

Improving Research Performance

Teamwork trumps solo endeavors

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Managing the research environment involves assessing capability, but don't let stereotypes unduly affect your decisions.

This spring the world has been celebrating the 50th anniversary of one of biology's milestone discoveries – the structure of DNA. On February 28, 1953, Francis Crick boldly announced that he and James Watson of the Cavendish Laboratory in Cambridge, England, had "found the secret of life." A one-page article describing their discovery was published in the journal *Nature* in April. The "back story" of collaborations that led to this revolutionary discovery reveals significant contributions of others as well, particularly Maurice Wilkins and Rosalind Franklin. Much of the scientific world remained skeptical for a few years; it was too simple and elegant a solution. However, in 1962 Watson, Crick and Wilkins were awarded the Nobel Prize for their work.^[1]

The work of the research team that generated this discovery not only revolutionized areas of basic science, but it also generated entirely new areas of business. Stories about this discovery provide some provocative suggestions about how effective research and development teams produce results, although one must be careful about generalizing from a single case, no matter how interesting. Only with more data can generalizations be made with any confidence.

Therefore, to complement the DNA story, we offer data from a larger study of the dynamics of business management research teams. Although this study involves a different discipline, the processes of working together in a research and application/publication process are similar. Put together, these insights may be useful to those who want to create environments that encourage creative research processes or who are charged with "managing" research teams.

The Management Research Study

A scientific research project is useful only if it is "consumed" or used by other researchers to further their work, or if the findings lead to some practical application. Proprietary research for commercial development is obviously kept confidential for use by that firm. Most university research, however, and even some that is done in private firms, is published in peer-reviewed journals so that it can be widely shared and the findings can be verified by others.

One way of measuring the impact of a published study is to count how often it is cited by later researchers in their work. Citations provide an "objective" measure that reflects the degree to which researchers perceive the work of others as relevant or useful to their own.^[2] Fortunately, with the advent of modern computer technology, this type of tracking information is readily available. The focus of this management research project was on identifying characteristics of research teams that are associated with more significant research results as measured by greater numbers of citations.

Briefly, the project involved selecting all of the articles published in six of the top-rated management journals in one year and then determining how many times each of the articles was cited in other works in the following six years.^[3] The larger the number of

citations, the greater the assumed impact of that article. The researcher characteristics included whether there was a single author or a team, and if a team, the number of authors; the gender of each author; the composition of the team in terms of gender; and the gender of the lead author on mixed-gender teams.^[4] The capability of each author was also noted. As a proxy for capability, we used the number of articles the individual had published in our list of six top-rated journals over the ten years prior to our base year, weighting the results by whether the author was lead, second or third author on the article.

What Do the Results Suggest about Successful Research Teams?

An Individual or a Team?

Is discovery best made by the lone researcher working diligently at his or her lab station or computer, or are there synergies that occur when two or more people work together that enhance the quality of the final product?

As mentioned above, Watson and Crick were the first to discover the structure of DNA. As a team they encouraged one another and challenged each other's thinking. In Watson's own words, ". . . we had each other. It helps to have someone else to take over the thinking when you get frustrated."^[5] They also had significant help from Wilkins, and to some degree from Franklin. Additionally, one of Franklin's photographs was critical to Watson's seeing the solution.^[6] Crystallographer Jerry Donohue also made important contributions at a crucial time.^[7]

Their chief competitor, at least in their eyes, was Linus Pauling. Though he was working alone, Pauling almost figured out the solution ahead of them, but the fact remains that it was the team that won.

Turning to the case of management researchers, it is clear that multiple authorship is increasingly the norm in management publications. Although publication pressures may be a factor in the growing popularity of multiple-author articles by academic researchers, it also appears that synergy develops as researchers pool their expertise and resources, thus enhancing the quality of the final product. Our data show that teams had significantly more citations for their articles than did individual authors and that teams of three did better than teams of two.

We did not include four- and five-author articles in the statistical analysis because there were too few of them, but a review of those we did have showed a trend toward a lower research significance than that of the three-author articles. Given our small numbers, we cannot make any strong inferences here, but we speculate that the challenges of coordinating more than three people's work may outweigh the benefits received from the additional expertise and resources that they bring to the table.

Capability of the Researchers

The number of minds contributing to a project may impact the significance of the research outcomes, but the ability of team members should also make a difference. We found this definitely to be the case in the management research study. Those who published more during the ten years prior to our study (our proxy measure for capability) produced articles in our sample that were cited significantly more often than articles of those who published less. First, experience may enhance a researcher's understanding of what it takes to produce high quality work in the field. In addition, and no doubt more important, some people simply are more capable scholars and researchers than others, and that fact is recognized by others as they consider the significance of published works.

