TEAM SCIENCE

"Team research, especially interdisciplinary research, is characterized by synergies among experts that can transform both scholars and scholarship“

– John Cacioppo, PhD, the Tiffany and Margaret Blake Distinguished Service Professor in Psychology, The University of Chicago, from the Arete Initiative website http://arete.uchicago.edu/ (2010)
What is Team Science?

Cross-disciplinary Research + Collaboration = Team Science
Cross-disciplinary Collaboration

- **(Un)Disciplinary** research
- Three **Cross-disciplinary** collaborative research orientations
  - Combine or integrate from more than one field:
    - Concepts, Methods, and Theories
  - **Multidisciplinary**
    - Independent, Sequential, Divisional
    - Exchange
  - **Interdisciplinary**
    - Joint, Interactive, Partnership
    - Dialogue, Hybridization, Complementary
  - **Transdisciplinary**
    - Integrative, Interdependence, Emergence
    - Reciprocity, Discourse, Share Vocabulary, Extends
Interdisciplinary research (IDR) is a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.
Collaboration

Science Facilitated by Team Science

- Problem/Project/Product-oriented
- Urgent and Complex
- Shared Goal between investigators from different disciplines/with different expertise
- Shared Approach through a common facility, instrumentation, data set(s)
- Intractability: Successive efforts not able to make progress
- Grand Challenge: Intellectual challenge and potential high payoff
- Complementary to *not mutually exclusive of* individual investigator-driven research
Science of Team Science (SciTS)

- A new interdisciplinary and rapidly emerging field
- Concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of large-scale cross-disciplinary, collaborative research, training, and translational initiatives

Field has grown
- Societal concerns
- Cost-effectiveness
- Accountability
Science to Practice

- There is an increased demand for team science initiatives in academia and by external funding agencies
- Coordination costs mean that team science takes more time, at least proximally; distal payoff in terms of acceleration
- Imperative then that we understand the most effective practices for productive cross-disciplinary collaboration and team science
- So that we can train individual investigators, institutional leaders, and funding agencies to employ them
Evidence Informing Practice

- Increasingly difficult to make scientific discoveries
- More people required to find out new things
- Research increasingly done in teams, for virtually all fields
- Teams typically produce more highly cited research than individuals
- Teams that are more diverse are even more highly impactful
- More team science is done inter-institutionally
- Virtual communities produce higher impact work
- International collaboration shows a further boost in citation impact
- But, dispersed teams have a high rate of failure
- Women scientists who do not collaborate are less productive
Contextual Factors Influencing Team Science

Interpersonal
- Members' familiarity, informality, and social cohesiveness
- Diversity of members' perspectives and abilities
- Ability of members to adapt flexibly to changing task requirements and environmental demands
- Regular and effective communication among members to develop common ground and consensus about shared goals
- Establishment of a hospitable conversational space through mutual respect among team members

Organizational
- Presence of strong organizational incentives to support collaborative teamwork
- Nonhierarchic organizational structures to facilitate team autonomy and participatory goal setting
- Breadth of disciplinary perspectives represented within the collaborative team or organization
- Organizational climate of sharing (e.g., sharing of information, credit, and decision-making responsibilities is encouraged)
- Frequent scheduling of social events, retreats, and other centerwide opportunities for face-to-face communication and informal information exchange

Physical Environmental
- Spatial proximity of team members' workspaces to encourage frequent contact and informal communication
- Access to comfortable meeting areas for group discussion and brainstorming
- Availability of distraction-free workspaces for individualized tasks requiring concentration or confidentiality
- Environmental resources (e.g., sound masking, closable doors and workstation panels) to facilitate members' regulation of visual and auditory privacy

Societal and Political
- Cooperative international policies that facilitate exchanges of scientific information and transdisciplinary collaboration
- Environmental and public health crises that prompt intersectoral and international transdisciplinary collaboration in scientific research and training
- Enactment of policies and protocols to support successful transdisciplinary collaborations (e.g., those ensuring ethical scientific conduct, management of intellectual property ownership, and licensing)

Technologic
- Technologic infrastructure readiness including access to necessary bandwidth, electronic communication equipment, strong network linkages between remote sites, availability of technical support
- Members' technologic readiness (e.g., their familiarity with electronic information tools and protocols, and the effectiveness of their communication styles)
- Provisions for high-level data security, privacy, rapid access and retrieval

Collaboration Motivations and Deterrents

COADUNATION
= Unified Structures & Combined Cultures

Hard to Find mechanisms to Sustain a Collaboration
Natural affinity to help others, strong service attitude

Hard to Find Funding Mechanisms to support Collaborative Research
Best Serves Problem-centric Science

COLLABORATION
= Integrated Strategies & Collective Purpose

Concerns about authorship
Difficulty determining the appropriate level of Cross-disciplinary integration

