How to Write a Collaboration Plan

Why Plan for Collaborations?

Science is becoming increasingly collaborative, and frequently involves multiple investigators, institutions, disciplines, and fields. Such collaborations often are able to address more complex and sophisticated research problems, by integrating the expertise and resources of multiple collaborators. But they also involve a number of costs, most particularly management complexities, including additional attention to planning for and facilitating effective team functioning, and preventing or addressing challenges specific to teamwork that can threaten the success of the initiative. Poorly managed collaboration may negatively impact the quality of the science, whereas well managed collaborations have the potential to foster innovation, creativity, and productivity.

To help enhance the success in scientific collaborations, funding agencies may ask investigators to submit "collaboration plans" as part of their funding applications, just as they ask investigators to submit research plans. Collaboration plans may benefit any scientific endeavor that includes two or more investigators working together. Though as a proposed scientific collaboration grows in scope and size, such plans become increasingly important.

Collaboration plans should address a range of issues relevant to laying the foundation for the collaboration, as well as implementing and managing the collaboration, and engaging in quality improvement activities specific to collaborative interactions. These plans identify existing supports and challenges relevant to the collaboration, and describe a program of action that will be implemented to help support smooth collaboration. Submitted collaboration plans can be used by investigators as "roadmaps" for their future initiatives, and by reviewers to help assess the capacity of a proposed team to collaboratively execute its scientific objectives.

Collaboration plans may vary substantially in size and complexity, as reflective of team science and complexity. Science teams can vary on a host of multi-level factors, such as team members' past experience with collaboration, geographic distribution of team members, and scientific problem space, among many others. In addition, each collaboration occurs in a unique context, shaped by the participating departments, institutions, and disciplines. As a result, each collaboration plan will be unique. For example, three co-PIs from the same department who have worked together successfully in the past might need only a modest collaboration plan. But a large multi-disciplinary multi-institution collaboration will likely require a detailed collaboration plan that, for instance, discusses how disciplinary differences will be bridged, and how the participating institutions will work together.

How to Use this Document

Funding agencies will provide specific requirements for collaboration plans in funding announcements and policy documents. The goal of this document is to provide general

guidance for investigators on key factors to consider in preparation for a collaborative initiative, and how factors may be described in a collaboration planning document. The document offers ten key factors important to planning for effective team functioning. Systematic consideration of these factors will help investigators to identify strengths and weaknesses of their proposed collaborations, and to plan strategies to support smooth team functioning given this unique set of conditions, with the ultimate goal of optimizing the team's scientific work together.

1. Rationale for Team Approach and Team Configuration

Team Approach: The collaboration plan should begin by justifying why the particular scientific questions and goals require a team approach. For example, to answer a question beyond the scope of an individual discipline, experts from other disciplines may be needed on the research team. Alternatively, a research question may require that a team rely on equipment or infrastructure located at multiple institutions, within multiple centers or labs.

Not all research questions are necessarily best addressed using a team-based approach. Scientific considerations are paramount when determining whether an individual or team-based approach is best. For instance, Hays notes, "if fields of science have not sufficiently evolved toward one another or their underlying support structures are incongruous, it may be difficult or impossible to initiate and maintain cross-disciplinary research even though the participants are eager and other readiness challenges have been successfully met" (Scientific Readiness: Hays, 2008).

Team Configuration: The collaboration plan also should identify how the proposed team composition is necessary to pursue the research goals. The team should include sufficient breadth to ensure the expertise and manpower necessary to fulfill research objectives. However, as the number of collaborators increases so do the potential challenges to collaboration (Cummings et al., 2012; Hall et al., 2012). The collaboration plan should describe the team size in light of this knowledge.

2. Collaboration Readiness

The plan should provide evidence for the collaboration readiness of the individual participating investigators, the team as a unit, and of the institutions involved. Not all individuals, teams, and institutions may be optimally ready for complex collaborations. Therefore collaboration plans should describe the existing collaboration readiness and describe strategies to address limitations.

