FEEDBACK FOR NSERC MATH LONG RANGE PLAN

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I am submitting my comments for the Mathematics NSERC Long Range Planning Exercise. I am doing so foremost as an individual researcher, and to a lesser extent as Chair of my Department. My experience includes a term as Deputy Director of PIMS, so I have some insight into the role of the institutes, BIRS and MITACS from that perspective. In general, my comments are more relevant to the area of applied mathematics and interdisciplinary research. I am following the given outline; additional comments are at the end.

1. Science

1.1. **What are some highlights of science in your research area and broad discipline?** My area of research is scientific computing, numerical analysis and computational methods in medical imaging. I am also interested in image processing in general. My own NSERC funding has come from a Computer Science Committee. A particular highlight of my research in medical imaging is the increasing mathematical and computational sophistication of the methods employed, and the need for mathematical methods from a wide range of fields, ranging from optimization, partial differential equations methods to traditional and novel signal processing techniques.

1.2. **What changes do you see occurring, and do you expect to occur in the scientific landscape, over the next five to ten years?** The research is very much driven by experimental and practical feedback, and it is becoming increasingly important to be able to communicate with scientists from other fields (physics, pharmacology, computer science) and with medical professionals. Computation and experimentation will become increasingly important, yet advances in these areas will rely on a strong theoretical mathematical foundation.

1.3. **What opportunities do you see for advancing your science, over the next five to ten years?** For my specific area of medical imaging I see new methods having a huge impact on diagnostic and therapeutic tools. Medicine will be more guided by quantitative information, and medical professionals are becoming more open to studying and using these advanced tools.

1.4. **What is the importance to your area of cross–disciplinary work?** The research is driven by the practical needs of the medical applications.

1.5. **What is the scope of collaboration: within the area, within related areas of mathematical sciences, within science, ... ?** Projects tend to involve more and more researchers from other sciences and medicine.

1.6. **Are there barriers at granting agencies that limit your ability to engage in interdisciplinary research?** Yes, there are serious barriers. Interdisciplinary research is often praised, but when it comes to evaluating projects this evaluation tends to be performed by researchers in one of the fields touched by the project. Proposals to CIHR have reviewers who are dismissive of certain aspects of the work, simply because they do not understand the mathematics, and, by its mathematical nature, the research plan does not follow the traditional path of medical research projects. Mathematically sophisticated reviewers often find the mathematical core content of the projects not advanced enough to merit funding.

2. Research funding

2.1. **How does existing research infrastructure help your research and training? What additional types of infrastructure are needed, and to what extent are these available in Canada?** Our research requires access to medical scanning equipment, which is secured through collaborators. Funding is provided by NSERC, MITACS internships and to a lesser extent through the institutes.

2.2. **What activities do you foresee over the next five to ten years having most impact on research in your area? What types of research opportunities for your field would enhance the research potential?** Predictable medium-term funding to support HQP graduate students, postdoctoral fellows, research associates. Some of the needed opportunities do exist, for example in the form of NSERC postgraduate scholarships and PDFs, more programs like these are needed, in particular for comparable support of international students.

2.3. **Are there research areas that are falling between the cracks in terms of funding opportunities?** I believe so, although I do not think it is intentional. There is the natural tendency of reviewers to be more positive about their own and nearby areas of research. The other problem as mentioned earlier is the evaluation of interdisciplinary research projects.

3. Institutes

One element of the plan is to examine the role of the mathematics institutes, including BIRS, as community resources.

3.1. **What current institute activities are most relevant for your area, and more broadly?** Support for postdoctoral fellows, and help with organizing workshops and conferences.

3.2. **Are there new activities that would best fit at an institute, that you feel would be beneficial for research and training? What role do institutes currently play in training HQP in your area?** Currently they do not play a very significant role. There is no direct support for graduate students, although at times there are opportunities for workshops and conferences for the students. PIMS has a postdoctoral program, but its scope is not large enough due to funding constraints. This program, however, has a significant impact in the mathematical sciences where grants are low, and the partial PIMS support makes it feasible for researchers to have a postdoc. MITACS through its internship program, does play a more prominent role in graduate student support.

