Report of the NSF Advisory Workshop on Research Networks

Alejandro Adem (Pacific Institute for the Mathematical Sciences)
Gerard Ben Arous (Courant Institute)
Nassif Goussoub (University of British Columbia)
Douglas Lind (University of Washington)
Douglas Ulmer (University of Arizona)

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WORKSHOP DESCRIPTION

Thirty-five mathematical scientists, broadly representative of the community, met in Washington, DC during April 19-20, 2009, to advise the NSF Division of Mathematical Sciences (DMS) on whether to establish a new program of research networks to complement and strengthen its current modes of individual investigator awards and research institutes. They were joined by seven observers from the DMS. A list of participants is given at the end of this report. The workshop was organized by Alejandro Adem, Gerard Ben Arous, Douglas Lind, and Douglas Ulmer, and supported by NSF Grant DMS-0929868.

The workshop began with an overview by Peter March describing NSF funding and how a program of research networks might complement current support mechanisms. This was followed with presentations by Nancy Kopell on the Cognitive Rhythms Collaborative, Gerard Ben Arous on the PIRE international probability network, Nassif Ghoussoub on the PIMS networks in western Canada, and Frank Kiefer on the Priority Programs of research networks in Germany. The ensuing discussions isolated key questions and concerns, leading to three breakout sessions to consider these in detail, and a concluding general session to come to agreement on the main recommendations.

There was unanimous enthusiasm for creating a program of research networks at DMS. Participants made many concrete suggestions for how such a program might work, and for soliciting and evaluating proposals. The following report tries to accurately reflect these discussions, and although not every participant may agree with every recommendation, we believe that our report captures the essential conclusions of the workshop.

VISION, NEED, GOALS

A program of DMS Research Networks will provide a new platform to attack complex mathematical and related problems by creating networks that cross professional, institutional, disciplinary, geographic, or other boundaries. It envisions a flexible distributed structure of nodes and edges that will foster interactions not activated nor achieved by existing mechanisms.

A node is an existing concentration of expertise, while an edge is the possibly missing interaction between the nodes. Funding for Research Networks will focus on supporting edges rather than nodes.

Workshop participants felt that a Research Networks program would fill a serious need in research support in the mathematical sciences. Currently DMS supports research through either highly focused individual investigator awards extending over multiple years, or shorter programs at the seven mathematics research institutes that it funds. Missing from this portfolio is a mechanism to support larger groups of mathematical scientists engaged in sustained, collaborative efforts, especially those that cross the kinds of boundaries mentioned above. The current program of Focused Research Groups is a step in this direction, but we envisage Research Networks to be significantly larger, more inclusive, and often more interdisciplinary. They would leverage current funding methods with new and cost-effective ways to amplify their impact and reach.

The goal is to build regional, national and international scientific partnerships that will develop interactions among diverse groups of scientists, institutions or disciplines which would benefit from a more sustained collaboration. Research Networks will address increasingly complex problems that require more sustained and collaborative interactions requiring a variety of expertise. They will encourage imaginative and novel ventures with the potential for high value outcomes. In addition, they will substantially enhance the training of new generations of mathematical scientists by increasing their exposure to new ideas, and the development of expertise and methods crossing boundaries. They have the potential to re-invigorate and stimulate scientists through supporting new interactions, multiplying opportunities, and by linking academia with industry to be an effective promoter of research and development. They would also serve as an effective platform for generating support for the mathematical sciences from other funding agencies.

The value of research networks has been recognized abroad. The European Union has extensive experience in creating research networks crossing national as well as disciplinary boundaries in numerous scientific disciplines. The Priority Programs of the Deutsche Forschungsgemeinschaft are well-funded six-year research networks in Germany involving multiple universities. Closer to home, the Collaborative Research Groups of the Pacific Institute for the Mathematical Sciences in western Canada and the northwestern US have a track record for innovative research.

NETWORKS

A Research Network is a (possibly) time-varying collection of nodes and connecting edges. Nodes are typically institutionally based, and include mathematical science departments (including statistics departments), other academic departments, national laboratories, industry, and international institutions. Edges are boundary-crossing activities such as exchanges of

postdocs and graduate students; joint supervision of postdocs; visits for collaboration; conferences, workshops, and schools; team-taught or distance courses; regular web-based seminars; and shared access to facilities, equipment, instrumentation, or cyberinfrastructure. Many of these edge activities could take advantage of the rapid advances in communication technology such as videoconferencing and internet collaborations.

A network should have a lead institution (which could vary over time). There are many possible organizational structures, and determining an effective structure for a particular network is a serious challenge. To give just one example, the other nodes might be arranged in tiers, with a central core of permanent nodes and tier of secondary nodes which might join and leave the network in response to scientific developments.

Nodes may be enabled through collaborative proposals or subcontracts. We encourage DMS to explore ways to simplify these mechanisms and mitigate the issue of double overhead on subcontracts.

A successful Research Network should be transformative: it enables new ideas, collaborations, interactions, and discoveries that would not be possible under current funding schemes. Its effects should be significantly greater than the sum of its parts. It would also empower researchers to think bigger, increasing the scope and range of scientific questions as well as the variety of possible funding sources. A network should not be a substitute for a collection of individual research grants. It should also not grow so large as to be unmanageable or to "corner the market" in a research area.

Although attacking core scientific questions is a major motivation for networks, a network activity will also have positive secondary effects on the US scientific workforce such as broadening participation, providing significant resources to highly qualified researchers who are not supported by individual research awards, increasing the diversity of participants, and providing junior researchers with valuable guidance about where to focus their energies. Availability of network involvement could also develop the research capabilities of faculty at otherwise isolated institutions.