Individual collaboration readiness refers to individual characteristics related to collaborative initiatives, e.g., willingness to and interest in engaging in collaboration, and past experience with team collaborations (Stokols, et al., 2008; Hall et al, 2008, Stipelman, 2010). Team members may have different personalities, work styles, and experience that influence their engagement in team-based work, therefore recognition of those differences and strategies for managing such differences should be considered (e.g., See Bennett, Gadlin, Levine-Finley, 2010 at

https://www.teamsciencetoolkit.cancer.gov/public/TSResourceTool.aspx?tid=1&rid=267
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Team collaboration readiness includes factors such as the mix of collaboration histories of proposed team members. For example, teams with a mix of prior collaborators and new collaborators may be most successful because they can benefit from the good working relationships of prior collaborators as well as the new perspectives injected by new team members(Uzzi & Spiro, 2005). Online team diagnostic surveys can be used to assess a team's readiness for collaboration (e.g., Wageman R, Hackman R, and Lehman E, 2005; Bietz MJ, Abrams S, Cooper DM, Stevens SR, Puga F, Patel DI, et al., 2012).

Institutional collaboration readiness refers to the resources, infrastructure, and policies that each of the participating institutions have in place to support the collaboration. Institutions may provide support relevant to each of the key planning factors described in this document. Examples include: technologies to support communication and coordination; training opportunities relevant to collaboration; promotion and tenure policies that recognize (or at least do not penalize) participation in science teams; research development professionals (e.g., http://www.nordp.org/) whose job it is to support team formation and nurture partnerships; and consultants who can enhance leadership and management skills, and facilitate quality improvement activities. This section should address each of the institutions involved in the proposed collaboration.

The goal of this portion of the plan is to demonstrate individual, team, and institutional readiness for the proposed collaboration. It is not expected that conditions will be ideal at any of these levels, but challenges should be identified before entering upon a collaboration, and whenever possible, the plan should identify steps that will be taken to address the challenges.

3. Technological Readiness

The plan should document the availability and planned use of technological resources to support the scientific collaboration. These may include mechanisms to support the scientific process, including technologies for data sharing and analysis (e.g., data sharing agreements, common databases, online collaborative data analysis platforms). These may also include mechanisms to support collaborative processes, such as communication technologies (e.g., videoconferencing, teleconferencing) and coordination technologies (e.g., calendaring, task management platforms, and work flow or project management tools).

An important consideration is whether members of the team are ready to use the available technologies, including having both the willingness and skills to use the technologies necessary for the collaboration. Another important consideration is the interoperability of systems, as members of the group may have trouble working together if they are using different systems (e.g., different videoconferencing systems, different database systems, or different data analysis packages).

4. Team Functioning

The collaboration plan should describe plans for carrying out key processes that underlie effective team functioning. These might include plans for generating a shared vision, mission and goals; creating shared mental models; and externalizing group cognition throughout the collaboration (e.g., generating visual schematics that capture the group's understanding of a variety of factors relevant to their collaboration, including the scientific problem space and collaborative research work flow). Additional key team processes include developing team-level understanding of each team member's areas of expertise, roles on the team, and contributions to the science. This is also known as developing shared understanding of who knows what (compilational memory) and does what (compositional memory), and how things get done (taskwork memory) (Hall et al., 2012).

Collaboration plans for interdisciplinary teams may also include plans for fostering key team processes necessary for interdisciplinary work, such as critical awareness of the strengths and weaknesses of contributing disciplines, and shared language that bridges disciplinary differences (Hall et al., 2012).

Examples of strategies that can be used to support these team processes include: kick-off retreats focused on developing the shared vision, mission, and goals; development of cooperative agreements and operating manuals for collaborations; and regularly scheduled "touch" meetings for team members to maintain and update their shared understanding of the science and work process. These strategies should take into account unique or complex factors for the proposed collaboration, such as the phase of the research process (Hall et al., 2012), interpersonal relationships and collaborative history of team members (Stokols et al., 2008), and the complexity of the collaboration (e.g., the size, diversity, dispersion, task interdependency of team). Professional consultation or facilitation may be helpful to support some of these processes.

