17 Team Assembly

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17.1 Introduction

The study of team assembly is a crucial area of research for the team science community. Not only are teams an essential component of the scientific enterprise (Falk-Krzesinski et al. 2010; Katz and Martin 1997), but there are now more observational data available to help understand the team assembly process (Pentland 2012). As a result, there is currently a convergence of social science theory, readily available digital data traces, and web-based technologies that leverage theories and insights from multiple domains to better understand and enable team assembly (Contractor 2013). The convergence could not have come at a better time. With the uncertainty surrounding scientific research funding, providing researchers with insights into the assembly of effective teams will aid them in maximizing their chances for scientific success and innovation.

Much scientific achievement relies on well-functioning and effective teams (Kozlowski and Bell 2019; Kozlowski and Ilgen 2006; Mathieu et al. 2008; National Research Council 2015; Shneiderman 2016). Science teams are required to effectively combine knowledge to produce novel, high-impact products (Uzzi et al. 2013). Facilitating such high-impact scientific research requires the allocation and coordination of many resources, including people, samples, equipment, and computational facilities (Shrum et al. 2007). Leveraging these scarce and needed resources makes collaboration a necessity, distributed teams more common, and interdisciplinary research essential in the current science environment (Cummings and Kiesler 2014). The prevalence of multi-university science teams who publish high-impact research is indicative of the need to assemble qualified teams despite such constraints (Jones et al. 2008). Additionally, international collaborations have become key for scientific growth (Coccia and Wang 2016). Unfortunately, science teams collaborating in

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these situations may report less productive outcomes and face higher coordination costs (Cummings and Kiesler 2007).

In addition to the move towards multi-university, geographically distributed teams, science is increasingly turning to interdisciplinary teams. Interdisciplinary research is valuable because taking a problem-based perspective for conducting research focuses on addressing a problem while not being confined within the traditions of a single discipline (Jacobs and Frickel 2009). However, most organizations still maintain disciplinary foci and rely on individuals and teams to span the necessary boundaries to conduct scientific research involving multiple disciplines (Ancona and Caldwell 1992a; Dahlander and McFarland 2013). The organizational structure influences the performance of interdisciplinary teams because locating people with needed knowledge is often the responsibility of people who already have cross-disciplinary and interdepartmental connections (Burt 2004, 2009; Hansen 1999; Reagans and McEvily 2003; Singh et al. 2010). The creation of interdisciplinary research centers is a solution that has been enacted to alleviate some knowledge transfer issues that occur within research organizations (Dahlander and McFarland 2013; Jacobs and Frickel 2009). The presence of such centers is an example of the commitment made to assembling productive interdisciplinary research teams, but coordination challenges still arise due to distance when different center-affiliated departments are not in close physical proximity (Birnholtz et al. 2012; Nomura et al. 2008).

Clearly, assembling interdisciplinary teams is critical for, but not a guarantee of, success. The demand to assemble interdisciplinary teams is stimulated by the increase in interdisciplinary initiatives by funding agencies. Analyses of National Science Foundation (NSF) project proposals for two interdisciplinary initiatives show that researchers who win highly competitive research awards and grants have successful prior collaboration records with team members but cite different bodies of knowledge increasing the odds for offering new insights based on novel combination of ideas (Lungeanu et al. 2014). Collaboration is not the only requirement for success, but assembling a team of people who have demonstrated the ability to work well together and provide different perspectives is essential for winning a research grant. However, even the grant-winning research teams face challenges. One such challenge is the productivity penalty encountered by interdisciplinary researchers. The complexity in navigating across multiple scientific communities results in some researchers having lower productivity (Leahey et al. 2016).

Because specific combinations of people affect performance, developing an understanding of the factors that impact team assembly is crucial. Collaboration in teams has long been an important component of many work tasks in scientific research (Hagstrom 1964; Leahey 2016). Effectively managing relationships within a team plays a key role in team performance, and simply put, assembling the wrong people into a team can derail a project from its beginning (Gewin 2015). To avoid such derailment, developing and openly communicating expectations before beginning a collaborative project is a useful strategy to help increase the chances of having a productive collaboration (Gadlin and Jessar 2002). Considering factors other than expertise when assembling a team is a necessity given the recent empirical evidence showing trends of increasing collaboration (Leahey 2016; Wuchty et al. 2007). As an example, the team size in scientific fields has been increasing over time (Guimerà et al. 2005; Lee et al. 2015; Milojević 2014; Valderas 2007). Additionally, incorporating new team members when assembling teams promotes new ideas and perspectives since performance suffers with repeated collaborations (Guimerà et al. 2005; Reagans et al. 2004; Rink et al. 2013; Skilton and Dooley 2010). We conceptualize team assembly to be broader than the related concept of team composition because we consider not only the individual and team characteristics but also the impact of broader social networks and the organizing processes within which these teams assemble (Humphrey and Aime 2014). Specifically, we delineate the factors influencing team assembly into perspectives operating at

Table 17.1 Key concepts and definitions

Key concept	Concise definition
Team assembly	Factors leading to the formation of teams
Staff-assembled team	A team whose members are staffed by a person either in the team or someone outside the team. The team members have low agency in the selection of the members. In some cases, a manager will staff a team.
Self-assembled team	A team whose members self-select into the team. The team members have high agency in the selection of the members. Research, creative, and consultant teams are more often self-assembled than teams in other industries.
Compositional perspective	Explaining team assembly based on the individual attributes of the members in the nucleating team.
Relational perspective	Explaining team assembly based on prior and current social relationships that exist both among members of the nucleating team as well as with others outside the team.
Ecosystem perspective	Explaining team assembly based on the interlocking structure of teams within which the nucleating team is embedded.
Apprentice-based collaboration	Collaborations that include a senior researcher working with others of lower experience levels, including, –but not limited to –students, technicians, and other researchers
Peer collaboration	Collaborations among researchers at the same career level. For example, student-student collaborations.

three levels: a compositional perspective, relational perspective, and an ecosystem perspective. Our goal for this chapter is to provide a review of the team assembly literature when teams are either staffed or self-assembled. Additionally, we highlight the potential role that technology plays in assembling and studying the team assembly process. The key concepts associated with this chapter are listed and defined in Table 17.1.

17.2 Chapter Roadmap

We begin the chapter by distinguishing between two types of team assembly: *staffed* and *self-assembled*. A staffed team is one that is appointed by a person either outside the team or by a person within the team who mandates participation by others. Self-assembled teams are those where individuals have more agency in self-organizing into teams. It is possible for teams to be a hybrid of both assembly types. As an example, a large research team may form based on the self-assembly into a team by a group of senior researchers. However, they might then staff teams that work on various components of the project. Detailing both *team staffing* and *team self-assembly* provides coverage for how such a hybrid research collaboration is assembled.

Recognizing these differences in the ways in which teams assemble, we next turn to the different perspectives relevant for assembling teams. Clearly, it is important to consider the qualifications, expertise, and abilities of each team member to help ensure the success of projects (Bell 2007; Cooke et al. 2015; Nurius and Kemp 2019; Woolley et al. 2008). The characteristics of team members are then aggregated to give an indication of the entire team's ability to perform (Klein and Kozlowski 2000; Kozlowski and Klein 2000). Using information about individuals' characteristics or attributes as criteria for team assembly reflects what we define as the *compositional* perspective.

However, it is also evident that simply having a collection of individuals with the requisite expertise is a necessary, but not sufficient, condition for success. Research has increasingly considered the relationships, interactions, and the match (similarity or complementarity) of individuals' attributes as important factors influencing team performances. We define the consideration of these criteria for team assembly as the *relational* perspective. There is a growing body of research using the relational perspective. For example, teams whose members have had prior collaborations are more creative and productive across multiple domains (Guimerà et al. 2005; Perretti and Negro 2007; Skilton and Dooley 2010; Uzzi and Spiro 2005), teams composed of friends have more positive work experiences (Jehn and Shah 1997; Ren et al. 2014; Shah and Jehn 1993), and accessing and utilizing diverse knowledge in a team relies on interpersonal networks (Reagans and McEvily 2003; Reagans et al. 2016; Reagans et al. 2004; Reagans and Zuckerman 2001). Quite simply, people's prior relationships influence their assembly into a team and its subsequent performance.

In addition to the compositional and relational perspectives, team assembly is also influenced by the larger networks of prior and current teams where individuals have membership. Working on multiple scientific teams simultaneously is a reality facing most science professionals (González and Mark 2004; Hudson et al. 2002; Scupelli et al. 2005). Individuals on these multiple teams each have members who are in turn on multiple other teams. Some of the membership across these teams overlaps, creating team interlocks. A team interlock exists between two teams that share one or more members (Lungeanu et al. 2018). The collection of teams who are connected by team interlocks to other teams that are in turn connected to even more teams results in an ecosystem of teams. Recent research shows that forces within the ecosystem explain the assembly and performance of teams above and beyond what is explained from a compositional or relational perspective. We refer to this approach as the *ecosystem perspective*. Competing commitments and obligations of the ecosystem often influence a person's ability to collaborate in teams based on the environment (Mortensen 2014). As a result, many professionals have multiteam memberships and competing task dynamics that affect the amount of engagement that one gives to any team at a single point in time (O'Leary et al. 2011; Wageman et al. 2012). On the positive side, information spreading through team interlocks also has the potential to bring new ideas and resources to a team. Therefore, the larger ecosystem in which a team is embedded influences the nature of collaboration and the dynamics of team assembly. To summarize, team assembly must be understood as being influenced by factors operating at three levels—compositional, relational, and ecosystem perspectives.

Following an elucidation of factors influencing team assembly from these three perspectives, we will consider the potential role of technology in enabling and understanding team assembly. While a much deeper treatment of research networking systems is offered in the following chapter (Weber and Yuan 2019), we focus here on how technology can leverage insights from research on team assembly to facilitate the formation of more effective teams. Many of today's social interactions are mediated through technology, and many teams use online platforms such as communities and forums, social media, shared document editing software, and messaging applications to collaborate and coordinate around their work tasks. Many of these online platforms, such as nanoHUB, GitHub, and other open-source software development networks, require individuals to self-assemble into teams (Dabbish et al. 2012; Hahn et al. 2008; Hertel et al. 2003; Margolin et al. 2012). However, there is a pressing need for these platforms to improve their ability to provide members with evidence-based tools to assemble into effective teams. In other words, there is a need for developing the equivalent of matchmaking tools like match.com, eHarmony, and Tinder to help assemble teams. Lastly and relatedly, the emergence and use of these matchmaking tools to enable team assembly also have the collateral benefit of providing researchers with data to further advance our understanding of team assembly and collaboration at scale.

17.3 Types of Team Assembly

Key Takeaway: An outside authority is responsible for the performance of a staffed team, while self-assembled teams are responsible for their own success.

In scientific research, as in other domains, there are at least two ways in which teams assemble: staff-assembled and self-assembled. People are either assigned to a specific team or self-assemble. In this chapter, staffing a team is analogous to assigning members to a team, and the terms are used interchangeably. There are different considerations to be made by those who need to staff a team in which they may also be a member as compared to those who self-assemble into a team.

