

The study cannot tell how many chains would have meandered indefinitely without reaching the target.

Of the 384 successful chains, nearly half, 169, went to the Cornell

professor, which surprised Dr. Watts, who did not consider the professor the most socially connected of the 18 targets. "He's just a normal guy," Dr. Watts said. "Why is he 10 times better connected than someone else? He's not."

Instead, that success rate might reflect more about the participants. Eighty-five percent of them had a college education and more than half were American.

Compared with the unsuccessful chains, the successful chains also contained more "weak" links, where someone forwarded the message to someone he knew "casually." Dr. Granovetter, who proposed the idea that weak links are important in social interactions, said: "They're more your windows on the world. If you need information that comes from outside your circle, that's where you go."

The social networks did not exhibit the hub-and-spoke structure of airline routes. When asked how they selected whom to send the messages to, participants reported that they looked for someone who lived in the same geographical area as the target or who worked in the same field, not to someone who knew lots of people.

For example, Eric Albert of Newton, Mass., received a message from his cousin that was aimed for a reporter at Bloomberg News in New York. He forwarded it to Will Shortz, the crossword puzzle editor of The New York Times, a fellow member of the National Puzzlers' League.

"I figured Will Shortz since he works in New York and he works at The New York Times and knows lots of people so he probably knows somebody who works at Bloomberg News or at least knows someone who knows someone who works at Bloomberg News," Mr. Albert said.

Dr. Albert-Laszlo Barabasi, a professor of physics at the University of Notre Dame who has advocated the idea of well-connected people who act as major social hubs, said the Columbia study did not argue against the existence of hubs.

Rather, he said, people use different channels of communication for different purposes. People might call on a busy, important acquaintance in an emergency, like seeking a organ donor, but not for trivial matters. "What it nicely shows is that for the purpose of this particular experiment, they tend to avoid the hubs, or the hubs drop the message," he said.

The Columbia researchers have begun an improved experiment that will delve more deeply into how people decide whom to message. For the first time, participants will also be able to contact more than one acquaintance.

The follow-up experiment is at http://smallworld.columbia.edu.