5. Communication & Coordination

Team-based scientific initiatives require that effort be invested in supporting effective communication and coordination of tasks. As team size increases, so does the investment needed for effective communication and coordination.

Communication: Teams that are particularly diverse in terms of team members' locations, demographics or disciplinary cultures (e.g., authorship traditions, work styles, terminology, preferred methods) will face increased communication challenges. The collaboration plan should describe the plans for communication within the team, such as meeting frequency and modality (e.g., teleconference, in-person meeting), for collaborations across time zones (e.g., mutually respectful meeting timing) and for asynchronous communications (e.g., email use or document sharing).

Coordination: Greater use of coordination mechanisms has been found to be related to more successful outcomes in large teams (Cummings & Keisler, 2005, 2007). The collaboration plan should include strategies to coordinate day-to-day operations and

approaches for the completion of scholarly products (e.g. work flow, data sharing and integration). The plan should address how tasks get allocated, how resources get shared, and how work gets integrated into the collaborative effort. These plans need to be specific to the particular collaboration, addressing, for example, such factors as the number and distribution of team members and the design of team tasks.

6. Leadership, Management, and Administration

The plan should describe the planned leadership and management approach that will be used to address the other components in the specific team context proposed in the initiative.

Leadership: Providing vision and direction for an initiative is critical to success, particularly in team-based science. The more complex the initiative, the greater the demands on leadership and management. There are numerous approaches to leadership (e.g., hierarchical, heterarchical, transformational, transactional). A leader's approach will depend on the particulars of the initiative and the personalities of the leader and other team members. When more than one formal leader is identified for a collaboration, specific shared leadership strategies are needed (e.g., see NIH multiple PI leadership plan examples: http://grants.nih.gov/grants/multi_pi/sample_leadership_plans.pdf).

Management: Ensuring that the vision established by the scientific leader is carried out requires roles to be established, tasks to be identified, and research plans to be executed. The collaboration planning documents should outline overall strategies for managing personnel, processes and procedures within the team and across institutions. For example, teams should establish how key decisions will be made about scientific direction or changes in the team.

Administration: As team size increases, administrative tasks become increasingly important to team coordination. Administrative activities of critical importance to large teams including recruitment, hiring, and daily administration of the team workforce.

7. Conflict Prevention and Management

Some degree of conflict within a collaboration is inevitable and indeed, may even be helpful for the team to achieve its goals, for example by leading to new avenues of thinking for everyone involved. But there is a qualitative difference between generative debate that focuses on scientific disagreement, which may help to further scientific goals, and relational conflict that may undermine team functioning, and ultimately negatively impact the science.

The potential for conflict will depend on the specifics of the team, e.g., member diversity in terms of demographics (e.g., age, gender, culture) or disciplinary training may lead to conflict. But the specific areas of conflict, and the ways they play out, will vary with the unique combination of types of diversity on the team (Eigenbrode et al., 2007). For example, the existence of subgroups among team members may produce fault lines along which conflicts emerge (Bezrukova, 2013).

Many sources of team conflict can be anticipated (e.g., disciplinary differences). But conflicts may arise even when not expected. For example, investigators with similar training may underestimate the potential for conflict due to incorrect assumptions about areas of agreement.

Conflict Prevention: Considering potential factors that may lead to conflict (e.g., ownership of data; intellectual property rights; authorship order) and addressing these factors before the collaboration begins can reduce conflict later on. The plan should identify strategies for engaging in this process. For instance, for a small scale collaboration, an example strategy is the use of a pre-collaboration agreement, also sometimes called a "prenuptial agreements for scientists" (Gadlin & Jessar, 2002). For a large scale collaboration, development or use of an operating manual may be warranted (e.g., http://www.teamsciencetoolkit.cancer.gov/public/TSResourceTool.aspx?tid=1&rid=371).

