Funding Mathematics in Canada

A submission by the

Canadian Mathematical Society

to the

NSERC Long Range Plan Committee

for Mathematics and Statistics

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1. Where we are

The Canadian Mathematical Society (CMS), as the members of the LRP committee no doubt all know, is the main vehicle in Canada representing mathematicians as a community. For over 65 years, it has helped build this community, and continues to do so, through its meetings, its publications, its outreach activities, and of course its advocacy. The basic mission, indeed, of the Society is the development of a strong mathematical community.

There are two words here that one should emphasize: the first is strong. Our community has indeed grown in scientific stature in a remarkable way over the last ten years, as we hope you will see in the study of mathematics in Canada which accompanies this document. We would like to pride ourselves at the CMS in thinking that we are at least partly responsible for this, by what we do, and by our devotion to quality.

The second word is community. We are deeply preoccupied with the scientific health of our enterprise as an organic whole. One cannot overstate the importance of this, and the interconnectedness of our scientific enterprise; to a great degree we are preoccupied with a current tendency to neglect and downplay this. This is in our minds a mistake. Switching metaphors from the organic to the mechanical, one should have all cylinders firing, to the degree to which this is possible.

NSERC's role through its granting system has been to provide the crucial fuel. In particular, we depend more than other disciplines on the Discovery grants for what we do; it is still, as you will see, the main game in town. We are therefore grateful to the members of the LRP committee for undertaking their task.

As we have noted, the CMS commissioned a study of Mathematics in Canada, and we would first like to summarise some of its conclusions. The full text has been given to the LRP committee, and the committee is heartily invited to browse; indeed one of the excuses of the relative brevity of this document is the back-up provided by the study.

i) *We are strong, and getting stronger.* It is quite clear, when one looks at the catalogue of what is being done in this country in Mathematics, that there is a remarkable variety of first rate work being done in this country. The progress is even more clear, in particular when one compares with the base-line set by the study piloted by Richard Kane fifteen years ago. There is no good substitute for actually looking, by the way. Indeed, the measurement of mathematical quality by indicators, even more than in other sciences, seems to be marked by variance and unreliability. We have colleagues who have won every conceivable prize for their work, but whose h-index has chemists giggling; on the other hand, it is these colleagues, and not the gigglers, who get offers to move to the top universities in the continent. Even within the discipline, there seems to be a wide variance according to subject area.

ii) *The demographics*: While the total number of faculty has not increased very much, there has been a huge turnover in the past ten years, with new people flooding in. Over 50% of our faculty were not here ten years ago. These people bring new ideas, but also expectations for a career.

On the level of graduate students, the growth in the past ten years has been startling: a doubling of the number of PhD students, and a more than doubling of our post-doctoral fellows. Again, this creates need.

iii) *Internationalisation of our community*: While our scientific community has always had a strong international flavour, this aspect continues to accentuate. The recruits are of a very high level of quality. It is amusing to track the number of Sloane fellows among mathematics faculty now in Canada. These fellowships are awarded to junior faculty across North America. Amongst our current faculty, 5 won it on the 1980s (3 of these won it in the US and moved to Canada later, on CRCs!), 10 in the 1990s, and 15 in the last decade. There have been 47 Canada Research chairs in Mathematics awarded in Canada, and at least half of these are from abroad. This proportion is reproduced in the set of all recruits to our departments: Canada is a good place to come and work.

iv) *Areas of strength.* There were a variety of areas of strength identified, in the review of Canadian mathematics done 15 years ago: probability theory, number theory and automorphic forms, combinatorics are examples. All these areas continue to thrive, and indeed have increased in strength.

In the mean time, many new areas have seen explosive growth. The most striking example, basically, is all of applied mathematics. (This in time should do wonders for our collective citation rate, that totem of our Science Policy people; it is my regret that it has not kicked in sooner.) Various factors have helped this. Some are local: MITACS, for example, has shifted the way we do things in many of our departments. International trends within mathematics, and the trend towards greater multi-disciplinarity have also contributed. Within applied mathematics, the young star on the scene is mathematical biology; it now seems that no Canadian university is complete without its own laboratory or centre in the area. In any case, Canadian applied mathematics has been given a consecration of sorts by being asked to host the 2011 ICIAM Congress.

There are areas of pure mathematics whose growth to maturity has also been quite surprising: algebraic geometry, symplectic geometry and topology, and partial differential equations are three examples which come to mind. Again, we suggest a look at the study.

