Invited Editorial

Novel Collaborations within Experienced Teams Lead to Best Research Outcomes

Evita premiered on Broadway at the Broadway Theatre on September 25, 1979. The production ran for an incredible 1,567 performances and won a remarkable seven Tony Awards, including best book, best score, and best musical of the year. *Evita* was Andrew Lloyd Webber's last show with Tim Rice before he went on to less successful collaborations. A third key member of the creative team was Harold Prince, the director of numerous groundbreaking productions such as *Cabaret* and *West Side Story*.

Evita is loosely based on the life of Eva Peron, the charismatic wife of post-World War II Argentine president Juan Peron. Rice builds a compelling story around Eva Peron's rise from poverty to power. The impact of the story is augmented by Lloyd Webber's Latin-inspired music. *Evita*'s showstopper is ''Don't Cry for Me, Argentina,'' but the score includes many other hits.

At this point, even fans of *Chicago Hope* and of Mandy Patinkin, who played Che Guevara in the original production of *Evita*, may be starting to wonder what relevance all this Broadway ''stuff'' has to vascular surgery. As it turns out, the creation of a Broadway musical shares many similarities with other creative endeavors, such as scientific research. In a recent manuscript published in *Science*,[1] my coworkers and I investigated the mechanisms by which teams of creative agents self-assemble and how those assembly mechanisms determine the success of the teams.

Assembling creative teams. Whether in theater, astronomy, social psychology, or surgery, teams are assembled because of the need to incorporate individuals with different ideas, skills, and resources. Moreover, team members who are outsiders to the field can effectively bring innovations proven in their area of expertise to the new domain. Team diversity thus has the potential to spur innovation. However, research suggests that the right balance of diversity on a team is elusive. While diversity may potentially spur creativity, it typically promotes conflict and miscommunication and it runs counter to the security most individuals experience in working and sharing ideas with past collaborators.

In the article in *Science*,[1] we analyzed data from the Broadway musical industry and the scientific disciplines of social psychology, economics, ecology, and astronomy. In a break with past research, we quantified team diversity primarily according to the team members' experience and collaboration history. Some agents are newcomers—rookies—with no reputation in the field and, perhaps, unseasoned skills. Other agents are incumbents. They are established persons with a track record, a reputation, and identifiable talents.

The distribution of different types of agent and their past histories reflects the team's underlying diversity. For example, if teams have a preponderance of repeated collaborations between incumbents, it is less likely that they will have innovative ideas because their shared experiences tend to homogenize their pool of knowledge. In contrast, teams with a variety of types of agent are likely to have more diverse perspectives and, therefore, to contribute more innovative solutions.

The effect of team composition on output quality. To test the influence of team diversity on the quality of the team's creation, we analyzed teams publishing in scientific journals with different reputations, as measured by their impact factor. We found that the fraction of incumbents was positively correlated with impact factor for economics, ecology, and social psychology, whereas the likelihood of incumbents repeating past collaborations was negatively correlated with impact factor for the same fields. These findings support the idea that successful teams have a higher fraction of incumbents, who contribute expertise and know-how to the team, but that some of these incumbents have never collaborated before.

Remarkably, we found that the successful teams in the musical industry, economics, ecology, and social psychology have very similar values for the fraction of incumbents in the team and for the likelihood of repeating past collaborations. An

intriguing question prompted by our results is, Are the same mechanisms at play within medical research teams, in general, and vascular surgery research teams, in particular? If the same mechanisms are at play, what does this imply for individual researchers, research administrators, and funding agencies?

Implications of individual choices on field structure. A remarkable finding of our study was the effect of team assembly on the entire structure of the collaboration network of a field. Teams publishing in high-quality journals give rise, due to the existence of new collaborations among incumbents, to a giant cluster connecting around half of the published authors in the journal. This implies that there is a chain—in fact, a *short* chain—of intermediaries connecting about half of the authors in the journal. This has important implications for the spread of knowledge generated within the field among all researchers. If the majority of the researchers in a field are within close reach, then those researchers are able to easily obtain the know-how necessary to implement novel discoveries. Moreover, the community of researchers forming a field is more likely to *efficiently* agree on ''best practices.''

In contrast, teams publishing in low-quality journals give rise to a collaboration network comprised of many small clusters of authors. The lack of connections among clusters will likely decrease the flow of knowledge among researchers. In a medical context, this could have important consequences as best methods may not be adopted soon enough or even widely enough.

The contrast between the two situations just described is clearly relevant to the decisions that funding agencies and research administrators must make concerning the role and importance of collaborative research. Moreover, it must also direct the way in which individual researchers develop plans for future collaborations.

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DOI: 10.1007/s10016-005-8674-7
Published online: October 24, 2005