17.3.1 Staffed Teams

The staffer of a team may be a principal investigator of a research laboratory, a manager within an organization, or an administrator of scientific research. Additionally, the staffer typically will have responsibility for the team's performance and must attempt to predict a team's potential for achieving the desired goals (Reagans et al. 2004). A staffer, who may or may not be a member of the team, will also seek to ensure that the members of staffed teams meet requirements for skills and diversity, but the team members ultimately have to be willing to utilize the same factors that the staffer and management deem to be necessary requirements for work (Aalbers et al. 2013; Shin et al. 2012). In staff-assembled teams, member understandably feel low agency as compared to self-assembled teams (Contractor 2013; Hackman 1987). Hence, when staffing teams, there is a risk that members will have lower commitment since they did not have much agency to choose the teammates with which they must work (Colquitt et al. 2007; Deci and Ryan 2002). Therefore, a team staffer needs to be cognizant of the planned tasks, requirements for the team members, and expectations for the team processes needed to achieve successful performance outcomes (Stevens and Campion 1999; Thompson 2018).

Staffing a team is a core component of the apprentice-based collaboration model in science where a scientist with some form of authority is making decisions about the students and technicians whose work will be needed to accomplish the scientific goals of the team (Hagstrom 1964). When staffing a team in such a scenario, it is necessary for the staffer to provide well-defined plans and articulate performance expectations because teams vary in their abilities to guide themselves (Hackman et al. 1976). In addition to having a developed task, plans, and expectations, a team staffer will also need to consider the characteristics of the team itself with regard to the abilities of the members, the overall diversity of the team, and imposed constraints from higher levels of management or the organization (Thompson 2018). A team staffer needs to rely upon compositional attributes like the personality, mental ability, and teamwork skills of potential team members when making selections for a team (Stevens and Campion 1999; Zaccaro and Dirosa 2012). Staffing a team places much of the responsibility for the team's performance on a person who the person staffing in the collaboration.

17.3.2 Self-Assembled Teams

Self-assembly generally suggests a bottom-up process where actors self-organize themselves (Pelesko 2007). Some scientific teams are commonly self-assembled and exist in a dynamic environment where people freely work with multiple collaborators (Wang and Hicks 2015). A computational model for team assembly only using team size, the fraction of newcomers, and the tendency to repeat collaborations reproduced the empirical trends of co-authorship in multiple scientific fields (Guimerà et al. 2005). While the self-assembly of these high-impact science teams was explained by simple organizing principles, the teams achieved great impact.

Historically, science has been associated with independence and intellectual freedom for the scientists participating in the enterprise (Fox and Faver 1984). Despite the autonomy of choice, collaboration is necessary for most scientists and self-assembling teams is a manifestation of the agency of people to collaborate with who they choose. People who have such independence are also able to engage in "dating" collaborations where they can learn about new teammates, even strangers, through small projects before agreeing to longer duration, high-commitment projects (Lykourentzou et al. 2017; Lykourentzou et al. 2016). Teams with the autonomy to identify and then select people for the given task requirements have a better understanding of the needed skills and work for a team to be successful, and can adjust to the task requirements through their selection of members (Harrison and Humphrey 2010). The ability to self-assemble is indicative of the peer collaboration model in science where people exercise agency in deciding with whom to collaborate, in contrast with the apprentice-based collaboration model where staffed teams are more prevalent (Hagstrom 1964).

Team members who self-assemble are responsible for making choices based on personal motivations and consider the complementary skills and skill levels of potential team members (Zhu et al. 2013) as well as social norms in a research environment (Kraut et al. 1987). When self-assembled teams are composed of friends and acquaintances, the teams tend to perform better than staff-assembled teams (Jehn and Shah 1997). Self-assembled teams that are successful also tend to collaborate with one another again for knowledge-intensive projects (Hahn et al. 2008). As suggested earlier, the preference of people to self-assemble into teams is related to their self-determination and agency, which positively influences intrinsic motivation (Bandura 1989; Deci and Ryan 2002). Following this logic, people will be more motivated to work on a team if they have agency in assembling it. People who collaborate in autonomous work groups have more positive attitudes and are more socially motivated by their teammates (Cordery et al. 1991; Grant and Berry 2011). Self-assembling teams have responsibility for their own abilities, and they design their own collaborations.

17.4 Perspectives on Team Assembly

Key Takeaway: Team assembly combines compositional, relational, and ecosystem perspectives, resulting in a multilevel, holistic understanding of the process.

Regardless of whether a team is staffed or self-assembled, there are expectations that a given team will be able to perform and achieve a stated goal. For this reason, using all available information when assembling a team will aid the team in performing well. Designing, or at least understanding, the work context and the tasks being planned for the team is a key consideration in team assembly and requires multiple types of characteristics (Morgeson and Humphrey 2008). There are factors at multiple levels that influence a team, and the science of team science benefits from considering the individual level to the system level (Börner et al. 2010). Using information about the composition of the team (compositional), the collaboration network (relational), and structural features in which the teams are embedded (ecosystem) helps explain productivity and key team processes (Bercovitz and Feldman 2011; Reagans et al. 2004; Stvilia et al. 2011). For many science teams, their work occurs in concert with other teams through the sharing of facilities and resources (Dahlander and McFarland 2013; Jacobs and Frickel 2009; Shrum et al. 2007). Accounting for such interdependencies and contextual factors when assembling teams helps create productive teams for the modern scientific environment.

A helpful example to illustrate the usefulness of using factors at multiple levels is the assembly of teams in the field of cancer research. The demands for diverse skills and perspectives required for cancer research create many opportunities for collaboration and interaction among multiple disciplines (Savage 2018). This results in a large-scale effort of multiple teams to develop solutions to provide better treatment and prevention of cancer (Saporito 2013). There are numerous teams who are composed of highly trained individuals who specialize in some area of inquiry; have interdependencies within the team based on sharing information, results, and research data; and coordinate their research efforts with other science teams researching novel solutions for curing cancer. The fact that science teams are researching in concert with other teams is a manifestation of the notion of "teaming"—the notion that modern, high-impact teams are more dynamic with respect to their membership and individuals are connected to multiple teams based on needs at a given moment (Edmondson 2012a, 2012b). Using the cancer research example to illustrate this point, it is not uncommon for multiple teams to share the same imaging specialist because there may be a finite number of research centers with the resources to perform a specific type of imaging. In such a case, the imaging specialist is a valued team member for multiple teams and focuses her work based on multiple needs of different teams.

There are countless other examples of how reflecting upon a team's composition, relationships, and embeddedness within a larger ecosystem will influence the productivity of a science team. Therefore, a practitioner who is cognizant about factors at each level will be able to apply the different perspectives as needed when assembling a team. The members, team context, and organizational context have long been used as inputs to explain effective teams (Mathieu et al. 2008). Including these types of inputs when reflecting upon team assembly further demonstrates the complexity of teams and how to consider the interactions between members (Arrow et al. 2000; Katz et al. 2004). Recognizing these three perspectives will enable a practitioner to be more knowledgeable about assembling high performance teams.

17.4.1 Compositional Perspective of Team Assembly

Teams are important for scientific research, but how are effective, well-performing teams assembled? There is some risk associated with balancing innovative research approaches with traditional and familiar ones (Foster et al. 2015), and assembling the right team helps mitigate some of this risk. When assembling teams, there are numerous factors to consider, including personality and competence in the team (Cable and Edwards 2004; Humphrey et al. 2007; Moynihan and Peterson 2001; Nurius and Kemp 2019; Rulke and Rau 2000), demography (Duguid 2011; Duguid et al. 2012; Gibbs et al. 2019; Joshi and Roh 2009; Williams and O'Reilly 1998), and the requirements of the project (Thompson 2018).

When assembling teams, the members' individual attributes are important in determining the type of team being assembled and the potential for performance. There are numerous individual attributes that contribute to the assembly of effective teams. Individual cognitive ability is important for the completion of individual work tasks and for consideration when assembling teams. However, in addition to the cognitive ability of team members, there are multiple factors that determine the team-level cognitive ability or intelligence (Devine and Philips 2001; Woolley et al. 2010). For example, the ability to integrate and coordinate expertise within a team (Faraj and Sproull 2000), and the inclusion of teamwork skills, personality, and diversity should all be used when assembling teams because these factors affect team performance (Arrow et al. 2000; Mathieu et al. 2008).

Assembling a team also requires diligence in identifying explicit criteria for composition when selecting the most appropriate members for a given team (Stevens and Campion 1999). Including multiple types of individuals is helpful when predicting the performance of an assembled team. As an example, combining personality traits, such as extraversion and emotional stability, along with the ability of team members, explains positive supervisor ratings for team performance and team viability (Barrick et al. 1998). Decision-making teams with a hierarchy are more accurate in their decisions when the leader and other members have high cognitive ability and conscientiousness (LePine et al. 1997). In addition to cognitive ability, personality, and technical competencies, other knowledge, skills, and abilities (KSA) are needed for productive collaboration in teams. KSA for teamwork are a set of attributes that help account for necessary interactions within a team collaboration environment (Kozlowski and Ilgen 2006; Stevens and Campion 1994). KSA differ from technical competencies because a successful team needs people who are not only capable of accomplishing their tasks, but also performing interpersonal and management functions that help the team collectively accomplish their goals (Klimoski and Jones 1995; Stevens and Campion 1994). Overall, social skills, experience in teams, and personality are important for assembling teams because belonging to a team is a social activity where team members will need to engage beyond the work tasks and the abilities of team members (Lepine and Dyne 2001; LePine et al. 2000; Morgeson et al. 2005).

In addition to surface level composition factors (such as age and gender), combinations of deep-level composition factors explain team performance in a variety of settings (Bell 2007). A meta-analysis of 89 studies showed that the relationship between compositional variables and team performance differed in field and laboratory research settings. Most field settings focused on the performance of physical teams, and the following personality traits emerged as consistent predictors of team performance: team minimum agreeableness and team mean conscientiousness, openness to experience, collectivism, and preference for teamwork. Meanwhile, laboratory settings mostly focused on the performance of intellectual teams, and only negligible effects were observed for the relationships between personality traits and team performance. The important factors related to team performance in laboratory settings were team minimum general mental ability, maximum general mental ability, and team mean emotional intelligence (Bell 2007). The meta-analysis highlights the value of using personality traits and combinations of traits when studying teams in specific types of settings.

In addition, compositional perspectives have also considered the heterogeneity that exists among team members. For science teams, the presence of multiple disciplines within the team is often required or desirable (Jacobs and Frickel 2009; Leahey 2016; Leahey et al. 2016; Lungeanu et al. 2014). The purpose of interdisciplinary teams is to incorporate different perspectives towards a single problem's solution. Appreciating heterogeneity helps to ensure a proper understanding of the team's composition, the roles that members possess within a team, and the expectations for performance of a team (Humphrey et al. 2009; Klein et al. 1994; Stewart 2006; Welbourne et al. 1998). When determining the fit of heterogeneous team members, the fit of members along personality and skills brings deeper understanding to a team's composition (Cable and Edwards 2004; Hollenbeck et al. 2002; Humphrey et al. 2007).

