The Science Behind Six Degrees

It’s not just who you know. It’s who they know and who knows the people who know them.

An Interview with Duncan Watts

Duncan Watts and Gardiner Morse

The idea that we’re all connected by just “six degrees” – six other people – is entrenched in our folklore. But Columbia sociologist Duncan Watts is working to see if such small worlds really exist and how they might work. Watts is one of the principal architects of network theory, the study of network structure and behavior. By teasing out the fundamental rules that govern networks of people, machines, companies, and economies, Watts hopes to learn more about how ideas spread, financial systems fail, and businesses survive crises. In his new book out this month, Six Degrees: The Science of a Connected Age (W.W. Norton), Watts explores the cutting edge of network science and its practical implications. HBR’s Gardiner Morse recently spoke with Watts about his work. Following are edited excerpts of their conversation.

You’re using the Internet to study the “six degrees” phenomenon. What have you found?

The notion of six degrees of separation grew out of work conducted by the social psychologist Stanley Milgram in the 1960s. Milgram decided to investigate the so-called small-world problem, the hypothesis that everyone on the planet is connected by just a few intermediaries. In his experiments, a few hundred people from Boston and Omaha tried to get a letter to a target – a complete stranger in Boston. But they could only send the letter to a personal friend whom they thought was somehow closer to the target than they were. When Milgram looked at the letters that reached the target, he found that they had changed hands only about six times. This finding has since been enshrined in the notion that everyone can be connected by a chain of acquaintances roughly six links long.

If this small-world hypothesis is correct, it has important implications for the nature of social networks. But Milgram’s actual results were far less conclusive than most people realize. So, my colleagues and I are conducting an Internet experiment to try to settle the matter. We now have over 50,000 message chains originating in 163 countries in search of 18 targets around the world. The preliminary picture is more complicated than Milgram realized, but it looks like his main finding of six degrees is in the ballpark.

Until recently, it’s been hard to study the small-world problem because we lacked adequate computing power. That has changed really only in the last decade, and there’s been a corresponding burst of interest in network science. Researchers are studying networks of people, companies, boards of directors, computers, financial institutions – any system that comprises many discrete but connected components – to look for the common principles. And what we seem to be finding is that the small-world phenomenon is not only real but far more universal than anyone thought. The
principles that apply to social networks, and account for the six-degrees phenomenon, seem to apply to many other kinds of networks as well. That could have implications for understanding practical problems like how ideas spread, how fads catch on, how a small initial failure can cascade throughout a large network like a power grid or a financial system — even how companies can foster internal networks to cope with crises.

**What can network science tell us about how fads spread?**

Let’s look at the phenomenal success of *Harry Potter*. The first book actually started life quite inconspicuously and then, like Razor scooters and the *Blair Witch Project*, it just caught on. But why? People tend to think that successful products are somehow destined to succeed because of some intrinsic combination of features that creates and sustains demand. But network science suggests there’s more to the picture.

In the case of *Harry Potter*, before Bloomsbury bought the rights, several other publishers rejected the manuscript. It’s tempting to think of them as fools who missed a sure thing. In fact, it never was a sure thing. For every *Harry Potter* that explodes out of nowhere, there are thousands of books, movies, authors, and actors who live their entire lives in obscurity, and my work suggests that it’s not because they lack quality or desirability. In other words, the market for a successful product should not be thought of as existing in some latent state before the product launch waiting for the product to arrive. Rather, it arises dynamically, driven in large part by the growing success of the product itself. In economics, this phenomenon is known as an information cascade: a social chain reaction in which increasing numbers of people buy a product principally because other people are buying it.

One objective of network science is to explain the mechanics of how these self-perpetuating markets form. We’re finding that the structure of the networks is probably much more important than anyone thought in influencing the dispersion of ideas or behaviors. *Harry’s* success may have more to do with particular attributes of the social and media network it’s spread across than with any inherent quality of the book. That turns our traditional notions about cause and effect on their head.

