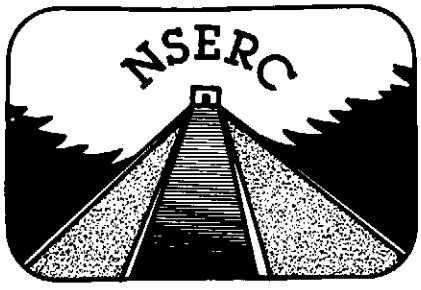

Some Views From Beneath the Top: A Commentary on NSERC Grant Selection Policies and Procedures

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In a sense this is a continuation of the opinions of Neale (1978), Naldrett (1979) and Barnes (1981), but with a difference: I do not want to explain the system but to point out a number of NSERC policy trends that I find sufficiently disturbing that I feel I must air them to see whether or not I am the odd man out. Although my comments are made from the perspective of an earth scientist, I think they may be applicable more widely.

Let me say at the outset that I am a firm believer in E.W.R. Steacie's philosophy that while teams of scientists and engineers might take an idea and develop it into a technological marvel, the great intuitive advances in science come from individuals. It was this philosophy which led to the NRC techniques for funding individuals pursuing curiosity-oriented research, a philosophy taken over by NSERC when it was first started but which, I now fear, is becoming overly attracted towards mission-oriented or targeted research.

Taken individually the indicators of the overall trend may not be very significant, but taken together, we seem to be heading towards the disaster of a centrally controlled national research effort where university faculty members are regarded as a pool of talent which can be mobilized to pursue some highly specified national objectives. Capable individuals pursuing curiosity-oriented research are found in places other than universities, but by far the greatest number of such individuals are in universities. It therefore follows that NRC, and later NSERC, was regarded as "our" organization presenting the point of view of universities to government, lobbying for "hands off" funds for undertaking research and generally attempting to make sure that qualified individuals had an opportunity to demonstrate that they were capable of independent and original research, and of transmitting their knowledge to students. This does, of course, still go on, but although NSERC is making the right noises I think it is moving in the wrong direction for the long term intellectual, cultural and, indeed, economic health of the country. Let us look at some of the individual pointers.

Funding of Excellence

If one asks NSERC what it is doing,the short answer is likely to be "we are funding excellence". That has a very nice ring to it and most of us tend to accept it without question. However, let us think about it a little more deeply. What is meant by "excellence"? Are we talking about excellent people? Excellent projects? Excellent proposed methodologies? Or some weighted mean of all of these? Well, anyone who has served on a committee has had to wrestle with these thoughts, and probably the only common thing about our conclusions is that we are dissatisfied with the answer. But there is an even earlier question that should be asked: If we are talking about people, where is the boundary above which we can regard everyone as excellent? Is it the top 2%? The top 5%? If we look at the application form for scholarships and fellowships, even NSERC seems to be undecided, since the top 10% of people are classified as exceptional but it is broken down into two groups of the top 2% and the next 8%; since anyone below this is only above average (or worse), presumably we are being generous if for the sake of argument we accept the top 10% as being in the "excellent" category and therefore capable of doing research of "excellence". But does this means that out of the total university population of earth science faculty members only 10% should be funded? Probably not, but we will come back to this point later for we have not even looked at the problem of how to measure excellence.

Determining Excellence

Measuring excellence is another area in which every Committee Member has struggled with an attempt to form an opinion based upon the applicant's proposal, the referees' reports, the publication lists, selected reprints, site visit reports, but not, because of NSERC policy, the number of graduate students being supervised and other sources of funds. It is best to deal more thoroughly with some of these factors.