There are two views of fit that determine whether a team should include a given member: supplementary fit and complementary fit (Kristof 1996; Kristof-Brown et al. 2005; Muchinsky and Monahan 1987). According to Muchinsky and Monahan (1987), supplementary fit suggests that a "person fits into some environmental context because he or she supplements, embellishes, or possesses characteristics which are similar to other individuals in this environment" (p. 269). For a science team, an example of supplementary fit would be assembling a team of researchers who all have demonstrated the ability to independently perform high-impact research in their area of expertise. On the other hand, complementary fit states "the characteristics of an individual serve to 'make whole' or complement the characteristics of an environment. The environment is seen as either being deficient in or requiring a certain type of person in order to be effective" (Muchinsky and Monahan 1987, p. 271). An example of complementary fit in a science team is the inclusion of a team member who has unique technical skills that others do not possess. The presence of the complementary skills in the team expands the types of research that the team can pursue.

Aside from the fit of team members within a team, using diversity along different dimensions when assembling a science team has implications for a team's future performance. Although there is a long tradition of using demography as part of selection criteria in organizations, managers still face challenges when assembling demographically diverse teams (Page 2008; Reagans et al. 2004; Williams and O'Reilly 1998). One such challenge is that demography has ambiguous performance implications since there is a trade-off to consider for a team, a demographically diverse team may not have strong familiarity among team members, but will have access to a broader set of perspectives (Reagans et al. 2004). Sometimes, diversity must be considered after a task has been identified, and a team needs to consciously assemble with qualified members who help achieve some level of diversity. The diversity within a team gives an opportunity to gain exposure to multiple unique perspectives, which results in ideas that may be reflective of different genders, races, or age groups (Harrison and Humphrey 2010). However, diversity within a team has likewise been shown to lead to conflict and diminish team functions, processes, and performance (Harrison and Klein 2007; Williams and O'Reilly 1998). Additionally, the context and industry in which work is being performed is a major determining factor in whether a diverse team will have successful team performance (Joshi and Roh 2009). To further illustrate the importance of context for diverse science teams, increasing the gender diversity of science and engineering teams leads to greater productivity when the teams are in disciplines with more female faculty members (Joshi 2014). In this study, the productivity of gender diverse teams is also influenced by the gender representation of a given discipline, further illustrating the value of considering the work context for assembled teams.

Another key aspect of diversity is functional and skill-based diversity. Returning to the example of the interdisciplinary cancer research team, one member was an imaging specialist creating value for several teams due to the unique skills that the teams gained by including the specialist as a member. The increasing complexity of work tasks makes diverse teams essential because such tasks make crossing functional and disciplinary boundaries a standard part of modern collaboration. There is a trade-off to consider when assembling functionally diverse teams, problem-solving and product development stages may benefit from the unique combinations of functional perspectives, but the speed of implementation is diminished because the team is less equipped for teamwork than homogenous teams (Ancona and Caldwell 1992b). Functional diversity is beneficial to consider in team assembly, but it is also important to specify the different forms of functional diversity. There are at least four different ways to consider functional diversity for team members during team assembly: dominant function diversity, functional background diversity, functional assignment diversity, and intrapersonal functional diversity (Bunderson and Sutcliffe 2002). Dominant function diversity is the distribution of functional areas represented by team members. Functional background diversity is the difference between team members with respect to their functional backgrounds. Functional assignment diversity is the extent to which the current assignment covers certain functional areas. Lastly, intrapersonal functional diversity is the diversity within each team member's functional experiences; i.e., is a person a functional specialist or a generalist (Bunderson and Sutcliffe 2002). Science teams, both interdisciplinary and disciplinary, rely upon functional diversity, and using a clear conceptualization of functional diversity when assembling the team will make assembly more consistent with respect to the criteria used to assemble a functionally diverse team.

In summary, the composition of a team with respect to competencies, skills, and traits affects a team's collective properties since diversity, team-level ability, and other features are aggregated from individual-level attributes (Mathieu et al. 2008). However, the aggregation of composition factors results in two different types of team properties: shared and configural (Klein and Kozlowski 2000). Although there are differences, both shared and configural properties are the "experiences, attitudes, perceptions, values, cognitions, or behaviors that are held in common by the members of a team" (Klein and Kozlowski 2000, p. 216). Measuring *shared* team properties requires gathering data from individual team members and aggregating the data to the team level. Examples of shared team properties include team mental models, team cohesion, and team satisfaction. Aggregation indicates the amount of sharedness for a property. On the other hand, measuring configural team properties relies on the "array, pattern, or variability of individual characteristics within a team" (Klein and Kozlowski 2000, p. 217). The key distinction between shared and configural properties is that configural properties capture the differences along individual attributes within the team, but shared properties do not capture the differences. Shared and configural properties help incorporate the compositional perspective into understanding the team at a level beyond the individuals. However, the insights obtained from this compositional perspective can be supplemented by including the relational perspective for a team discussed next.

17.4.2 Relational Perspective of Team Assembly

When assembling teams, the relationships among potential team members inform the performance potential of the team. Therefore, developing an awareness for the impact of relationships when assembling teams is immensely important. A team's ability is not only the aggregation of individual attributes but also results from the combination of members and their interactions (Woolley et al. 2010). For individuals, it is important to recognize the need for creating and maintaining relationships throughout a scientific career. Over the years, a scientist will have countless opportunities to collaborate with colleagues having diverse levels of experience, will need to adjust strategies regarding the pursuit or acceptance of collaborations based on personal experiences, and must make conscious decisions about with whom to re-engage in collaboration when assembling new teams (Petersen 2015). Collaboration relies on the ability and effectiveness of team members when *interacting with one another*.

Teams that generate innovative ideas need to interact with the dissenting and divergent-thinking members to simulate a team's creativity (De Dreu and West 2001), and establishing coordination procedures for various social practices and processes ensure effective communication while in a collaboration (Fussell et al. 1998; Kraut and Streeter 1995). To address the need to have useful collaboration practices, scientific researchers have been shown to commonly work with prior collaborators (Guimerà et al. 2005; Norton et al. 2017; Taramasco et al. 2010). Based on previous experience with certain individuals, the preference to work with prior collaborators can be partially attributed to having a clear understanding of collaborators' behaviors and expectations for coordination (Cummings and Kiesler 2008; Hahn et al. 2008; Hinds et al. 2000; Lungeanu et al. 2014). Groups where members have strong relationships exhibit different interactions and perform better on decision-making and motor tasks when compared to groups of people with weaker relationships (Shah and Jehn 1993). The importance of strong relationships is present when teams encounter and must work through task conflict because team performance suffers most when there are both task conflict and relationship conflict (De Dreu and Weingart 2003). In another example, the combination of within-team interactions, individual attributes of team members, and the leadership relationships in a team provides a multifaceted and nuanced treatment of how relationships and team processes impact a team's performance (Balkundi et al. 2009; Balkundi et al. 2011; Balkundi and Harrison 2006; Balkundi and Kilduff 2006). These examples demonstrate the benefits of a relational perspective in team assembly and its helpfulness in building firmer expectations for the subsequent interactions that will occur within teams.

Given the importance of relationships to teams and their assembly, we adopt concepts and theory from social network theory to provide a relational perspective. There are numerous theoretical explanations that are used to explain the role of social networks in team assembly: self-interest theories, social exchange or dependency theories, mutual or collective interest theories, cognitive theories, and homophily theories (Contractor 2013; Katz et al. 2004; Monge and Contractor 2003). Each of these theories illustrate different motives that people follow when assembling teams, and all are relevant to the scientist who is assembling or being assembled into a team.

Self-interest theory states that actors will behave to maximize their individual interests, while also accounting for the social structure in which an actor belongs (Coleman 1988). This theory is applicable to team assembly because researchers who are assembling into teams will undeniably have their own personal goals and interests they wish to advance by working within the team. While theories of self-interest explain why one individual would like to assemble into a team with another who maximizes the former's self-interest, it does not take into account the latter's self-interest. In such cases, *theories of social exchange* or dependencies theories provide a frame of reference to think about how individuals assemble into teams where each member contributes resources to, and benefits from, others (Emerson 1976). This frame of reference helps to explain why people with different types of resources will collaborate. If one party has access to technological infrastructure while another person has the specific skills required to efficiently use the technological infrastructure for research, then both parties benefit by exchanging their own resource for another resource that they consider valuable. In contrast, *theories of collective action* suggest that multiple people with a shared interest will assemble not because they need resources from each other (as posited by social exchange theory) but because they believe that acting collectively as a team increases their ability to get resources or other outcomes from a third party (Marwell et al. 1988). Research communities like nanoHUB emerge as a "public good" through the collective efforts of many people who find value in the common resource, and teams assembled within such a community are typically composed of people who share a collective interest around advancing nanotechnology research.

Cognitive theories explain team assembly based at least two motivations: cognitive consistency and transactive memory. The first motivation, *cognitive consistency*, uses balance theory to refer to people's need for consistency and balance in social relationships with respect to the perceptions they share with their close relations. The common example is that two friends should both also be friends with a shared third person to create balance to their relationships (Heider 1958). Based on this perspective, individuals are more likely to assemble into teams with those who have collaborated with their previous collaborators. The second motivation, *transactive memory*, refers to team members' ability to identify who possesses expertise and skills within a team and then develop relevant interaction networks to effectively engage and communicate with the necessary people (Ren and Argote 2011; Wegner 1987, 1995; Wegner et al. 1991). Based on this perspective, individuals are more likely to assemble into teams with those who they believe (based on their transactive memory system) possess the necessary skills required in the team. *Homophily theories* explain the assembly of teams based on the presence of shared characteristics and belonging to the same social groups (McPherson and Smith-Lovin 1987; McPherson et al. 2001; Ruef et al. 2003). Therefore, people are more likely to build relationships with people who are like them along some dimensions; e.g., have the same gender, race, disciplinary expertise, etc. All five of these theoretical families—self-interest, social exchange, collection action, cognitive theories, and homophily—simultaneous contribute to motivations for team assembly. Therefore, incorporating a relational perspective on team assembly is meaningful since science teams rely on multiple types of relationships and need access to multiple information sources to accomplish their research goals.

The prevalence of interdisciplinary teams underscores the value of being able to access multiple information sources. Interdisciplinary teams are privileged in their social networks because their members are diverse along at least some dimensions that are relevant to the problem. Using a network perspective, a team's performance in generating new ideas results from the structural diversity of a team's members and not a team's demographic diversity (Balkundi et al. 2007). Another benefit of diversity comes not only from the unique contributions of each member but also stems from a diverse team's ability to cross organizational and disciplinary boundaries to access unique, nonredundant information (Cross and Cummings 2004; Podolny and Baron 1997). Teams that effectively communicate outside of the unit gain information that helps them in accomplishing their work. Ancona and Caldwell (1992b) observed that a major benefit of functionally diverse teams was the amount of their communication that occurred outside of the team. The teams that engage in external communication activities organize and schedule their activities in such a way to better support a team's chances of being productive and successful (Ancona and Caldwell 1992a).