By and large there is some remarkable strength out there: the BC-Ontario probability school, long a world leader, has expanded to even greater strength. In combinatorics, the pioneering presence of Bill Tutte and Jack Edmonds at Waterloo has expanded into world-beating strength all across the country. In number theory and automorphic forms, the three main cities of Montreal, Toronto and Vancouver have developed into a pole of attraction for the whole world. Mathematical Biology is an example of an area in which we were pioneers, and in which our role continues to be dominant; one sign of this is the succession of Canadians at the head of the Society for Mathematical Biology.

v) Institutes: The impact of our institutional framework, whether the three Mathematics Institutes, or BIRS, is hard to overstate. We have no doubt that they will, individually or together, be presenting a case to this effect to the LRP committee. The impact manifests itself in various ways, but our subject being a question of people, the underlying mechanism is the same: they

bring people here, and they bring people together. This happens in many ways. The basic one, and an important one, is by presence at scientific activities; Canada is a place to go to do your science. There is more, however: Canada is now a place to move to, because of all the scientific activity; Canada is now a place to complete your training, because of the first two factors. The impact of the Institutes on post-doctoral training, in particular, is enormous. The Institutes have played a very important role of positioning us into the international stream.

The Institutes also have a strong local effect. It is indeed true that this effect, by definition, is most strongly felt in the vicinity of the Institute. On the other hand, using NSERC Discovery grants as a (very rough) proxy for measurement of scientific strength, about 70 % of the activity is concentrated in the Vancouver area, the Toronto area, the Montreal area and the two main cities in Alberta, directly in the zone of coverage of the Institutes. In addition, efforts, some of them quite admirable, are also made to spread the Institute effect beyond their core locations. Perhaps more could be done, but the coverage is already pretty good.

And it is cheap. Our institutions function at a high level, on what, by American standards, are ridiculously low levels of funding; the three Canadian Institutes *together* receive 1.5M less from NSERC than what MSRI receives from NSF. They manage to achieve what they do by leveraging, obtaining provincial and university funding to match the NSERC contributions, as well as by being quite careful with their resources. And they have, in our scientific scene, changed the scene dramatically.

The Institutes fund scientific events, training of HQP, and support for local research groups. It is hard to estimate the proportion spent on each, but they are roughly commensurate. In the latter areas, the concentration of resources on particular areas at particular times allows many things to happen that wouldn't otherwise; the prime example of this has been the proliferation of post-doctoral fellows.

BIRS. This has been a great success; the conference program is strongly oversubscribed, with only one in three proposals accepted. Again, it is extending the reach of Canadian science, and is one of the few recurrent Canadian partnerships with the NSF. Now also Conacyt, the Mexican granting agency, is involved.

AARMS: Again, on a smaller scale, a striking example of what can be done collectively. It has had a very positive, niche impact in Atlantic Canada. Again, there is strong leverage, with funds obtained from provincial and university sources, and it has allowed a remarkable range of scientific activity, complementing Atlantic universities graduate programs in a remarkable way.

We have been asked to comment on the efficacy of the Institute model, in the face of the statement that there is somehow too many of them. This is science policy bafflegab.

It works extremely well. That in itself should be enough reason to leave it alone.

2. Funding it

i) Bread and butter. How is it all paid for? The recent survey of our departments reports that the amounts of NSERC Discovery funding outstrips other sources (including other NSERC) by 13M to about 10M (in the departments reporting); total NSERC Discovery grants to mathematicians in our Mathematics departments is about 15M. There are about 750 such grants in our mathematics departments; this compares to about 650 grants funded by the Mathematics GSCs in 2009-10; there is thus an important disciplinary spread, into such areas as computer science and engineering, within our mathematics departments.

The conclusion is simple; we are still crucially dependent on this source. Leaving aside the Institutes and BIRS, the NSERC Discovery grant is still the main game in town.

These funds are the bread and butter of our departments' research efforts, and are crucial, more than in other places, and more than in other disciplines, to the research effort. More than in other places, because our universities are poor in graduate funding and in internal research funds, compared to, say, the US; more than in other disciplines, simply because the Discovery grant's share of the research portfolio is greater for our discipline, than in, say, engineering.

ii) Relative poverty. Many of our grantees (about 100 in mathematics departments across Canada) know the relative ease that comes with being able to pass as a physicist, or as a computer scientist, or an industrial engineer. The sums available when you cross the border are typically 50% higher: the figures for 2009-2010 on the OST search engine give averages of 17-18K for mathematician, 25-27K for a computer scientist, and 24K for an industrial engineer. Yet the expenses are roughly the same.