Publication List. The one parameter that can be measured quantitatively is the number of publications (or even the number of pages of publications) bearing the applicant's name, and it is probably for this reason that we tend to place too much reliance on published papers as an indicator of activity and excellence. In fact, one of the reasons the present writer agreed to sit on the Committee was his unhappiness with the way in which publications are subdivided and subcategorized: it is unnecessarily confusing, and some of the inferences that could be drawn are not pleasant. For example, why separate papers published in refereed journals (category A) from those published in refereed conference proceedings (category B), which implies that refereed conference proceedings are somehow inferior? Even within a discipline the preferred mode of publication varies; for some subdisciplines, refereed conference proceedings might be regarded as the most important type of publication and the one to which one would naturally turn to read the most up to date material. Officially, in the eyes of NSERC refereed conference proceedings and refereed journals are of equal status. If this is the case, one must ask, again, why they are placed in separate categories, since they can easily be identified according to the way they are referenced. Similarly, why separate research notes and discussions (in refereed journals) from the rest? Some research notes can involve more work and can be more important than full length papers, and some discussions can be more valuable and involve more work than the papers they are discussing. Once again, whatever one feels about the relative quality of these types of communications, they can readily be identified by the form of referencing in the list. Even to distinguish between refereed journals and unrefereed journals has its problems: we have all seen the occasional terrible paper in a well regarded journal and an excellent paper in an unrefereed journal. Why not simply ask people to list in reverse chronological order, (a) communications in publicly available print media and (b) reports, theses, oral communications, etc. This format would make it easier on the applicant and certainly easier on the Committee member trying to judge a person's productivity over the years.

Even this simplification does not assist in solving a related problem. How do you count publications? Is one paper a year by a single author (he obviously cannot cooperate with anyone) as good as four papers a year from a group foursome (she obviously cannot work alone and is just tacking her name onto someone else's work)? Is a citation index a reliable guide to the importance of a paper (make sure you are the first named author if you want the citation to be in your count)?

Other Sources of Funds. If we ask the question, "Are these applicants adequately funded from all sources for what they propose to do?", the response is likely to be that this is not a consideration, that NSERC is in the business of funding excellence and the decision should be based only on the quality. Surely it is not as simple as this. Suppose we have identified a person who is turning out one good paper a year (which is not bad going for someone with anything close to a normal university load, especially if field work is required), on an NSERC grant of $20,000 per year, and we identify that person as one who needs a significant increase – say, to $40,000 a year. And suppose we have another person with a similar publication record and NSERC grant, but who also has had another quarter of a million dollars from, say, a DSS contract. Are the two people of equivalent quality? And if they are, should the second person receive the same sort of increased NSERC grant as the first one?

Graduate Students. If someone exclaims at a Committee meeting that "this person hasn't had a graduate student in decades" the exclaimer will be informed that that is irrelevant, that NSERC is in the business of funding excellence and Committee recommendations should be based on our judgement of that alone. It was, in fact, this attitude which caused me to start thinking more deeply about the clarion call "we fund excellence". We at the universities are also in the "excellence" business, but excellent research is only one aspect. As far as I am concerned, our job as university professors is to teach the youth of our country to question the conventional wisdom and replace it with a better one, whether one be studying sociology or magneto-hydrodynamics. The process starts in first year and continues through to the levels of graduate student and faculty. A good research program will produce more questions than it answers. One has to assess constantly these new questions to find those that are sufficiently challenging to be interesting, yet not so difficult as to be discouraging, to students; if one happens to be temporarily without students and a particularly good problem is turned up, it may even be set aside for a few years until an interested student comes on board, thus in a sense slowing down the research program. To be fair, the ESGSC (and perhaps other GSCs) does not, in fact, completely ignore this aspect of graduate student load, but I would like to see more official recognition of its importance.

In my opinion, anyone who refuses to take on graduate students because they will slow down the professor's rate of research should be in an independent research organization and not in a university. In any case, it is a curiously shortsighted attitude. One of my measures of the quality of a university professor is the quality of his students and their work, and nothing is more stimulating than to have a student who turns out to be a great deal better than you ever were. This has a bearing on another aspect of NSERC policy: the manpower training program (a horrible title). If all university professors decided they did not want to be bothered with graduate students, it wouldn't matter how much money was poured into scholarships.

Contributions to National and International Affairs. Once again, we have a problem with the interpretation of "funding excellence". Many of us would like to look at all contributions to science by the applicant. One important component we cannot consider, and there is no allowance for it on personal data forms, is what contributions to national and international scientific organizations have been made by the person concerned. As most of us know, international progress in science requires some bureaucratic organization; maybe there is too much bureaucracy, but it is a fact of life that attention to some low profile and unrewarding, in the personal sense, committee work is necessary for the long term benefit of national and international science – the work of the IGCP sponsored by the IUGS, or the Commission on Practice of IASPEI are typical examples from the ICSU family of Unions representing non-government organizations. I am not talking about the professional bureaucrat but about an active researcher who may decide to devote considerable time to these useful projects and who receives little or no credit for it. Can we neglect this work in the assessment of a person? The answer must surely be "no", for if there has been apparent slowdown in publication rate it is important to know if the cause was a good one. If we do not give some consideration to this aspect there is a danger that the active scientist, the very person we want, will be under-represented on these committees and that the professional bureaucrat will take over.

