What does it take to truly make a mark as a researcher?

Nothing Succeeds Like Success

When I was first starting out in physics, I thought that there were two kinds of scientists: those with Nobel prizes and those without. But I soon realized that there are intermediate degrees of success. The big question, however, is how achievements in science should be properly evaluated. Research work is frequently hermetic and must be assessed by people outside the given narrow field. This becomes critical when major grants are to be awarded: will they end up in good hands, will the promises be kept? Then expert evaluators get appointed, who make decisions based on evidence of previous successes. And so we come back to the issue of how to evaluate scientific success in the first place.

At one time, one simply looked at a researcher's number of publications – this offers a certain gauge of their achievements, as journals are peer-reviewed and not everything gets accepted for publication. But various journals are of unequal status, so people started to count only those in prestigious titles. But sometimes a less prestigious article may turn out to attract broader attention than a more prestigious one. So the number of citations began to be counted, a measure that remains in use today.

One short-cut way of looking at this is called the Hirsch index. If someone has an index H = 20, that means he or she has published 20 articles, each of which have been cited at least 20 times. But a few truly important papers will not give a high H value, and a single article cited even a thousand times still yields just H = 1! In physics, an H value of over 40 is considered a very good result. But here a certain skepticism is also in order. It is easier to achieve a high H in fields where many scientists are working. There is also the more general problem of the true value of having many citations. Without a doubt, many citations means that a given paper has been of some importance to many people, so it helps advance science. But does that automatically mean it is very good or original?

Once when I was starting a stay at MIT an English experimenter asked me to join what looked to be a promising theoretical project. I regretfully turned him down, because I was already collaborating on another project. A few months later it turned out that the Englishman's paper was a runaway success; today it has hundreds of citations. It has of course sometimes crossed my mind that I should have taken the offer, although I console myself a bit with the thought that the project I would have had to have abandoned was more interesting in terms of the physics involved. Citations exhibit a certain snowball effect: the more a certain article has, the more readers find out about it and cite it, and so on. And in general, readers tend to focus on well-known authors.

After a certain threshold of popularity is exceeded, citing a well-known author bolsters the prestige of the citer. Well-known scientists frequently "accumulate" the achievements of others. It is even said that only rarely do discoveries bear the names of their true discoverers. It is increasingly argued that the most famous equation in physics, $E = mc^2$, should not be ascribed to Einstein after all, as it was first correctly proved by another major figure in physics, Max Planck. In my own specialization, for instance, I know that a formula that underlies much of the now-popular field of spintronics was published in a joint paper by two Russian physicists, although in practice it is cited using the name of the second, better-known one, omitting the first. And so, success breeds more success.

Success in science is a bit like success in the world of fashion – one has to be lucky with timing. There are also certain fashionable research topics, for which it is easier to win grants and publish papers. I myself have repeatedly seen money being taken for working on a fashionable topic, but once the project was finished no one knew what to do with the results. I then recalled Indiana Jones's super-human efforts to find the Lost Ark of the Covenant, which once found gets stashed away in the farthest corner of a huge warehouse.

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Publicity can also help. Good publicity takes work, but one also needs a bit of luck. The magnificent discovery of the frescos in Faras would have enjoyed less fame if had not included the beautiful portrait of St. Anne, which became world-famous and is also included in this issue of "Academia." Before Andre Geim earned a Nobel Prize for the discovery of graphene, he came into the spotlight for a little film on the Internet, showing a live frog floating in the air above a magnet. I don't know whether Geim is well-known today more for graphene, or more for the levitating frog.

If the mechanisms described here sound somewhat skeptical, it is because they share a common denominator with the ordinary media limelight, merely playing out among a different community. But the substance of science is different than that of ordinary media topics, in that scientific achievements are constantly subject to verification by other researchers. If a success in science stands the test of time, it becomes a success of science. And successes of science, although sometimes hermetic at first, eventually change the world.

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