The capability of the authors also enhanced the impact of the number of authors on the significance of the research. Assuming that synergies result from the combined efforts of researchers, adding capable individuals to a team does more for the significance of the work than does adding less capable individuals, as would be expected. That is, this feature does not operate independently.

In the example of the DNA researchers, clearly all of those involved were extremely capable, although in the case of Watson and Crick, their expertise has been validated more by their work after the DNA discovery than by what they accomplished prior to it since they were both just beginning their careers at that time.

What about Gender?

Some types of diversity are important in team research. People with different specific skill sets may be required for the project. People who have different intellectual foundations may provide a challenge to conventional thinking that sparks new insights. Some kinds of diversity may be considered for other reasons, even if there is no specific relationship to the team project. Gender is one such aspect of diversity. Although it is not the only social characteristic that may be of interest, it is one that we investigated.

Research has demonstrated that men have generally enjoyed greater recognition for their work than have women. While there has been some change, many stereotypes remain.^[8] However, even if this is true for single-person research, the dynamics may shift when dealing with multiple-member teams. Some have suggested that female leaders more naturally integrate the contributions of the group than do men and that this tendency may yield superior outcomes. A growing body of research has demonstrated that women are more likely than are men to have mastered "the patient skills of relationship development, communication, and social sensitivity,"^[9] all of which should improve synergy formation within a research team. However, it should be noted that there are others who take issue with the notion that men and women manage differently.^[10]

In our project on management research, the gender of the authors involved in the study did affect the significance of the publication effort in one particular way. We found no significant difference in the number of citations for either male and female single-author articles or single-gender teams. However, when the teams were composed of both men and women, female-led teams were more often cited than were male-led teams, thus providing preliminary support for the notion that women may be more effective than men at integrating the contributions of research team members. However, same-gender teams were more frequently cited than were mixed-gender teams.

Although the literature proposes that diversity should enhance creativity and decision making, it also indicates that diversity may also lead to a greater degree of interpersonal conflict and breakdowns in communication.^[11] Gender was our only measure of diversity in team membership, although it is not the only type of diversity that matters. However, the finding that single-gender teams were more effective than mixed-gender teams is of interest.

The relationship of Franklin, Wilkins, Watson and Crick would also seem to support the concept that some types of diversity may lead to interpersonal conflict. Franklin is widely reported to have had a "prickly" personality and to have been a difficult person with whom to work. Clearly she was not the model for women having mastered the patient skills of relationship development and social sensitivity. She reportedly threatened to physically assault both Wilkins and Watson (on separate occasions) if they did not leave her laboratory, shared experiences that seemed to have cemented the relationship between the two men. On the other hand, they seemed to treat her as less than a colleague and had difficulty dealing with such a strong woman.^[12] Franklin might well have done better work with another woman, but that was not an option at the time.

Final Thoughts

A recent research study on knowledge transfer among research scientists^[13] examined the question of what affects the willingness of scientists to share information and how this sharing may affect their work. The results indicate that both the quality of social relationships among individuals and the degree of competition between them affect their willingness to exchange information. Obviously proprietary information should not be, and usually is not, shared. However, more knowledge and experience can often be very helpful to others, especially tacit or nonverbal knowledge that is not readily available in printed form. Three key factors were identified as affecting the willingness to share and the quality of the information shared. One is the strength of the personal relationships between individuals; the others are the degree of competition between their teams or firms and the degree to which there is an expectation of reciprocity.

While our quantitative data cannot address these questions, the DNA discovery does illustrate these findings. Watson and Crick worked separately from Wilkins and Franklin and used different methods to approach the problem. Nevertheless, the three men in particular shared a great deal of information about their work and what they were finding. There was some competition, but also a high level of reciprocity. The nature of the men's personal relationships with Franklin, including both their chauvinism and her independent streak and personality, resulted in their sharing less with her. However, even with Franklin, there was some informal sharing. When Watson and Crick were officially pulled off of the DNA project and reassigned to other studies (after committing a major research gaffe), they sent their models to Wilkins and Franklin to help them in their work. They wanted to see their friends discover the structure of DNA rather than someone they viewed as a competitor. The informal exchange among the four of them played a critical role in reaching their goal. With Pauling, on the other hand, the relationship was strictly competitive. Pauling had written to the laboratory for which Franklin worked requesting copies of the DNA photographs. This request was refused. Apparently no expectation of reciprocity existed, and there were no established social bonds upon which to draw.

Implications for Practice

What does all of this suggest for the management of research teams?