Conflict Management: Despite efforts to prevent conflict, conflict may still arise. To be successful, initiatives must develop systems for managing conflicts, e.g., processes for encouraging debate and facilitating productive conflict while preventing or managing negative forms of conflict; as well as processes and procedures for resolving detrimental conflicts. Institutions might support teams by providing informal and formal channels for conflict resolution. Plans for managing conflict should be included in the collaboration planning document. The approach taken should be commensurate with the characteristics of the proposed collaboration (e.g., size, geographic dispersion of members, cross-cultural make-up).

8. Training

Training plans should be included to help participating investigators to enhance collaboration. Training may be included, for investigators for whom collaboration is new as well as for those with prior collaborative experience, to enhance knowledge and skills specific to factors related to the proposed collaboration. Training may occur at start of the initiative and/or periodically throughout the collaboration.

Training Content: Training for scientific collaboration can help to build skills in many of the key areas identified in this document (e.g., team processes, leadership, management, communication, coordination and quality improvement activities) (Fiore, Hall, et al., in progress). For interdisciplinary collaborations, training might also include a focus particular to cross-disciplinary work, such as critical awareness of the strengths and weaknesses of all disciplines, and strategies for combining approaches (e.g., theories, concepts, methods) from two or more disciplines. Trainings may also convey skills related to using platforms and technologies that will be used in the particular collaboration, e.g., shared databases and data analysis software.

Training format: Training should be designed to meet a wide variety of investigator circumstances and needs, including: different career stages, learning styles, training interests and needs, and practical constraints. For example, web-based and webinar-based training may be most appropriate for geographically distributed teams. Training can be

carried out at the individual level and for team units. Training might be formal (e.g., online courses, such as teamscience.net, which provides a completion certificate) or informal (e.g., seminar series featuring the work of all participating team members, to build cross-disciplinary awareness and greater mutual understanding).

9. Quality Improvement Activities

Teams that engage in systematic and iterative reflection about team performance and subsequently adapt their team objectives and processes show better performance, including higher levels of innovation (West et al., 2011; West & Lyubovikova, 2012). The collaboration plan should describe activities that will be implemented over the course of the research initiative to facilitate reflection about team performance (e.g., pre-briefing and debriefing). It should also describe how the resulting information will be used for continuous quality improvement, to help address challenges and improve the quality of the collaboration. For a large and complex initiative, it may be helpful to involve outside experts to design and implement these feedback and quality improvement oriented activities (e.g., appreciative inquiry processes, Toolbox Collaborative Communication Instrument - http://www.teamsciencetoolkit.cancer.gov/public/TSResourceTool.aspx?tid=1&rid=775.) Institutions might help by providing support for such activities.

10. Budget/Resource Allocation

Successful collaborations require investments in training, management and quality improvement, all of which require financial support to ensure their successful implementation. The collaboration plan should identify the specific budget items that support the activities included in the plan. Clear but flexible plans for funds can allow optimal preparation for and facilitation of collaboration. This can be particularly important in large and complex initiatives where directions can change and additional collaborations can be formed during the course of the initiative.

Final Considerations

As noted above, collaboration plans offer a structure that can guide investigators in thinking through how they will plan to support the activities of collaboration involved in a team-based scientific endeavor. It also helps them consider what challenges the collaboration will face—for example, related to institutional barriers, cross-disciplinary collaboration, or distance collaboration—and to plan for whether and how these might be addressed through management and leadership activities. Accordingly, collaboration plans should be "living documents," first developed in the planning stages of a collaboration, and then periodically updated as the collaboration is underway, to reflect changes in the circumstances of the collaboration and the growing experience and knowledge of the team as they continue to work together.

As investigators gain experience in collaboration planning, plans and procedures may become standardized for a research group, institution or even a community of scholars (e.g., a discipline or field). Such standardization might be reflected in the development of

language that reflects particular institutionalized procedures, as well as available resources. Having such language to draw upon, in addition to examples of prior collaboration plans with information about successful and unsuccessful strategies, can greatly facilitate the development of future collaboration plans. Ultimately, however, each plan will be tailored to the unique circumstances of the proposed collaborative initiative. The goal is to effectively collaborate to more rapidly advance science.