Teams that are designed with diversity considerations can be assembled to maximize both a team's internal density and external range with respect to the team's interactions (Reagans et al. 2004). A team's internal density is the amount of connections that exist among team members. A team's effectiveness in coordination is diminished if a team does not have strong relationships among members, has a hierarchy, or there is a lack of communication within the team (Cummings and Cross 2003). Assembling a team that has prior network connections has a positive effect on team performance, most likely due to team members being accessible to one another, able to share information with one another, and having relationships before the start of collaboration. Assembling a team that has diverse networks connections outside the team, or external range, also has a positive effect on performance. External range refers to a team's ability to access different parts of a broader network to utilize nonredundant information. The external range is an essential component for the development of a team's social capital and individual's ability to productively transfer knowledge across boundaries and utilize information from diverse information sources (Cummings and Pletcher 2011; Reagans and McEvily 2003; Reagans and Zuckerman 2001). Assembling interdisciplinary teams that have both internal density and external range are better positioned to have success.

More benefits of the relational perspective are apparent when scientific research is understood to exist within a larger community and network (Shrum et al. 2007). Achieving scientific breakthroughs and innovations depends on both the team itself and the broader network of relationships in which the team is embedded. When selecting collaborators, people have many decision criteria and their choices are dynamic and contingent upon their goals, but also the availability, interest, and expertise of others (Bikard et al. 2015). Inventors with patents are able to generate breakthroughs in part because of extended networks and have higher impact because of team and organization affiliation (Singh and Fleming 2010). The ability of such teams to innovate within a scientific industry is influenced and constrained by the overall structure of the network relations (Ahuja 2000). Teams are valuable products of the social environment in which their members exist before assembling a team, and relationships play an important part in understanding science team assembly as part of a much larger ecosystem discussed next.

17.4.3 Ecosystem Perspective of Team Assembly

The preceding sections have underscored the insights offered by the compositional and relational perspectives on team assembly. In this section, we consider how the assembly of a team and its subsequent performance are shaped by the broader ecosystem in which a team is embedded. The effectiveness of teams is "a function of task, group, and organization design factors, environmental factors, internal processes, external processes, and group psychosocial traits" (Cohen and Bailey 1997). Accounting for all such factors results in increasingly complex conceptualizations of the team and task environments to understand the effectiveness of any team (Crawford and Lepine 2013; Marks et al. 2005; Marks et al. 2001; Mathieu et al. 2008). Therefore, teams must assemble to meet the expectations and goals of the larger ecosystem or organization to which they belong. Assessing the performance or ability of a team is highly dependent upon such factors, and the team will not be considered successful without its goals having a strong alignment with the organization (Hackman 1992; Kozlowski and Ilgen 2006).

The ecosystem encompassing scientific research promotes the assembly of interdisciplinary teams (Cummings and Kiesler 2005). As a result, there is high investment in developing infrastructure and physical spaces to facilitate and support interdisciplinary research (Dahlander and McFarland 2013; Jacobs and Frickel 2009). The interactions that occur between collaborations and their supporting infrastructure affect a team's performance. For example, sharing facility and equipment resources may result in scheduling conflicts and delays, or the reporting requirements of an organization may determine the priority of work tasks for a team (Shrum et al. 2001). Scientific enterprises are organized and managed in ways that promote diverse collaboration styles, e.g., bureaucratic, leaderless, nonspecialized, and participatory (Chompalov et al. 2002). These differences in collaboration styles are useful to reflect upon when assembling teams. *Bureaucratic collaboration* is helpful in multi-university or multi-institution projects to help define goals, determine hierarchy and authority structures, and minimize ambiguity in the collaboration while balancing the interests of all parties. *Leaderless collaboration* delegates tasks to parties deemed competent and responsible, while letting the parties maintain control of their main specialties. *Nonspecialized collaboration* typically has a hierarchy and reporting structure but will not delegate or distribute clear responsibilities. *Participatory collaboration* typically takes place within a single discipline, and the members performing tasks tend to manage themselves and regulate the internal activities needed by a research project. Any of these collaboration styles will be determined by the organizations that host the research teams (Chompalov et al. 2002).

Teams pursuing high-risk interdisciplinary research projects are encouraged and rewarded by the modern science ecosystem (Cummings and Kiesler 2014; Lungeanu et al. 2014; Ma et al. 2015). Lungeanu et al. (2018) characterize the ecosystem in terms of team interlocks. Team interlocks ecosystems comprise teams linked to one another through overlapping membership in teams and/or overlapping knowledge domains. Conceptually, team interlock ecosystems offer novel insights about "how the structural characteristics of embedding ecosystems serve as the primordial soup from which new teams assemble" (Lungeanu et al. 2018, p. 1). Specifically, they found that teams were more likely to assembly if the members of the potential team also belonged to other teams, in the immediate neighborhood, that had minimal overlap. Intuitively, this suggests that the members of the nascent team are able to draw upon the ideas and resources of diverse nonoverlapping other teams in the local ecosystem in which they are embedded. Concurrently, they also found that teams are more likely to assemble when there is considerable overlap in the overall global ecosystem. That is, a nascent team is more likely to nucleate if the potential members of this team belonged to other teams, who had members belonging to other teams, who have members belonging to yet other teams, and there was considerable overlap in membership in the overall global ecosystem. Taken together, these findings suggests that (i) less overlap in the local ecosystem facilitates the assembly of teams that can engage in innovative ideas drawing upon their diverse nonoverlapping sources in other teams and (ii) more overlap in the global ecosystem facilitates the assembly of teams by providing legitimacy to the broader intellectual enterprise in that scientific domain.

The ecosystem has also lead to the birth of new disciplines that emerge to better integrate multiple areas. Using oncofertility as an example, researchers specializing in fertility preservation and researchers specializing in cancer began assembling into teams to explore questions at the intersection of both topics (Lungeanu and Contractor 2015). The emergence of a new discipline means that a team working in such a space must almost exclusively rely on the information that exists within the originating disciplines, and the assembled team must efficiently synthesize the diverse information with the explicit goal of creating something above and beyond each of the parent disciplines. The teams performing these types of tasks rely on their external connections outside of the team (Ancona and Caldwell 1992a, 1992b; Cummings 2004; Cummings and Pletcher 2011), but the quality of the information is the result of the larger ecosystem.

It is complex to navigate a broader ecosystem when collaborating and interacting. A frequent outcome is the emergence of a "structural fold" that occurs among teams that have overlapping membership; it is important to note that the overlapping teams can potentially have highly different levels of ability and experience different levels of success (de Vaan et al. 2015). The overlapping teams make clear that members must constantly make contributions to multiple teams, which is often typical in scientific research. Making contributions to multiple teams requires nontrivial amount of effort by the members. The interdependence among teams is affected by the individuals' goals and decisions regarding where to put their efforts when balancing the interests from multiple teams (Wageman et al. 2012). The concept of teaming refers to the dynamic and changing membership and team activities in which people in the modern collaboration environment participate (Edmondson 2012a, 2012b). Science team members with specialized skills are often faced with prioritizing tasks for multiple teams and are often participating in different teams on a temporary basis. Belonging to multiple teams requires conscious allocation of time and attention by a person, but productivity and learning of people are influenced by the work contexts of the teams and the connections that exist among the teams (O'Leary et al. 2011). These considerations for individuals mean that all team members are balancing potentially conflicting priorities and maintaining a shared understanding for a given team's progress, status, and membership may be difficult for the members (Mortensen 2014). The ecosystem of science teams is dynamic and requires the people therein to manage their responsibilities and obligations, making team assembly dependent upon the team environment.

In summary, the *compositional* perspective considers the combination of individual's attributes and traits, and with this perspective, a person assembling a team can ensure that the members meet the requisite abilities and personality characteristics needed to successfully accomplish the essential work tasks. The *relational* perspective considers the social relationships and networks in which the team members belong and using relationships among team members means that it is possible to better understand the interactions and the social dynamics that will exist during a collaboration. Both perspectives are augmented by the inclusion of the *ecosystem* perspective, which provides the context in which the assembled team will be working. The context may include the scientific landscape, large organizations, departments, disciplines of inquiry, or the established work routines that will affect a team. It is important for a practitioner to be cognizant of all three perspectives that contribute to the assembly of effective scientific teams. However, garnering information from all these perspectives and integrating them into the task of team assembly are nontrivial for a single individual. In the following section, we discuss the role of technology and data sources to help make team assembly decisions that use as much available data as possible.

17.5 Technology, Data, and Recommendation Algorithms in Team Assembly

Key Takeaway: Technology is becoming increasingly useful in assembling teams, and there is now a large amount of readily available digital data and growing interest in the development of recommendation algorithms that enable and understand team assembly.

Newly available digital data opens many new opportunities to measure the social interactions encompassing team assembly. The use of digital trace data gathered from our use of technology is a powerful resource for the study of teams and team assembly. People engage in various behaviors when selecting their teammates: searching and screening information about others, extending invitations to others, considering invitations from others, rescinding invitations, and recusing themselves after accepting an invitation. However, much of these "sausage-making" details about the assembly process are well-nigh impossible to glean accurately from retrospective self-reported data, such as surveys and interviews, or in-person observations. Indeed, social networks research has repeatedly shown that respondents are inaccurate in their reporting of network connections (Bernard and Killworth 1977; Bernard et al. 1984; Bernard et al. 1980; Bernard et al. 1982; Humphrey and Aime 2014;

Killworth and Bernard 1976, 1980; Krackhardt 1987; Marsden 1990).

These limitations have the potential of being scaled due to the availability of digital trace data on a large scale, ushering in the era of *computational social science* (Lazer et al. 2009). Computational social science provides new opportunities in the exploration of team assembly through the analysis of web-based platforms that are used for team assembly and collaboration as well as the increased access to digital archives of collaboration records and histories. Team research has historically been at a data deficit when considering preteam communication or interactions, but now digital trace data and accessible longitudinal data in digital archives have the potential to provide rich data about social interactions and individuals engaged in the process of team assembly. These data hold great potential for both studying team assembly and providing an environment for the development of better systems to facilitate team assembly. The two aspects driving this movement are the developments of technology to enable team assembly and the data that fuels their use. These are discussed in the next two subsections.

17.5.1 Technology

Technology is present in many aspects of scientific work, and the presence of social technology has brought many benefits to the modern workplace. Many organizations have implemented web-based social technologies to connect employees to one another and facilitate organization learning, communication, expertise search, and collaboration (Colbert et al. 2016; Leonardi et al. 2013; Lin et al. 2009; Treem and Leonardi 2012). The proliferation of such technology benefits team assembly because people are more able to acquire knowledge and information about their broader organization and the potential collaborators therein (Huang et al. 2013; Leonardi 2015).