iii) MITACS. The MITACS NCE has been a driving force in the development of a thriving culture of applied mathematics and industrial collaborations. The MITACS program touches much more than mathematics, reaching into statistics, computer science, and electrical engineering. The NCE funding of $5.5M per year disappears in 2012, and puts at risk another $1.5M in current industrial funds. The loss of this targeted federal funding and industry support for mathematical research is a significant cut to the mathematical community. While MITACS' new offshoot Mprime Inc may continue to play the matching-make role between industry, academics, and possible new funding sources, there is great uncertainty resulting from the termination of the NCE funding.

iv) Increasing need. From the study, it is quite clear of a much greater need for resources for doctoral and post-doctoral training. There are also a lot of bright new researchers out there, needing the funds to feed their scientific careers. We emphasize that while the funds would help them, it helps our ("our" in the sense of "Canadian") cause also, in the nourishment of a greater scientific culture.

v) Recent developments at NSERC. It is difficult to find colleagues in the community who are unalloyed fans of recent developments at NSERC with regards to the Discovery grants. Discontent is attributable to several factors:
- The new evaluation methods have made for much more mobility in the system, as desired, but with the obvious consequences of fluctuations and instability.

- They have also been accompanied by an (unspoken) drive to lower success rates, and this has led to some severe stress in our community, in particular in the small universities.
- The emphasis on training of HQP, in particular its role as an eliminating factor, has been particularly felt, with departments with no graduate programs feeling the pinch.
- There is also a detaching of the academic committees from the actual funding decisions, that does, in some cases, lead to rather absurd results.

3. Recommendations

A) **To LRP committee, in answer to its mandate:** The LRP committee, in some sense as its first task, was asked to split a fixed funding pot between the various actors, starting from a funding base that is roughly 80% Discovery and 20% Institutions. In answering, and sometimes in spite of the mandate from its NSERC minders, it should

i) *Ask for More*. By all criteria, our funding is too low. The recent Discovery grants competition has definitely brought this to the fore. The growth in graduate and postdoctoral needs, and the fact that, comparatively, our funding is below that for other disciplines with the same cost of research profile already give a compelling case. Above all, though, the main case is simply the increase in quality and in breadth of what we are doing.

ii) *Institutes vs rest:* The current balance, of about 20-80, is good, and should be kept. On one hand, the provincial and institutional leverage and concentrated impact of the Institutes (including BIRS) push towards greater funding for them, and lowering their funding substantially would kill some very fine institutions. On the other hand, the sheer pressure on individual grants nowadays militates in favour of the other direction.

iii) *MITACS:* The disappearance of MITACS from our funding scene is a cause of worry. It has driven a certain amount of cultural change in our discipline, and it is regrettable to see this go. It would be good to see some continuation of this funding, perhaps through NSERC industrial programs; some modest funding of MITACS might be contemplated, not so that it can then fund the research, but rather so that it can continue in its matchmaking role in cooperation with NSERC's CRD programme, for example.

iv) As a proposal for the use of extra funds, the LRP committee should give consideration to the funding of more *accelerator grants,* possibly in a modified form (e.g. half-accelerators). These have been a great boost to a number of academic careers, and have allowed our enterprise to blossom. It is also in line with the recommendation of the International Review of the NSERC Discovery programs, and so has a chance of happening. We emphasize: as *one* use for *new* funds.

v) *Math vs. stats*: We have been asked to comment. In fact, there is not much need to. On the level of Discovery grants things are roughly the same, as indeed they should be. The Institutional side of statistics is less well developed, and there might be things to do there, though it is more for the statisticians to decide. In any case, we have no desire to join in a game of beggar thy neighbour, in particular as he is as poor as we are. It goes without saying that some reciprocity in this is expected.

B) **To NSERC, through the LRP committee.** We have a certain number of recommendations to make, which though not strictly speaking in the remit of the LRP, can perhaps form part of the message.

i) *Funding decisions must be made by researchers*. The last few years have seen a steady stream of attempts by the NSERC bureaucracy to steer funding decisions, whether to achieve a desirable success rate, or a desirable funding level. This should be resisted. We are not in favour, by the way, of NSERC hiring mathematical staff; this would simply provide cover.

ii) *Review*. Many of the current inconsistencies-horror stories could probably have been avoided by a bit of review of the files by the committees, once they have done their work. NSERC staff seem to be averse to this idea, for reasons we cannot fathom. We spend a lot of time telling students to review their work; our committees should be allowed to do the same.

iii) *HQP should not be an eliminating factor in grants.* The link of amounts to training is sensible, and can indeed be a very strong link, as students are the main requirement for funds. Nevertheless, it should not be an eliminating factor, as there is much valid research that does not require them. Not having it as an eliminating factor would also help solve a lot of the difficulties with small universities.

On behalf of the CMS,

Jacques Hurtubise
President.