Concerns that my referees won’t be supportive
Lack of external recognition reward
Concerns about getting promoted/tenured

Need for division of labor
Too hard to agree on a common goal

Enjoy learning about new areas of science/scholarship
Interdisciplinary literacy
To avoid competition

To extend reach, build my network
Mentoring Opportunity
Necessary to pursue interdisciplinary research

Lack of Institutional Recognition/Reward
Having a special specific skill set that others need
Like sharing my passion

Solve problems faster
Want need to learn new skill (set)

My impression of the validity of qualitative versus quantitative data
Don’t want to become dependent

It’s fun
Like working with other people

Intellectual Stimulation
Threat to my status
Prefer unilateral decision-making authority

Disparity in methods for acquiring and validating information
Prefer hierarchical relationships
Threat to my power

Coordination
= Common Tasks & Compatible Goals

Shared Interests
Access to trainees

Access to scientific resources
Value Individual Expertise

Science is best served via individual investigator
Communication/IT infrastructure

An interdisciplinary team
Preference of for competition

A previous disappointing experience
Time Constraints

Fear of rejection
Don’t wish to express need

Fear of rejection
Loss Aversion

COOPERATION
= Shared Information & Mutual Support


SELF-actualization
= Morality, creativity, spontaneity, problem-solving, lack of prejudice, acceptance of facts

Esteem
= Self-esteem, confidence, achievement, respect of others

Love/Belonging
= Friendship, family, sexual intimacy

SAFETY
= Security of body, employment, resources, of morality, of the family, of health, of property

Psychological
= Breathing, food, water, sex, sleep, homeostasis, excretion

Maslow (1954)
TOOLS FOR TEAM SCIENCE

“...a generation of scientists must be trained to both understand and embrace team science.”

TEAM SCIENCE
Volume 2, Issue 2 – 2012

In our new issue, academic leaders around the globe share their knowledge of and experience with team science. Authors from the United States, Germany, Malaysia, and India explore team science in terms of institutional and national influence, team science tools and leadership, team formation and research networking systems.

The **Science of Team Science (SciTS) listserv** facilitates conversation among individuals who are engaged in, studying, or managing team science, in the US and internationally. The listserv is maintained collaboratively by the SciTS Team at the National Cancer Institute, Division of Cancer Control and Population Sciences, Behavioral Research Program ([http://cancercontrol.cancer.gov/brp/scienceteam](http://cancercontrol.cancer.gov/brp/scienceteam)) at the NIH.

- **TO SUBSCRIBE:** Send an email with a blank subject line to: listserv@list.nih.gov. The message body should read: subscribe SciTSlist [your full name]. Please do not include the brackets. For example, for Robin Smith to subscribe, the message would read: subscribe SciTSlist Robin Smith. You will receive a confirmation email.
- **TO POST TO THE LISTSERV:** Send an email to SciTSlist@list.nih.gov. Any subscriber may post to the list.
- **TO VIEW THE ARCHIVES:** To view the archives of all previous postings, go to: [http://list.nih.gov/archives/SciTSlist.html](http://list.nih.gov/archives/SciTSlist.html)
- **TO RECEIVE MESSAGES IN A DAILY DIGEST:** The default setting sends you each message as it is posted to the listserv. To receive one daily digest, instead, go to: [http://list.nih.gov/cgi-bin/wa.exe?SUBED1=SciTSlist&A=1](http://list.nih.gov/cgi-bin/wa.exe?SUBED1=SciTSlist&A=1) and select “digest” as your subscription type.
- **TECHNICAL PROBLEMS WITH YOUR SUBSCRIPTION?** Contact the list administrator, Judy Kuan, at: kuanj@mail.nih.gov. Please be sure to state that your email is in reference to the SciTS listserv.
Mendeley SciTS Group

http://www.mendeley.com/groups/3556001/science-of-team-science-scits/
Groups of Documents

[Image of a webpage with a table and text]

**Credit Promotion and Tenure in Science of Team Science (ScITS)**

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<th>Authors</th>
<th>Title</th>
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<td>Hertman, Neel</td>
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<td>Graybill V., J and Shandas</td>
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<td>Caro, Richard</td>
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<td>Feder, M E; Madara, J L</td>
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[Link: http://www.mendeley.com/groups/3556001/science-of-team-science-scits/]
Team Science Toolkit

An interactive website to help you support, conduct and study team-based research.

Discover what resources are available...

"The Toolkit provides a wealth of resources for team scientists, including practical tools to use with your colleagues, such as team assessment guides and training resources."

—Holly Falk-Krzesinski, Vice President, Global Academic & Research Relations, Elsevier

Recent Added Resources

- New Directions in Assessing Individuals and Groups
- Finding the Needle in the Haystack: A Public Challenge
- The Individual and Scholarly Networks -- Virtuous Circle

The Toolkit currently includes 523 resources.