Access to such knowledge is invaluable for people who need to assemble teams when performing highly intensive scientific research since there are many, often competing considerations that must be made (Reagans et al. 2004). The inclusion of technology into team assembly considerations clarifies meaningful selection criteria and effective algorithms to assemble teams that accomplish meaningful outcomes. Technology aids the matching of team members based on their abilities as well as their fit among team members (D'Souza and Colarelli 2010; Spoelstra et al. 2015). To illustrate the value of technology in team assembly, we describe three technologies that improve knowledge availability for people who are assembling teams.

These platforms have applications in businesses, instructor-assigned student teams, and self-assembled research teams. The Pingboard platform allows for organizations to generate and aggregate data on the collaborations that are occurring within the organization instead of having a static reporting chart (Easy, beautiful org chart software | Pingboard n.d.). The application is meaningful because users can recognize the people who collaborate with one another and can use such information to assemble teams based on actual collaborations instead of assumed relationships based on inaccurate information. Another software platform, CATME, is used by instructors who are assigning students to teams and provides value because a single person can use the software to organize information and specify the criteria used to assemble teams (CATME n.d.; Jahanbakhsh et al. 2017; Layton et al. 2010). The MyDreamTeam platform facilitates the self-assembly of project teams for a population of users (Asencio et al. 2014; My Dream Team Assembler n.d.). MyDreamTeam gives agency to those assembling their own teams, provides information about potential collaborators through online profiles and search recommendations, and affords messaging interactions comparable to an online dating application. These three platforms are examples of a growing technology genre focused on team assembly. But there is still much to learn from mature and active online communities where users assemble teams and engage in scientific and technical collaborations to solve real-world problems.

17.5.2 Digital Trace Data

Data generated and tracked on digital platforms, such as messaging applications (e.g., Slack), software repositories (e.g., GitHub), and digital archives such as the Web of Science provide data that fuel the technology to help team assembly. The Internet has simplified access to United States patent records and published academic articles. For example, there are databases available from the US Patent and Trademark Office (USPTO), the Web of Science, Elsevier, US National Institutes of Health (NIH), and the United States National Science Foundation (NSF). These records are especially helpful in the study of teams because they are historical in nature, span the entire careers of some people in the sample, and include clear definitions of teams through authorship lists. The most important fact obtained by analyzing such data is that teams are increasingly becoming more prevalent and impactful. The amount of research done by teams has been increasing over time (Leahey 2016). From analysis of over half a million USPTO patent records, teams are shown to reduce the chance of producing poor outcomes while increasing the chance of having a highly successful invention (Singh and Fleming 2010). Using the Web of Science, researchers have uncovered important facts surrounding teams by leveraging the Web of Science database containing over 20 million records over five decades and 2.1 million patent records over three decades (Jones et al. 2008; Wuchty et al. 2007). Analyzing these research products and learning how the teams were composed and assembled provides a great deal of information about teams that are successful, innovative, and productive.

Another benefit of such data archives is that there is more available data on teams that were not as successful in accomplishing their goals as those who earned patents or publications. To have a comprehensive perspective of science team assembly, it is meaningful to explore teams that were unsuccessful. There are studies using data from the NSF about funded projects and proposals that include both successful and unsuccessful teams in terms of being awarded a research grant. Using data from the NSF, analysis shows geographically distributed teams are becoming more common and have higher impact than co-located teams (Cummings and Kiesler 2007, 2014). However, when accounting for both successful and unsuccessful proposals, it was found that multidisciplinary and geographically distributed teams are less likely to be successful than teams that are less multidisciplinary and geographically co-located (Cummings and Kiesler 2005, 2008). More recent research has been conducted based on 1103 successful and unsuccessful NSF grant proposals submitted to two interdisciplinary initiatives spanning a 3-year period. The results showed that people are more likely to assemble a proposal team with people with whom they already have relationships, but are more likely to be unsuccessful if they cite one another—implying an incestuous intellectual relationship that does not augur well for innovation (Lungeanu et al. 2014). Clearly, without the use of digital data archives, the availability of information regarding less successful or failed teams would not be as readily available.

17.5.3 Recommendation Algorithms

The Internet is a powerful tool for the future of work (Colbert et al. 2016). However, there are countless options and an overwhelming amount of information available online. To help people manage all the options and information, the development of approaches to filter information based on multiple users has been impactful and useful (Resnick et al. 1994). Modern technologies that recommend content are embedded in many web platforms. One would be hard pressed to find an online scenario that does not provide content to a user by making recommendations derived from an algorithm; friend suggestions, future purchases, the next website to visit, and the next content to consume in general are all examples of commonly generated recommendations (Lazer 2015). Using search queries, click-through data, survey responses, prior purchasing behavior, and countless other user data, a person's actions are modeled and compared to other people to generate recommendations that help drive individual choices on the Internet.

Recommendations online are also relevant to social relationships. Major social networking websites, such as LinkedIn, Facebook, Instagram, and Twitter, all recommend people that you may know or people with whom you should connect based on a given individual's interest, demographics, and shared network connections. These same types of algorithmic approaches can be used for the assembly of teams (Contractor 2013; Fazel-Zarandi et al. 2011). Recommendation algorithms use many more data sources and considerations than people can consider, which makes them able to assess numerous team combinations, recommend combinations with some level of confidence, and provide metrics to help assemble the teams with the highest possibility for success (Ghasemian et al. 2016; Lappas et al. 2009). Recent research has also investigated the ability of algorithms to replace members of teams (Li et al. 2015). There is great value in using recommendations to assess different options for a replacement team member that allows people to anticipate how a new addition will influence different team performance measures. The inclusion of technological considerations and recommendations will aid team assembly by making collaborations that may occur within the scientific task environment more responsive to changes.

17.6 Conclusion

There is always been prima facie intuition that team assembly is an important prerequisite to consider in the work of modern science teams. This chapter has sought to marshal the evidence and herald the potential of a more systematic evidence base for this intuition. In this chapter, we have distinguished, and weighed the pros and cons, of two different assembly types—staff-assembly and self-assembly. We have provided the practitioner with evidence for why team assembly must be considered from three perspectives: compositional (individual attributes of potential team members), relational (the prior relations among these members), and ecosystem (the relations of these members with others via their membership in multiple overlapping teams). We also previewed the potential of technology platforms, the proliferation of digital trace data, and the development of recommendation algorithms to dramatically improve our ability to both enable and understand team assembly. Given the ever-increasing need for science to be conducted in teams, the science of team assembly, and the need for practitioners to leverage these insights, will only grow in importance.

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References

Aalbers R, Dolfsma W, Koppius O. Individual connectedness in innovation networks: on the role of individual motivation. Res Policy. 2013;42(3):624–34.

Ahuja G. Collaboration networks, structural holes, and innovation: a longitudinal study. Adm Sci Q. 2000;45(3):425–55. https://doi.org/10.2307/2667105.

Ancona DG, Caldwell DF. Bridging the boundary: external activity and performance in organizational teams. Adm Sci Q. 1992a:634–65.

Ancona DG, Caldwell DF. Demography and design: predictors of new product team performance. Organ Sci. 1992b;3(3):321–41.

Arrow H, McGrath JE, Berdahl JL. Small groups as complex systems: formation, coordination, development, and adaptation. Thousand Oaks: Sage Publications; 2000.

Asencio R, Huang Y, Murase T, Sawant A, DeChurch L, Contractor N. Enabling teams to self-assemble: the my dream team tool. Presented at the 5th Annual International Science of Team Science (SciTS) Conference;2014.

Balkundi P, Harrison DA. Ties, leaders, and time in teams: strong inference about network structure's effects on team viability and performance. Acad Manag J. 2006;49(1):49–68.

Balkundi P, Kilduff M. The ties that lead: a social network approach to leadership. Leadersh Q. 2006;17(4):419–39. https://doi.org/10.1016/j.leaqua.2006.01.001.

Balkundi P, Kilduff M, Barsness Z, Michael J. Demographic antecedents and performance consequences of structural holes in work teams. J Organ Behav. 2007;28(2):241–60.

Balkundi P, Barsness Z, Michael JH. Unlocking the influence of leadership network structures on team conflict and viability. Small Group Res. 2009;40(3):301–22. https://doi.org/10.1177/1046496409333404.

Balkundi P, Kilduff M, Harrison DA. Centrality and charisma: comparing how leader networks and attributions affect team performance. J Appl Psychol. 2011;96(6):1209.

Bandura A. Human agency in social cognitive theory. Am Psychol. 1989;44(9):1175–84.

Barrick MR, Stewart GL, Neubert MJ, Mount MK. Relating member ability and personality to work-team processes and team effectiveness. J Appl Psychol. 1998;83(3):377–91.

Bell ST. Deep-level composition variables as predictors of team performance: a meta-analysis. J Appl Psychol. 2007;92(3):595.

Bercovitz J, Feldman M. The mechanisms of collaboration in inventive teams: composition, social networks, and geography. Res Policy. 2011;40(1):81–93. https://doi.org/10.1016/j.respol.2010.09.008.

Bernard H, Killworth PD. Informant accuracy in social network data II. Hum Commun Res. 1977;4(1):3–18.

Bernard H, Killworth PD, Sailer L. Informant accuracy in social network data IV: a comparison of clique-level structure in behavioral and cognitive network data. Soc Networks. 1980;2(3):191–218.

Bernard H, Killworth PD, Sailer L. Informant accuracy in social-network data V. An experimental attempt to predict actual communication from recall data. Soc Sci Res. 1982;11(1):30–66.

Bernard H, Killworth PD, Kronenfeld D, Sailer L. The problem of informant accuracy: the validity of retrospective data. Annu Rev Anthropol. 1984;13:495–517.

Bikard M, Murray F, Gans JS. Exploring trade-offs in the organization of scientific work: collaboration and scientific reward. Manag Sci. 2015;61(7):1473–95.

Birnholtz J, Forlano L, Yuan YC, Rizzo J, Liao K, Gay G, Heller C. One university, two campuses: initiating and sustaining research collaborations between two campuses of a single institution. In: Proceedings of the 2012 iConference. ACM; 2012. pp. 33–40.

Börner K, Contractor N, Falk-Krzesinski HJ, Fiore SM, Hall KL, Keyton J, et al. A multi-level systems perspective for the science of team science. Sci Transl Med. 2010;2(49):cm24. https://doi.org/10.1126/scitranslmed.3001399.

Bunderson JS, Sutcliffe KM. Comparing alternative conceptualizations of functional diversity in management teams: process and performance effects. Acad Manag J. 2002;45(5):875–93. https://doi.org/10.2307/3069319.

Burt RS. Structural holes and good ideas. Am J Sociol. 2004;110(2):349–99. https://doi.org/10.1086/421787.

Burt RS. Structural holes: the social structure of competition. Cambridge: Harvard University Press; 2009.

Cable DM, Edwards JR. Complementary and supplementary fit: a theoretical and empirical integration. J Appl Psychol. 2004;89(5):822–34.

CATME. (n.d.). http://info.catme.org. Accessed 19 Oct 2017.

Chompalov I, Genuth J, Shrum W. The organization of scientific collaborations. Res Policy. 2002;31(5):749–67. https://doi.org/10.1016/S0048-7333(01)00145-7.