3.3. **What is your assessment of the long–term impact of the institutes on research areas with which you are familiar?** The institutes have a stronger impact on areas of pure mathematics than applied. Clearly, many of the Institute activities are beneficial to the research community, facilitating conferences and workshops, and visits by researchers. The question of course remains whether equal or better outcomes would result if funding for the institutes was redirected to the researchers directly. The Institutes ability to leverage NSERC funding in obtaining provincial and industry funding, and the critical mass and research infrastructure provided make the NSERC investment into the Institutes worthwhile.

4. Training

4.1. **What structures are needed to support training in your area and more broadly? Are structures needed to expand the pipeline of advanced trainees? If so, what types of resources would be the most effective for this?** Predictable funding for HQP, in particular graduate students. This can be in the form of stipends directly to students, or with a system, which ensures that student funding is not in jeopardy when a researchers grant is reduced.

5. International

5.1. **What types of research support is available to your international colleagues, that could benefit research in Canada? Would it be advisable to fund these types of programs in preference to currently available programs? What types of structures would support international collaboration Is international funding available in your area? Are there structures that could enhance your ability to obtain international funding?** It is preferable to have a solid, well-funded general support program like the Discovery grants, as opposed to creating a slew of special purpose programs, which add unnecessarily to administrative cost and bureaucratic complexity. There is no compelling reason why most international activities could not simply be supported by funds from Discovery grants.

6. Further Comments

6.1. **Institutes.** In my view (and many of my colleagues agree) it is preferable to keep the Institutes outside the Mathematics Funding Envelope. To the mathematical sciences, the Institutes provide infrastructure in the way major research facilities do to other sciences. It does not make sense for the mathematical community to be in direct competition with the providers of infrastructure and research support to the community.

6.2. **Continuity and predictability.** NSERC appears to place a significant weight on HQP contributions. This is fine – although debatable – but with this emphasis should come a certain amount of predictability. A M.Sc. student typically takes two to three years to complete her degree, a Ph.D. student about five years. If a researcher with a current support level of $20,000 takes on three graduate students, and the grant subsequently is reduced to $10,000 per year, how can that researcher then continue to support these students? A system where grant decreases are phased in over a period of say 2 years would alleviate these concerns. Of course, the underlying problem is underfunding of the Discovery grants program, which presumably is even more difficult to fix.

6.3. **The HQP Card.** There is a growing sense that training of HQP may be given too much weight in the evaluation process. Is it always a good thing to train more researchers in a specific area? What are the trainees' job prospects? In academia employment is currently in short supply, and while one would hope that our training will prepare students for many different careers, this can still depend a lot on the researcher area of inter. The HQP component should play a major role in the amount of funding awarded. I am advocating an approach, where the research and training component are separated in the proposal evaluation stage, and funding is given out for each component.

6.4. **More on HQP.** Traditionally, research grants in mathematics have been lower than in many other disciplines, yet the cost to employ graduate students or postdoctoral fellows is the same as in, say, chemistry. If researchers in the mathematical sciences are to fulfill their training mandate, they must be funded accordingly.

6.5. **Erratic decisions.** There are increasing frustrations in the mathematical research community about awards decisions, which are seen as random and erratic. I know that you will hear about specific examples of essentially identical proposals being awarded hugely different amounts in different competitions or on appeal. Such a situation undermines the trust of the research community in fair process at grants competitions, whose results are immensely important to the careers of the applicants. I have also heard of frustrations by members of the selection committees, who feel that they are kept on a short leash, and NSERC administrators make the funding decisions. I strongly believe that our colleagues who volunteer on these committees can do an even better job if given more responsibilities.

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