So which network structure best encourages information cascades or idea contagion? We don’t know yet. But our work is beginning to identify some basic principles. For instance, it appears that having a wide range of personality types in a population can actually enhance the odds that a new idea or product will catch on. We also think that information cascades can be squelched if people in a network are exposed to too many opinions, or too few. Clearly, poorly connected networks inhibit idea contagion. What’s less obvious is that if the people in a network are too densely connected, that may also prevent a fad or a product from catching on.

It’s too early to say if any specific marketing tactics could yield the next *Harry Potter*. But our work suggests that conventional ideas about how to promote products may not be optimal.

**Companies think they understand the networks they rely on. Your work suggests just the opposite.**

Many critical networks in business are initially invisible, in the sense that they are not formally recognized. But they’re still important. So it’s vital to create the conditions that allow useful networks to form and be exploited. How does the “right” network of problem solvers form?

In Honda plants, for example, even relatively routine manufacturing problems are solved by rapidly created, temporary teams assembled when needed from people who come from throughout the plant — not just from the specific area where the problem was first observed. The roots of even seemingly straightforward problems can be far-
flung and thus require a surprisingly broad range of institutional knowledge to be resolved. A simple paint defect, for example, may result from a faulty valve, which might have stopped working because a spray station is continually overtaxed, because another spray station is never working, because that spray station has a problem with its computer control mechanism, which resulted from an incorrect software setup, which can be traced to an overworked system administrator who is spending too much time helping managers with the e-mail accounts, and so on. No single person can know all this, but companies like Honda have discovered that, given a sufficiently diverse portfolio of participants, even quite complicated causal chains can be identified quickly.

What Honda understands and exploits is not only that informal social networks are valuable (albeit in unpredictable ways), but also that they can be fostered by institutionalized procedures. One question we hope to answer is, What is the optimal level of network-building activity in a company? Throwing people together for no apparent reason is obviously costly. Where do you get the maximum return on the investment? We hope to determine both what the ideal level of emphasis should be on building networks and the kind of mixing strategies that work best.

**How far off are the practical applications of network science?**

Network science suggests that our notions of cause and effect are skewed, that we’re sometimes looking at the wrong actors in the play to try to understand why the drama is unfolding the way it is.

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Practical applications like how to successfully launch a fad or design the internal architecture of a large firm are a long way off. Right now, we’re at a stage analogous to molecular biology at the time when Watson and Crick announced the discovery of the structure of DNA. The significance of their discovery was immediately clear, but it still took 50 years and a massive commitment of human and financial capital to generate the biotech industry we have today.
This is what six degrees of separation says: the idea of all living things and everything else in the world are six or fewer steps away from each other so that a chain of a friend of a friend statements can be made to connect any two people in a maximum of six steps. Let’s focus on use of the six degrees of separation for intelligence gathering and education/job search. If you’re trying to find a job or learn about a particular industry, the six degrees of separation can connect you to a great resource or potentially a mentor to help educate you. You can get a lot of information about how y

The six-degrees-of-separation school of thought was born. The phrase "six degrees of separation" was made famous by playwright John Guare, who wrote a play of the same name (later made into a film) about a young black man who scams an upscale New York couple into believing he's Sidney Poitier's son and a classmate of their children. He does the same to other members of the upscale Upper East Side community, and since they are all connected, they discover the scam. The concept also influenced science. In 1996, Duncan Watts applied the idea to his doctorate research on the mating chirps of crickets. Watts wanted to understand how large groups of crickets synchronized their chirps. He realized they do this not by listening to the whole group but to their close neighbors. Six Degrees: The Science of a Connected Age (2004 in paperback, ISBN 0-393-32542-3 and 2003 in hardcover, ISBN 0-393-04142-5) is a popular science book by Duncan J. Watts covering the application of network theory to sociology. The book covers Watts' own work on small-world networks, and continues on to cover scale-free networks, network searching, epidemics and network failures, social decision making, thresholds in networks, and innovation in large organizations and its lack.