Coccia M, Wang L. Evolution and convergence of the patterns of international scientific collaboration. Proc Natl Acad Sci. 2016;113(8):2057–61. https://doi.org/10.1073/pnas.1510820113.

Cohen SG, Bailey DE. What makes teams work: group effectiveness research from the shop floor to the executive suite. J Manag. 1997;23(3):239–90.

Colbert A, Yee N, George G. The digital workforce and the workplace of the future. Acad Manag J. 2016;59(3):731–9. https://doi.org/10.5465/amj.2016.4003.

Coleman JS. Social capital in the creation of human capital. Am J Sociol. 1988:S95–S120.

Colquitt JA, Scott BA, LePine JA. Trust, trustworthiness, and trust propensity: a meta-analytic test of their unique relationships with risk taking and job performance. J Appl Psychol. 2007;92(4):909.

Contractor N. Some assembly required: leveraging web science to understand and enable team assembly. Philos Trans R Soc A Math Phys Eng Sci. 2013;371(1987):20120385.

Cooke NJ, Hilton ML, Committee on the Science of Team Science, Board on Behavioral, Cognitive, and Sensory Sciences, Division of Behavioral and Social Sciences and Education, National Research Council. Team composition and assembly. Washington D.C.: National Academies Press; 2015. https://www.ncbi.nlm.nih.gov/books/NBK310388/

Cordery JL, Mueller WS, Smith LM. Attitudinal and behavioral effects of autonomous group working: a longitudinal field study. Acad Manag J. 1991;34(2):464–76. https://doi.org/10.2307/256452.

Crawford ER, Lepine JA. A configural theory of team processes: accounting for the structure of taskwork and teamwork. Acad Manag Rev. 2013;38(1):32–48. https://doi.org/10.5465/amr.2011.0206.

Cross R, Cummings JN. Tie and network correlates of individual performance in knowledge-intensive work. Acad Manag J. 2004;47(6):928–37. https://doi.org/10.2307/20159632.

Cummings JN. Work groups, structural diversity, and knowledge sharing in a global organization. Manag Sci. 2004;50(3):352–64. https://doi.org/10.1287/mnsc.1030.0134.

Cummings JN, Cross R. Structural properties of work groups and their consequences for performance. Soc Networks. 2003;25(3):197–210.

Cummings JN, Kiesler S. Collaborative research across disciplinary and organizational boundaries. Soc Stud Sci. 2005;35(5):703–22.

Cummings JN, Kiesler S. Coordination costs and project outcomes in multi-university collaborations. Res Policy. 2007;36(10):1620–34.

Cummings JN, Kiesler S. Who collaborates successfully?: Prior experience reduces collaboration barriers in distributed interdisciplinary research. In Proceedings of the 2008 ACM Conference on Computer Supported

Cooperative Work. ACM; 2008. pp. 437–446. http://dl.acm.org/citation.cfm?id=1460633.

Cummings JN, Kiesler S. Organization theory and the changing nature of science (SSRN scholarly paper no. ID 2549609). Rochester, NY: Social Science Research Network; 2014. https://papers.ssrn.com/abstract=2549609

Cummings JN, Pletcher C. Why project networks beat project teams. MIT Sloan Manag Rev. 2011;52(3):75.

D'Souza GC, Colarelli SM. Team member selection decisions for virtual versus face-to-face teams. Comput Hum Behav. 2010;26(4):630–5. https://doi.org/10.1016/j.chb.2009.12.016.

Dabbish L, Stuart C, Tsay J, Herbsleb J. Social coding in GitHub: transparency and collaboration in an open software repository. In Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work. ACM; 2012. pp. 1277–1286. http://dl.acm.org/citation.cfm?id=2145396

Dahlander L, McFarland DA. Ties that last: tie formation and persistence in research collaborations over time. Adm Sci Q. 2013;58(1):69–110. https://doi.org/10.1177/0001839212474272.

De Dreu CK, Weingart LR. Task versus relationship conflict, team performance, and team member satisfaction: a meta-analysis. J Appl Psychol. 2003;88(4):741.

De Dreu CK, West MA. Minority dissent and team innovation: the importance of participation in decision making. J Appl Psychol. 2001;86(6):1191.

Deci EL, Ryan RM. Overview of self-determination theory: an organismic dialectical perspective. In: Handbook of Self-Determination Research; 2002. pp. 3–33.

Devine DJ, Philips JL. Do smarter teams do better: a meta-analysis of cognitive ability and team performance. Small Group Res. 2001;32(5):507–32.

Duguid MM. Female tokens in high-prestige work groups: catalysts or inhibitors of group diversification? Organ Behav Hum Decis Process. 2011;116(1):104–15.

Duguid MM, Loyd DL, Tolbert PS. The impact of categorical status, numeric representation, and work group prestige on preference for demographically similar others: a value threat approach. Organ Sci. 2012;23(2):386–401. https://doi.org/10.1287/orsc.1100.0565.

Easy, beautiful org chart software | Pingboard. (n.d.). https://pingboard.com. Accessed 19 Oct 2017.

Edmondson AC. Teaming: how organizations learn, innovate, and compete in the knowledge economy. Hoboken: John Wiley & Sons; 2012a.

Edmondson AC. Teamwork on the fly. Harv Bus Rev. 2012b;90(4):72–80.

Emerson RM. Social exchange theory. Annu Rev Sociol. 1976:335–62.

Falk-Krzesinski HJ, Börner K, Contractor N, Fiore SM, Hall KL, Keyton J, et al. Advancing the science of team science. Clin Transl Sci. 2010;3(5):263–6. https://doi.org/10.1111/j.1752-8062.2010.00223.x.

Faraj S, Sproull L. Coordinating expertise in software development teams. Manag Sci. 2000;46(12):1554–68. https://doi.org/10.1287/mnsc.46.12.1554.12072.

Fazel-Zarandi M, Devlin HJ, Huang Y, Contractor N. Expert recommendation based on social drivers, social network analysis, and semantic data representation. Presented at the 2nd International Workshop on Information Heterogeneity and Fusion in Recommender Systems. ACM; 2011. pp. 41–48. https://doi.org/10.1145/2039320.2039326.

Foster JG, Rzhetsky A, Evans JA. Tradition and innovation in scientists' research strategies. Am Sociol Rev. 2015;80(5):875–908. https://doi.org/10.1177/0003122415601618.

Fox MF, Faver CA. Independence and cooperation in research. J High Educ. 1984;55(3):347–59. https://doi.org/10.1080/00221546.1984.11777069.

Fussell SR, Kraut RE, Lerch FJ, Scherlis WL, McNally MM, Cadiz JJ. Coordination, overload and team performance: effects of team communication strategies. In: Proceedings of the 1998 ACM Conference on Computer Supported Cooperative Work; 1998. pp. 275–284.

Gadlin H, Jessar K. Preempting discord: prenuptial agreements for scientists. The NIH Catalyst. 2002;10:12.

Gewin V. Collaborations: recipe for a team. Nature. 2015;523(7559):245–7. https://doi.org/10.1038/nj7559-245a.

Ghasemian F, Zamanifar K, Ghasem-Aqaee N, Contractor N. Toward a better scientific collaboration success prediction model through the feature space expansion. Scientometrics. 2016:1–25.

Gibbs K, Han A, Lun J. Demographic diversity in teams: the challenges, benefits, and management strategies. In: Hall KL, Vogel AL, Croyle RT, editors. Strategies for team science success: handbook of evidence- based principles for cross-disciplinary science and practical lessons learned from health researchers. New York, NY: Springer; 2019.

González VM, Mark G. Constant, constant, multi-tasking craziness: managing multiple working spheres. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM; 2004. pp. 113–120. http://dl.acm.org/citation.cfm?id=985707

Grant AM, Berry JW. The necessity of others is the mother of invention: intrinsic and prosocial motivations, perspective taking, and creativity. Acad Manag J. 2011;54(1):73–96.

Guimerà R, Uzzi B, Spiro J, Amaral LAN. Team assembly mechanisms determine collaboration network structure and team performance. Science. 2005;308(5722):697–702. https://doi.org/10.1126/science.1106340.

Hackman JR. The design of work teams. In: Lorsch J, editor. Handbook of organizational behavior. Englewood Cliffs, NJ: Prentice-Hall; 1987.

Hackman JR. Group influences on individuals in organizations. In: Dunnette MD, Hough LM, editors. Handbook of industrial and organizational psychology, vol. 3. Palo Alto: Consulting Psychologists Press; 1992.

Hackman JR, Brousseau KR, Weiss JA. The interaction of task design and group performance strategies in determining group effectiveness. Organ Behav