Resources
- Tools
- Measures
- Bibliography

Connections
- Blog
- Expert Directory
- Listserv

www.teamsientoolkit.cancer.gov
Discover:
- Learn from colleagues by exploring Toolkit resources contributed by other users
- Download resources that can support your goals

Contribute:
- Share your knowledge of team-based research and the Science of Team Science (SciTS) field
- Upload resources such as documents and links, or comment on resources already in the database

Connect:
- Connect with colleagues who share your interest in team-based research through the expert blogs, news and events bulletin boards, expert directory, and listserv
The Science of Team Science

Project Scope

The NRC will conduct a consensus study on the science of team science to recommend opportunities to enhance the effectiveness of collaborative research in science teams, research centers, and institutes. The science of team science is a new interdisciplinary field that empirically examines the processes by which large and small scientific teams, research centers, and institutes organize, communicate, and conduct research. It is concerned with understanding and managing circumstances that facilitate or hinder the effectiveness of collaborative research, including translational research. This includes understanding how teams connect and collaborate to achieve scientific breakthroughs that would not be attainable by either individual or simply additive efforts. The committee will consider factors such as team dynamics, team management, and institutional structures and policies that affect large and small science teams. Among the questions the committee will explore are:

- How do individual factors (e.g., openness to divergent ideas), influence team dynamics (e.g., cohesion), and how, in turn, do both individual factors and team dynamics influence the effectiveness and productivity of science teams?
- What factors at the team, center, or institute level (e.g., team size, team membership, geographic dispersion) influence the effectiveness of science teams?
- How do different management approaches and leadership styles influence the effectiveness of science teams? For example, different approaches to establishing work roles and routines and to the division of labor may influence team effectiveness.
- How do current tenure and promotion policies acknowledge and provide incentives to academic researchers who engage in team science?
- What factors influence the productivity and effectiveness of research organizations that conduct and support team and collaborative science, such as research centers and institutes? How do such organizational factors affect human resource policies and practices and cyberinfrastructure affect team and collaborative science?
- What types of organizational structures, policies, practices and resources are needed to promote effective team science, in academic institutions, research centers, industry, and other settings?

Sponsored by the National Science Foundation and Elsevier, the project began in October, 2012. A report will be issued in late 2014 or early 2015.

Members

Dr. Nancy J. Cooke, Chair, Arizona State University  
Dr. Roger Blandford, Department of Physics, Stanford University
A Field Guide/Partner Agreement

Collaboration & Team Science: A Field Guide

- Overall Goals & Vision
- Who Will Do What
- Sharing/Storing Reagents & Data
- Authorship, Credit
- Contingencies & Communicating
- Conflict of Interest


http://ombudsman.nih.gov/collaborationTS.html
The Toolbox Project\textsuperscript{1,2} Collaborative Communication Workshop provides a philosophical yet practical enhancement to cross-disciplinary, collaborative science. Rooted in philosophical analysis, the Toolbox workshop enables investigators, research development professionals, project managers, and collaborators to engage in a structured dialogue about their research assumptions and cross-disciplinary collaboration. This yields both self-awareness and mutual understanding, supplying individuals with the robust foundation needed for effective collaborative research. Led by Toolbox Project Facilitators, Workshop participants will engage in small group discussion and share respective views in response to a number of probing statements about science motivation, methodology, confirmation, objectivity, values, and reductionism.


## Toolbox Questionnaire

<table>
<thead>
<tr>
<th>Philosophical domain and issue</th>
<th>Core question</th>
<th>Probing Statements</th>
</tr>
</thead>
</table>
| **Motivation**                | Does the principal value of research stem from its applicability for solving problems or its potential for making basic discoveries? | 1. Applied research is more important to me than basic research.  
   *Disagree* 1 2 3 4 5  
   *Agree* 1 2 3 4 5  

2. Cross-disciplinary, collaborative research is better suited to addressing applied questions than basic questions.  
   *Disagree* 1 2 3 4 5  
   *Agree* 1 2 3 4 5  

3. My research primarily addresses basic questions.  
   *Disagree* 1 2 3 4 5  
   *Agree* 1 2 3 4 5  

4. The importance of our project stems from its applied aspects.  
   *Disagree* 1 2 3 4 5  
   *Agree* 1 2 3 4 5  

5. The members of this team share similar views concerning aspects of basic and applied research.  
   *Disagree* 1 2 3 4 5  
   *Agree* 1 2 3 4 5 |
Collaboration Success Wizard

- On-line diagnostic survey for geographically distributed collaborations. The survey probes factors that may strengthen or weaken the collaboration. The Wizard provides both personal and project-level reports to help build successful and productive collaborative projects.