- First, try to recruit the most capable people you can. Previous professional accomplishments are certainly one measure of capability and should be considered. It also is important to learn how to judge and recruit bright, eager newcomers. Neither Watson nor Crick had much of a history of success when they figured out the structure of DNA, but they were broadly knowledgeable, obsessed with the problem at hand, and convinced they could solve it.
- Next, the data suggest that teams are likely to be more productive than are individuals. However, it is important to remember that it is the interaction of the size and capability of the team that produces the best results. Simply adding more people for the sake of numbers may not help. Furthermore, it is likely that teamwork produces a curvilinear relationship. The exact number may vary by type of project, but after some point, the effort to coordinate the work and personalities of more people outweighs their additional contributions.
- Third, our one measure of diversity was gender. While it cannot be used as a proxy for all forms of diversity, it is an important one. Our research suggests at least a couple of things about gender diversity.
 - First, men and women were equally successful, both as individual authors and as members of single-gender teams.

- Second, the single-gender teams were more successful, by our measures, than were the mixed-gender teams. While there may be good reasons for creating gender-diverse teams, doing so to improve performance may be questionable.
- If you have mixed gender teams, don't assume that the traditional male leadership model always works best. Our data suggest that women may, in fact, be better than men at integrating and organizing the work of other team members.
- Finally, a culture of sharing across teams may lead to payoffs. Teams within a firm may be competitive in terms of resources and attention, but if this competition carries over to the point that teams are reluctant to share information and tacit knowledge, it can hinder everyone's work. In fact, sharing non-proprietary knowledge, even with those outside of the firm, may be useful when there is a high expectation of reciprocity in these relationships. However, such sharing should be moderated according to the level of competition and the uniqueness of the information.

1 At first a collaborator with Maurice Wilkins and then an independent researcher, Rosalind Franklin was a crystallographer whose x-ray photographs of DNA contributed greatly to the solution that Watson and Crick discovered. Franklin died from ovarian cancer in 1958 at age 37, most likely due to her constant exposure to x-rays. Arguably, she should have shared in the Nobel Prize. Her early death saved the Nobel Committee a difficult decision, since they do not award the prize to more than three people for the same discovery. Because they do not award the prize posthumously either, Franklin did not have to be considered. See Michael D. Lemonick, "The DNA Revolution: A Twist of Fate," *TIME*, 48 (February 17, 2003) for a longer account of the collaboration.

2 It is important to note that citation analysis is not without its flaws, despite its popularity. For example, some writers may cite a work to highlight its shortcomings or to undeservedly showcase their own publications (i.e., engage in self-citation) for the sake of increasing their own recognition. [See J. M. Newman & E. Cooper, "Determinants of Academic Recognition: The Case of the Journal of Applied Psychology," *Journal of Applied Psychology*, 78, (1993), p. 518-526]. However, empirical evidence has already demonstrated that citation volume is strongly correlated with some measures of quality, such as the author's research productivity in the hard sciences. [L. R. Jauch & W. S. Glueck, "Evaluation of University Professors' Research Performance," *Management Science*, 22, (1975), p. 66-75], or the probability of winning a prestigious award or Nobel Prize [S. Cole & J. Cole, "Scientific Output and Recognition: A Study in the Operation of the Reward System in Science," *American Sociological Review*, (1967), p. 377-390; C. R. Myers, "Journal Citations and Scientific Eminence in Contemporary Psychology," *American Psychologist*, (1970), p. 1041-1048].

3 We considered this time frame appropriate since citations increased from the baseline established in the first year of our time frame and returned nearly to that level or below it in the last year for the journals assessed.

4 The convention in most published research work in the field of management is that the name of the person who has contributed the most to the research is listed first.

5 Michael Lemonick, "The DNA Revolution/Interview," *TIME*, (February 17, 2003), p. 52.

6 Lemonick, "The DNA Revolution: A Twist of Fate."

7 Ibid.

8 R. L. Helmreich, J. T. Spence, W. E. Beane, G. W. Lucker, & K. A. Matthews, "Making It in Academic Psychology: Demographic and Personality Correlates of Attainment," *Journal of Personality and Social Psychology*, 39, (1980), p. 896-908; R. C. Rodgers & C. L. Maranto, "Causal Models of Publishing Productivity in Psychology," *Journal of Applied Psychology*, (1989), p. 636-649; H. Zuckerman & J. Cole, "Women in American Science," *Minerva*, (1975), p. 82-102. P. W. Hamilton, "Running in Place," *D & B Reports*, 42, (1993), p. 24;

Janet Romaine, "Disappearing Acts: Gender, Power, and Relational Practice at Work," (Book Review), *Relations Industrielles*, 57 (Winter 2002), p. 201-203.

[9](#) M. Jelinek, & N. J. Adler, N. J.. "Women: World-Class Managers for Global Competition," *Academy of Management Executive*, 2 (1988), p. 11-20.

[10](#) Powell (1990).

[11](#) Cox (1991).

[12](#) Lemonick, *The DNA Revolution: A Twist of Fate*.

[13](#) Ariff Kachra, *Reciprocity and Knowledge Transfer: The Role of Social and Economic Factors*, doctoral dissertation, The University of Western Ontario, 2002.