Hum Perform. 1976;16(2):350–65. https://doi.org/10.1016/0030-5073(76)90021-0.
Hagstrom WO. Traditional and modern forms of scientific teamwork. Adm Sci Q. 1964;9(3):241–63. https://doi.org/10.2307/2391440.
Hahn J, Moon JY, Zhang C. Emergence of new project teams from open source software developer networks: impact of prior collaboration ties. Inf Syst Res. 2008;19(3):369–91.
Hansen MT. The search-transfer problem: the role of weak ties in sharing knowledge across organization subunits. Adm Sci Q. 1999:82–111.
Harrison DA, Humphrey SE. Designing for diversity or diversity for design? Tasks, interdependence, and within-unit differences at work. J Organ Behav. 2010;31(2–3):328–37. https://doi.org/10.1002/job.608.
Harrison DA, Klein KJ. What's the difference? Diversity constructs as separation, variety, or disparity in organizations. Acad Manag Rev. 2007;32(4):1199–228. https://doi.org/10.5465/AMR.2007.26586096.
Heider F. The psychology of interpersonal relations. New York: Wiley; 1958.
Hertel G, Niedner S, Herrmann S. Motivation of software developers in open source projects: an internet-based survey of contributors to the Linux kernel. Res Policy. 2003;32(7):1159–77.
Hinds PJ, Carley KM, Krackhardt D, Wholey D. Choosing work group members: balancing similarity, competence, and familiarity. Organ Behav Hum Decis Process. 2000;81(2):226–51.
Hollenbeck JR, Moon H, Ellis AP, West BJ, Ilgen DR, Sheppard L, et al. Structural contingency theory and individual differences: examination of external and internal person-team fit. J Appl Psychol. 2002;87(3):599.
Huang M, Barbour J, Su C, Contractor NS. Why do group members provide information to digital knowledge repositories? A multilevel application of transactive memory theory. J Am Soc Inf Sci Technol. 2013;64(3):540–57. https://doi.org/10.1002/asi.22805.
Hudson JM, Christensen J, Kellogg WA, Erickson T. I'd be overwhelmed, but it's just one more thing to do: Availability and interruption in research management. In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM; 2002. pp. 97–104. http://dl.acm.org/citation.cfm?id=503394.
Humphrey SE, Aime F. Team microdynamics: toward an organizing approach to teamwork. Acad Manag Ann. 2014;8(1):443–503. https://doi.org/10.1080/19416520.2014.904140.
Humphrey SE, Hollenbeck JR, Meyer CJ, Ilgen DR. Trait configurations in self-managed teams: a conceptual examination of the use of seeding for maximizing and minimizing trait variance in teams. J Appl Psychol. 2007;92(3):885–92.
Humphrey SE, Morgeson FP, Mannor MJ. Developing a theory of the strategic core of teams: a role composition model of team performance. J Appl Psychol. 2009;94(1):48.
Jacobs JA, Frickel S. Interdisciplinarity: a critical assessment. Annu Rev Sociol. 2009;35(1):43–65. https://doi.org/10.1146/annurev-soc-070308-115954.
Jahanbakhsh F, Fu W-T, Karahalios K, Marinov D, Bailey B. You want me to work with who?: stakeholder perceptions of automated team formation in project-based courses. In: Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems. New York, NY: ACM; 2017. p. 3201–12. https://doi.org/10.1145/3025453.3026011.
Jehn KA, Shah PP. Interpersonal relationships and task performance: an examination of mediation processes in friendship and acquaintance groups. J Pers Soc Psychol. 1997;72(4):775–90. https://doi.org/10.1037/0022-3514.72.4.775.
Jones BF, Wuchty S, Uzzi B. Multi-university research teams: shifting impact, geography, and stratification in science. Science. 2008;322(5905):1259–62.
Joshi A. By whom and when is women's expertise recognized? The interactive effects of gender and education in science and engineering teams. Adm Sci Q. 2014;59(2):202–39. https://doi.org/10.1177/0001839214528331.
Joshi A, Roh H. The role of context in work team diversity research: a meta-analytic review. Acad Manag J. 2009;52(3):599–627.
Katz JS, Martin BR. What is research collaboration? Res Policy. 1997;26(1):1–18. https://doi.org/10.1016/S0048-7333(96)00917-1.
Katz N, Lazer D, Arrow H, Contractor N. Network theory and small groups. Small Group Res. 2004;35(3):307–32. https://doi.org/10.1177/1046496404264941.
Killworth PD, Bernard H. Informant accuracy in social network data. Hum Organ. 1976;35(3):269–86.
Killworth PD, Bernard H. Informant accuracy in social network data III: a comparison of triadic structure in behavioral and cognitive data. Soc Networks. 1980;2(1):19–46.
Klein KJ, Kozlowski SW. From micro to meso: critical steps in conceptualizing and conducting multilevel research. Organ Res Methods. 2000;3(3):211–36.
Klein KJ, Dansereau F, Hall RJ. Levels issues in theory development, data collection, and analysis. Acad Manag Rev. 1994;19(2):195–229.
Klimoski R, Jones RG. Staffing for effective group decision making: key issues in matching people and teams. In: Guzzo RA, Salas E, editors. Team effectiveness and decision making in organizations. 1st ed. San Francisco: Jossey-Bass; 1995. p. 291–332.
Kozlowski SWJ, Bell BS. Evidence-based principles and strategies for optimizing team functioning and performance in science teams. In: Hall KL, Vogel AL, Croyle RT, editors. Strategies for team science success: handbook of evidence-based principles for crossdisciplinary science and practical lessons learned from health researchers. New York, NY: Springer; 2019.

Kozlowski SW, Ilgen DR. Enhancing the effectiveness of work groups and teams. Psychol Sci Public Interest. 2006;7(3):77–124.
Kozlowski SW, Klein KJ. A multilevel approach to theory and research in organizations: contextual, temporal, and emergent processes. In: Klein KJ, Kozlowski SW, editors. Multilevel theory, research, and methods in organizations: foundations, extensions, and new directions. San Francisco: Jossey-Bass; 2000. p. 3–90. http://psycnet.apa.org/psycinfo/2000-16936-001.
Krackhardt D. Cognitive social structures. Soc Networks. 1987;9(2):109–34.
Kraut RE, Galegher J, Egido C. Relationships and tasks in scientific research collaboration. Hum. Comput. interact. 1987;3(1):31–58
Kraut RE, Streeter LA. Coordination in software development. Commun. Assoc Comput. Mach. 1995;38(3):69–81.
Kristof AL. Person-organization fit: an integrative review of its conceptualizations, measurement, and implications. Pers Psychol. 1996;49(1):1–49.
Kristof-Brown AL, Zimmerman RD, Johnson EC. Consequences of individuals' fit at work: a meta-analysis of person–job, person–organization, person–group, and person–supervisor fit. Pers Psychol. 2005;58(2):281–342. https://doi.org/10.1111/j.1744-6570.2005.00672.x.
Lappas T, Liu K, Terzi E. Finding a team of experts in social networks. In: Proceedings of the 15th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining. New York: ACM; 2009. p. 467–76. http://dl.acm.org/citation.cfm?id=1557074.
Layton RA, Loughry ML, Ohland MW, Ricco GD. Design and validation of a web-based system for assigning members to teams using instructor-specified criteria. Adv Eng Education. 2010;2(1):n1.
Lazer D. The rise of the social algorithm. Science. 2015;348(6239):1090–1.
Lazer D, Pentland A, Adamic L, Aral S, Barabasi A-L, Brewer D, Van Alstyne M. Computational social science. Science. 2009;323(5915):721–3. https://doi.org/10.1126/science.1167742.
Leahey E. From sole investigator to team scientist: trends in the practice and study of research collaboration. Annu Rev Sociol. 2016;42(1):81–100. https://doi.org/10.1146/annurev-soc-081715-074219.
Leahey E, Beckman CM, Stanko TL. Prominent but less productive the impact of interdisciplinarity on scientists' research. Adm. Sci. Quart. 0001839216665364. 2016. https://doi.org/10.1177/0001839216665364.
Lee Y-N, Walsh JP, Wang J. Creativity in scientific teams: unpacking novelty and impact. Res Policy. 2015;44(3):684–97. https://doi.org/10.1016/j.respol.2014.10.007.
Leonardi PM. Ambient awareness and knowledge acquisition: using social media to learn "who knows what" and "who knows whom". MIS Q. 2015;39(4):747–62.
Leonardi PM, Huysman M, Steinfield C. Enterprise social media: definition, history, and prospects for the study of social technologies in organizations. J Comput-Mediat Commun. 2013;19(1):1–19. https://doi.org/10.1111/jcc4.12029.
Lepine JA, Dyne LV. Peer responses to low performers: an attributional model of helping in the context of groups. Acad Manag Rev. 2001;26(1):67–84. https://doi.org/10.5465/AMR.2001.4011953.
LePine JA, Hollenbeck JR, Ilgen DR, Hedlund J. Effects of individual differences on the performance of hierarchical decision-making teams: much more than g. J Appl Psychol. 1997;82(5):803–11. https://doi.org/10.1037/0021-9010.82.5.803.
LePine JA, Hanson MA, Borman WC, Motowidlo SJ. Contextual performance and teamwork: implications for staffing (Vol. 19). Greenwich, Conn: JAI Press; 2000.
Li L, Tong H, Cao N, Ehrlich K, Lin Y-R, Buchler N. Replacing the irreplaceable: fast algorithms for team member recommendation. In: Proceedings of the 24th International Conference on World Wide Web. Geneva: International World Wide Web Conferences Steering Committee; 2015. p. 636–46. http://dl.acm.org/citation.cfm?id=2741132.
Lin CY, Cao N, Liu SX, Papadimitriou S, Sun J, Yan X. SmallBlue: social network analysis for expertise search and collective intelligence. In: 2009 IEEE 25th International Conference on Data Engineering; 2009. p. 1483–6. https://doi.org/10.1109/ICDE.2009.140.
Lungeanu A, Contractor NS. The effects of diversity and network ties on innovations: the emergence of a new scientific field. Am Behav Sci. 2015; https://doi.org/10.1177/0002764214556804.
Lungeanu A, Huang Y, Contractor N. Understanding the assembly of interdisciplinary teams and its impact on performance. J Informet. 2014;8(1):59–70. https://doi.org/10.1016/j.joi.2013.10.006.
Lungeanu A, Carter DR, DeChurch LA, Contractor NS. How team interlock ecosystems shape the assembly of scientific teams: a hypergraph approach. Commun Methods Meas. 2018;12:1–25.
Lykourentzou I, Wang S, Kraut RE, Dow SP. Team dating: a self-organized team formation strategy for collaborative crowdsourcing. In: Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems. New York, NY: ACM; 2016. p. 1243–9. https://doi.org/10.1145/2851581.2892421.
Lykourentzou I, Kraut RE, Dow SP. Team dating leads to better online ad hoc collaborations. In: Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing. New York, NY: ACM; 2017. p. 2330–43. https://doi.org/10.1145/2998181.2998322.
Ma A, Mondragón RJ, Latora V. Anatomy of funded research in science. Proc Natl Acad Sci. 2015;112(48):14760–5. https://doi.org/10.1073/pnas.1513651112.
Margolin D, Ognyanoya K, Huang M, Huang Y, Contractor N. Team formation and performance on Nanohub: a network selection challenge in scientific communities. In: Vedres B, Scotti M, editors.