SOLICITATION

Support for Research Networks should arise and evolve in a way consistent with the nature of the network. The solicitation for proposals should allow for two phases.

An optional Phase I of modest initial support of perhaps two years would allow proposers to explore connections and opportunities, and prove viability. Network ideas could be incubated from programs at the research institutes, grow from collections of researchers seeking to form a critical mass, or formed by groups wanting to capitalize on new developments.

Phase II would support a fully functioning network for perhaps three to five years. Continued funding would be subject to careful review. Although the solicitation should not contain any explicit "sunset" provision, we do not envisage networks as long-term infrastructure grants, and any extension of funding should require a network to demonstrate its continuing transformative character. Proposals should contain plans to ramp down activities at the end of funding, and describe the long-term benefit of the network after funding ends.

Review criteria should be few and simple. A successful proposal should answer clearly the following questions:

- What is the “big idea” motivating the formation of a network? What is the scope of the research aims and goals of the network?
- Why is a network timely?
- Why is a network well suited or needed to achieve its goals? What are the boundaries crossed (for example intellectual or geographic), and what is the transformative nature of the network? What is the added value from funding a network?
- What are the nodes and edges, and how will they interact to create new ideas and collaborations?
- How will the network help train and mentor the next generation of mathematical scientists?
- Does the network have a natural term or lifetime?
- What is the detailed plan for managing, governing, and making decisions? How will scientific oversight and direction be given? What support staff will be needed?
- How will the management plan ensure the adaptability and evolution of the network? What sorts of serious periodic reviews of network activities will be held?
- How will the network be accessible and inclusive? Will it involve significant numbers of highly qualified researchers who enjoy little or no individual NSF support? How will it increase diversity and broaden participation?

Since the idea of research networks may be unfamiliar to many, we strongly urge DMS to hold workshops for scientists interested in making proposals to inform them of the overall goals of the programs and how their ideas might be fashioned into an effective proposal. Another idea is to ask for short pre-proposals first, to quickly weed out ideas that additional effort should not be spent on. These methods should lead to higher quality proposals.

Specific budget items that a network could support include:

- Postdocs, graduate students, consultants. There was discussion of employing postdocs centrally similar to the MSPRFs, with the aim of making them more mobile.
- Travel and participant support for conferences, workshops, and meeting.
- Dissemination, including through technology such as video conferencing.
- Staff and administrative support.
- The issue of faculty salary support generated much discussion. The general feeling was that since networks are primarily intended to fund edge connections, salary support should not be

regularly used to replace summer salaries on individual grants. However, there may be a role for salary support to enable participation which might otherwise be difficult or impossible. Any salary support of faculty who would normally be supported by other DMS mechanisms should be fully justified.

ASSESSMENT

A successful proposal should include clear mechanisms for regular self-assessment and benchmarks of success of the various nodes of the network as well as its overall functioning. It should indicate proposed means to measure the increased scientific activity and interactions created by the network. Will the network have an external advisory board, which could in part serve to assess the overall operations? It should also describe ways to measure how the network has broadened participation to a larger part of the community, increased diversity, and contributed to the training and placement of junior researchers.

We urge the DMS to hold annual meetings of network PIs to discuss the important issues they face, share ideas, and provide critical viewpoints. Such meetings could prove invaluable to the overall functioning of the Research Network program, and especially help DMS to modify and improve the program based this sort of frank, regular feedback from those most directly involved.

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WORKSHOP PARTICIPANTS

Alejandro Adem	*Director, Pacific Institute for the Mathematical Sciences*
Sheldon Axler	*Dean, San Francisco State University*
Gerard Ben Arous	*Courant Institute*
Roger Berger	*Arizona State University*
James Carlson	*Director, Clay Mathematical Institute*
Brian Conrey	*Director, American Institute of Mathematics*
James Donaldson	*Howard University*
James Crowley	*Executive Director, SIAM*
Dean Evasius	*NSF*

Mark Feshbach	*NSF*
John Franks	*Northwestern University*
Nassif Ghoussoub	*University of British Columbia*
James Glimm	*SUNY Stony Brook*
Rebecca Goldin	*George Mason University*
Jane Hawkins	*University of North Carolina*
Mary Ann Horn	*NSF*
Roger Howe	*Yale University*
Chris Jones	*University of North Carolina*
Joanna Kania-Bartoszynska	*NSF*
Frank Kiefer	*Deutsche Forschungsgemeinschaft*
Nancy Kopell	*Boston University*
Dave Levermore	*University of Maryland*
James Lewis	*University of Nebraska*
Douglas Lind	*University of Washington*
Deborah Lockhart	*NSF*
Peter March	*NSF*
Don McClure	*Executive Director, American Mathematical Society*
Tapan Nayak	*George Washington University*
Sastry Pantula	*North Carolina State University*
Sam Rankin	*American Mathematical Society*
Fadil Santosa	*Director, Institute for Mathematics and its Applications*
Henry Schenck	*University of Illinois at Urbana-Champaign*
Chris Stark	*NSF*
Michael Steuerwalt	*NSF*
Tina Straley	*Executive Director, MAA*
Eitan Tadmor	*University of Maryland*
Philippe Tondeur	*University of Illinois at Urbana-Champaign*
Douglas Ulmer	*University of Arizona*
Ron Wasserstein	*Executive Director, American Statistical Association*
Shmuel Weinberger	*University of Chicago*
Dana Williams	*Dartmouth College*
Mary Lou Zeeman	*Bowdoin College*