Measuring Collaboration Among Partners

- Evaluate collaboration and communication
- Levels of Collaboration Scale
- Visually display results of collaboration

Levels of Collaboration Survey

Figure 2
Levels of Collaboration Survey

This form is designed for those who work in one of the organizations or programs that are partners in the *Safe Schools, Healthy Students* initiative. Please review these descriptions of different levels of collaboration.

- On the response section at the bottom of the page, please circle the name of the organization or group with which you are associated.
- Using the scale provided, please indicate the extent to which you currently interact with each other partner. (Skip your own row.)

<table>
<thead>
<tr>
<th>Relationship Characteristics</th>
<th>Networking 1</th>
<th>Cooperation 2</th>
<th>Coordination 3</th>
<th>Coalition 4</th>
<th>Collaboration 5</th>
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<td>Aware of organization</td>
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<td>Loosely defined roles</td>
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<td>Little communication</td>
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<td>All decisions are made</td>
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<td>each other</td>
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<td>Somewhat defined roles</td>
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<td>Formal communication</td>
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<td>Defined roles</td>
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<td>Frequent communication</td>
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<td>Some shared decision</td>
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<td>Share ideas</td>
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<td>Share resources</td>
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<td>Frequent and</td>
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<td>All members have a</td>
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<td>vote in decision making</td>
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<td>Frequent communication</td>
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Leadership Series

- Leadership Skills
- Collaborative Communication
- Collaborative/Center Funding Opportunities and Grant Proposal Development
- Cognition and Conflict Management
- Negotiation and Networking
- Reward System Discussion
Discussion Questions

- What was the nature/impetus for the collaboration?
- What factors helped the team build trust?
- What factors threatened that trust?
- How did the team use communication effectively?
- What communication issues were problematic for the team?
- How did the team manage conflict?
- What strategies did the team employ to share credit?
- What role, if any, do power and hierarchical relationships play in this case?
NIH Science of Team Science (SciTS) 2015 Conference
National Institutes for Health
Natcher Conference Center, Bethesda MD
June 2-5, 2015

http://www.scienceofteamsciences.org
OCTOBER 23-26, 2015 AT ASILOMAR CONFERENCE CENTER

Improve Your Research and Leadership Capacity

REWARDING TEAM SCIENCE

“We will need to find better ways to do team science and reward it if we are to solve large overarching problems. Everybody on the team needs to get the same big gaudy championship ring…”

“Blackhawks' Stanley Cup rings will be handed out to players, coaches, equipment managers, trainers and medical staff…during a private ceremony.”
Individual vs. Contributory Assessment

- **Emphasis on individual accomplishments**
  - 1st/last author positions
  - PI status
  - Individual impact factor

- **Collaborative factors generally not considered**
  - Individual/group production
  - Extent to which an individual enables a team
  - Team size
Focus on Promotion & Tenure Policy

- NAS Facilitating Interdisciplinary Research Report, 2004
  - Academic survey respondents indicated that P&T criteria were the greatest impediment to interdisciplinary research in their campus

- Council of Environmental Deans and Directors Report, 2005
  - “Lured into the collaborative research needed for progress in an interdisciplinary field, scholars are later held to the standards of specific disciplines”
  - Need to develop new [recruitment, retention, promotion & tenure] procedures for handling interdisciplinary scholars

- University of Chicago Academic Medical Center Study, 2008
  - “Recognize all forms of scholarship as equally legitimate bases of academic tenure”
  - Subsequent change of P&T policy language that specifically addresses collaboration scholarship

- Creating interdisciplinary campus cultures: A model for strength and sustainability, J. T. Klein, 2010
  - Interdisciplinary career life cycle
  - Hiring, P&T
  - Ongoing faculty development
Team Science APT Study

“I am interested to know if your institution’s current APT policies or guidelines include any specific language regarding collaborations/collaborative activity, multi/interdisciplinary research and scholarship, and/or team science.”

Offered to share all responses with all respondents, in raw form

Deposit collected APT policy language to the NIH’s Team Science Toolkit

Use the policy information to guide the development of a publishable analysis aimed at understanding the relationship between codified policy relevant to collaboration, multi/interdisciplinary research and teaching, and team science and the implementation and realization of policy through processes, practices, and perceptions
The Responses

- Responses from 43 institutions
- Central Admin and/or Medical School
- 33 institutions shared policy excerpts
- Other responses
  - No response
  - Not applicable
  - Responded, but no such policy language exists
  - And one that may surprise you…
Still Resistance

“I would hesitate putting language like that in the [Arkansas and] Chicago descriptions in the tenure-track, clinical scholar and clinician tracks as doing so would lower our bar for promotion.”
The Details
Thank You

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