Networks in social policy problems. Cambridge, UK: Cambridge University Press; 2012. p. 80–100.
Marks MA, Mathieu JE, Zaccaro SJ. A temporally based framework and taxonomy of team processes. Acad Manag Rev. 2001;26(3):356–76.
Marks MA, Dechurch LA, Mathieu JE, Panzer FJ, Alonso A. Teamwork in multiteam systems. J Appl Psychol. 2005;90(5):964–71.
Marsden P. Network data and measurement. Annu Rev Sociol. 1990:435–63.
Marwell G, Oliver PE, Prahl R. Social networks and collective action: a theory of the critical mass. III. Am J Sociol. 1988;94(3):502–34.
Mathieu J, Maynard MT, Rapp T, Gilson L. Team effectiveness 1997-2007: a review of recent advancements and a glimpse into the future. J Manag. 2008;34(3):410–76. https://doi.org/10.1177/0149206308316061.
McPherson M, Smith-Lovin L. Homophily in voluntary organizations: status distance and the composition of face-to-face groups. Am Sociol Rev. 1987:370–9.
McPherson M, Smith-Lovin L, Cook JM. Birds of a feather: homophily in social networks. Annu Rev Sociol. 2001;27:415–44.
Milojević S. Principles of scientific research team formation and evolution. Proc Natl Acad Sci. 2014;111(11):3984–9. https://doi.org/10.1073/pnas.1309723111.
Monge P, Contractor N. Theories of communication networks. New York, USA: Oxford University Press; 2003.
Morgeson FP, Humphrey SE. Job and team design: toward a more integrative conceptualization of work design. In: Research in personnel and human resources management. Bingley: Emerald Group Publishing Limited; 2008. p. 39–91.
Morgeson FP, Reider MH, Campion MA. Selecting individuals in team settings: the importance of social skills, personality characteristics, and teamwork knowledge. Pers Psychol. 2005;58(3):583–611.
Mortensen M. Constructing the team: the antecedents and effects of membership model divergence. Organ Sci. 2014;25(3):909–31. https://doi.org/10.1287/orsc.2013.0881.
Moynihan LM, Peterson RS. A contingent configuration approach to understanding the role of personality in organizational groups. Res Organ Behav. 2001;23(Supplement C):327–78. https://doi.org/10.1016/S0191-3085(01)23008-1.
Muchinsky PM, Monahan CJ. What is person-environment congruence? Supplementary versus complementary models of fit. J Vocat Behav. 1987;31(3):268–77. https://doi.org/10.1016/0001-8791(87)90043-1.
My Dream Team Assembler. (n.d.). http://sonic.northwestern.edu/software/c-iknow-mydreamteam. Accessed 19 Oct 2017.
National Research Council. Enhancing the Effectiveness of Team Science. Washington, DC: The National Academies Press. 2015. https://doi.org/10.17226/19007.
Nomura S, Birnholtz J, Rieger O, Leshed G, Trumbull D, Gay G. Cutting into collaboration: understanding coordination in distributed and interdisciplinary medical research. In: Presented at the Proceedings of the 2008 ACM Conference on Computer Supported Cooperative Work. New York: ACM; 2008. p. 427–36.
Norton WE, Lungeanu A, Chambers DA, Contractor N. Mapping the growing discipline of dissemination and implementation science in health. Scientometrics. 2017;112(3):1367–90. https://doi.org/10.1007/s11192-017-2455-2.
Nurius PS, Kemp SP. Individual level competencies for team collaboration with cross-disciplinary researchers and stakeholders. In: Hall KL, Vogel AL, Croyle RT, editors. Strategies for team science success: handbook of evidence-based principles for cross-disciplinary science and practical lessons learned from health researchers. New York, NY: Springer; 2019.
O'Leary MB, Mortensen M, Woolley AW. Multiple team membership: a theoretical model of its effects on productivity and learning for individuals and teams. Acad Manag Rev. 2011;36(3):461–78.
Page SE. The difference: how the power of diversity creates better groups, firms, schools, and societies. Princeton: Princeton University Press; 2008.
Pelesko JA. Self assembly: the science of things that put themselves together. Boca Raton: CRC Press; 2007.
Pentland AS. The new science of building great teams. Harv Bus Rev. 2012;(April):60–70.
Perretti F, Negro G. Mixing genres and matching people: a study in innovation and team composition in Hollywood. J Organ Behav. 2007;28(5):563–86.
Petersen AM. Quantifying the impact of weak, strong, and super ties in scientific careers. Proc Natl Acad Sci. 2015;112(34):E4671–80. https://doi.org/10.1073/pnas.1501444112.
Podolny JM, Baron JN. Resources and relationships: social networks and mobility in the workplace. Am Sociol Rev. 1997:673–93.
Reagans R, McEvily B. Network structure and knowledge transfer: the effects of cohesion and range. Adm Sci Q. 2003;48(2):240–67.
Reagans R, Zuckerman EW. Networks, diversity, and productivity: the social capital of corporate R&D teams. Organ Sci. 2001;12(4):502–17.
Reagans R, Zuckerman E, McEvily B. How to make the team: social networks vs. demography as criteria for designing effective teams. Adm Sci Q. 2004;49(1):101–33.
Reagans R, Miron-Spektor E, Argote L. Knowledge utilization, coordination, and team performance. Organ Sci. 2016;27(5):1108–24. https://doi.org/10.1287/orsc.2016.1078.
Ren Y, Argote L. Transactive memory systems 1985–2010: AN integrative framework of key dimensions, antecedents, and consequences. Acad Manag Ann. 2011;5(1):189–229.
Ren H, Gray B, Harrison DA. Triggering faultline effects in teams: the importance of bridging friendship ties and breaching animosity ties. Organ Sci. 2014;26(2):390–404. https://doi.org/10.1287/orsc.2014.0944.

Resnick P, Iacovou N, Suchak M, Bergstrom P, Riedl J. GroupLens: an open architecture for collaborative filtering of netnews. In: Proceedings of the 1994 ACM Conference on Computer Supported Cooperative Work. New York, NY: ACM; 1994. p. 175–86. https://doi.org/10.1145/192844.192905.

Rink F, Kane AA, Ellemers N, Vegt G v d. Team receptivity to newcomers: five decades of evidence and future research themes. Acad Manag Ann. 2013;7(1):247–93. https://doi.org/10.1080/19416520.2013.766405.

Ruef M, Aldrich HE, Carter NM. The structure of founding teams: Homophily, strong ties, and isolation among US entrepreneurs. Am Sociol Rev. 2003;68(2):195–222.

Rulke DL, Rau D. Investigating the encoding process of transactive memory development in group training. Group Org Manag. 2000;25(4):373–96.

Saporito B. The Conspiracy To End Cancer | TIME.com. Time; 2013. http://healthland.time.com/2013/04/01/the-conspiracy-to-end-cancer/.

Savage N. Collaboration is the key to cancer research [News]. 2018. https://doi.org/10.1038/d41586-018-04164-7.

Scupelli P, Kiesler S, Fussell SR, Chen C. Project view IM: a tool for juggling multiple projects and teams. In: CHI'05 extended abstracts on human factors in computing systems. New York: ACM; 2005. p. 1773–6.

Shah PP, Jehn KA. Do friends perform better than acquaintances? The interaction of friendship, conflict, and task. Group Decis Negot. 1993;2(2):149–65. https://doi.org/10.1007/BF01884769.

Shin SJ, Kim T-Y, Lee J-Y, Bian L. Cognitive team diversity and individual team member creativity: a cross-level interaction. Acad Manag J. 2012;55(1):197–212.

Shneiderman B. The new ABCs of research: achieving breakthrough collaborations. Oxford: Oxford University Press; 2016.

Shrum W, Chompalov I, Genuth J. Trust, conflict and performance in scientific collaborations. Soc Stud Sci. 2001;31(5):681–730. https://doi.org/10.1177/030631201031005002.

Shrum W, Genuth J, Chompalov I. Structures of scientific collaboration. Cambridge: MIT Press; 2007.

Singh J, Fleming L. Lone inventors as sources of breakthroughs: myth or reality? Manag Sci. 2010;56(1):41–56.

Singh J, Hansen MT, Podolny JM. The world is not small for everyone: inequity in searching for knowledge in organizations. Manag Sci. 2010;56(9):1415–38. https://doi.org/10.1287/mnsc.1100.1201.

Skilton PF, Dooley KJ. The effects of repeat collaboration on creative abrasion. Acad Manag Rev. 2010;35(1):118–34.

Spoelstra H, van Rosmalen P, Houtmans T, Sloep P. Team formation instruments to enhance learner interactions in open learning environments. Comput Hum Behav. 2015;45(Supplement C):11–20. https://doi.org/10.1016/j.chb.2014.11.038.

Stevens MJ, Campion MA. The knowledge, skill, and ability requirements for teamwork: implications for human resource management. J Manag. 1994;20(2):503–30. https://doi.org/10.1177/014920639402000210.

Stevens MJ, Campion MA. Staffing work teams: development and validation of a selection test for teamwork settings. J Manag. 1999;25(2):207–28.

Stewart GL. A meta-analytic review of relationships between team design features and team performance. J Manag. 2006;32(1):29–55. https://doi.org/10.1177/0149206305277792.

Stvilia B, Hinnant CC, Schindler K, Worrall A, Burnett G, Burnett K, Marty PF. Composition of scientific teams and publication productivity at a national science lab. J Am Soc Inf Sci Technol. 2011;62(2):270–83. https://doi.org/10.1002/asi.21464.

Taramasco C, Cointet J-P, Roth C. Academic team formation as evolving hypergraphs. Scientometrics. 2010;85(3):721–40. https://doi.org/10.1007/s11192-010-0226-4.

Thompson LL. Making the team: a guide for managers. 6th ed. New York: Pearson; 2018.

Treem JW, Leonardi PM. Social media use in organizations: exploring the affordances of visibility, editability, persistence, and association. Communication Yearbook. 2012;36:143–89.

Uzzi B, Spiro J. Collaboration and creativity: the small world problem. Am J Sociol. 2005;111(2):447–504.

Uzzi B, Mukherjee S, Stringer M, Jones B. Atypical combinations and scientific impact. Science. 2013;342(6157):468–72. https://doi.org/10.1126/science.1240474.

de Vaan M, Vedres B, Stark D. Game changer: the topology of creativity. Am J Sociol. 2015;120(4):1144–94. https://doi.org/10.1086/681213.

Valderas JM. Why do team-authored papers get cited more? Science. 2007;317(5844):1496–8. https://doi.org/10.1126/science.317.5844.1496b.

Wageman R, Gardner H, Mortensen M. The changing ecology of teams: new directions for teams research. J Organ Behav. 2012;33(3):301–15. https://doi.org/10.1002/job.1775.

Wang J, Hicks D. Scientific teams: self-assembly, fluidness, and interdependence. J Informet. 2015;9(1):197–207. https://doi.org/10.1016/j.joi.2014.12.006.

Weber G, Yuan L. The power of research networking systems to find experts and facilitate collaboration. In: Hall KL, Vogel AL, Croyle RT, editors. Strategies for team science success: handbook of evidence-based principles for cross-disciplinary science and practical lessons learned from health researchers. New York, NY: Springer; 2019.

Wegner DM. Transactive memory: a contemporary analysis of the group mind. In: Theories of group behavior. New York: Springer; 1987. p. 185–208.

Wegner DM. A computer network model of human transactive memory. Soc Cogn. 1995;13(3):319–39.

Wegner DM, Erber R, Raymond P. Transactive memory in close relationships. J Pers Soc Psychol. 1991;61(6):923–9.

Welbourne TM, Johnson DE, Erez A. The role-based performance scale: validity analysis of a theory-based measure. Acad Manag J. 1998;41(5):540–55. https://doi.org/10.2307/256941.

Williams KY, O'Reilly CA. Demography and diversity in organizations: a review of 40 years of research. Res Organ Behav. 1998;20:77–140.

Woolley AW, Gerbasi ME, Chabris CF, Kosslyn SM, Hackman JR. Bringing in the experts how team composition and collaborative planning jointly shape analytic effectiveness. Small Group Res. 2008;39(3):352–71.

Woolley AW, Chabris CF, Pentland A, Hashmi N, Malone TW. Evidence for a collective intelligence factor in the performance of human groups. Science. 2010;330(6004):686–8.

Wuchty S, Jones BF, Uzzi B. The increasing dominance of teams in production of knowledge. Science. 2007;316(5827):1036–9.

Zaccaro SJ, Dirosa GA. The processes of team staffing: a review of relevant studies. In: Hodgkinson GP, Ford JK, editors. International review of industrial and organizational psychology, vol. 2012. Hoboken: John Wiley & Sons, Ltd; 2012. p. 197–229. https://doi.org/10.1002/9781118311141.ch7.

Zhu M, Huang Y, Contractor N. Motivations for self-assembling into project teams. Soc Networks. 2013;35(2):251–64. https://doi.org/10.1016/j.socnet.2013.03.001.