Referees' Reports. During my first two years as a committee member, I used to have horrible feelings of guilt about the referees' reports received for the applicants for whom I was one of the principal reviewers. I was always hoping they would resolve my doubts about the person and the proposal, but they rarely did. It was not until I became Chairman of the Committee, and received all reports, that from looking at the whole picture I found I could give a much better interpretation of the comments on the individual reports.

There is a sort of Committee joke that "very good" means "good", and "good" means "competent"; in other words, the referees' comments seem to be skewed towards the high end of the range. Certainly no one is rated less than competent (which is the penultimate category of the referee form), and one could be forgiven for thinking that this was because it would be difficult for applicants to sue a referee for saying they were competent. Rating someone as competent is, therefore, often regarded as damning with faint praise. However, is it as simple as that? The distribution of comments may not be as unreasonable as it seems at first. Nearly all the professors in Canadian earth science departments have Ph.Ds from reputable universities. They have, therefore, already gone through a screening process of sorts and are, or should be, a superior group; certainly the great depth of quality of the earth sciences in Canada is impressive. Furthermore, the few in universities who possibly are misplaced have probably been screened out of the NSERC system already, so that it is not surprising if most of the people receiving operating grants are, in fact, competent or better. Where one might perceive problems is in the area of sorting out these people in the upper categories.

The Star System. Whatever difficulties we may perceive in trying to follow the NSERC policy on excellence, things become even worse when we try to follow their ideas and policy on "stars". The basic idea of the star system is relatively simple: presumably, stars are the *crème de la crème* of the excellent, so for the sake of argument let us assume that the stars are the top 2% of the people producing work of outstanding intellectual quality. These people, it is argued, should be those receiving the most generous operating grants; being a star is a necessary and a sufficient criterion for a large grant. Not many people would quibble with the necessary part of this criterion – but until all stars both request and need large sums of NSERC money, should the condition really be sufficient? There is a further tendency to assume that if you have a large grant you are a star, and as a corollary that there are no stars in the system unless there are people with grants as large as (around $130,000) some of those in disciplines such as chemistry or plant biology. More recently, this train of thought seems to have been extended to the lower grant levels, a development which is too readily accepted by too many universities: somehow, the magnitude of your grant determines your position in the pecking order.

One of the problems faced by the ESGSC is that with roughly the same number of people in the system (about 500) as, for

example, the Chemistry GSC, our base funding for operating grants is only a little more than half of that available to the Chemistry Committee. In the ESGSC a high priority is the backing of potential winners in the younger group, and with only ten or eleven million dollars in operating grants to spread over 500 applicants in the system, by the time we are through taking care of the younger group there is not enough left over to give significant increases to the group who already have large grants; 20% of a $70,000 grant is a good grant for someone younger. Moreover, many of the high level grantees are older and more experienced, and if they really need the extra funds they can take care of themselves by obtaining the funds from elsewhere. Another aspect, not necessarily a problem, is that few requests exceed $100,000. The first requirement for producing a distribution curve similar to that of another discipline with the same number of applicants in the system is equal funding. But even if we had equal funding, do we really want to have a badly skewed distribution? The ESGSC is regarded as rather non-conformist because all past committees have apparently followed the policy of more evenly distributed funds; it has been hinted that our demands for a larger slice of the pie might be more sympathetically received if we were more conformist, and that we could achieve our objective (of giving top priority to young researchers) and the NSERC objective (of producing stars) by culling out the solid middle-of-the-road researcher. So we have a sort of chicken and egg situation, but which is the chicken and which is the egg is not clear. Nevertheless, it is a policy of the Council to promote the "star" system, and to "encourage" nonconformist Committees to adopt their view (the ESGSC may not be the only Committee involved) NSERC introduced what has come to be called the "honeypot" system. In addition to the base funding, a separate line item is created which can only be used for researchers who have been given an increase in their grant which exceeds a certain percentage level set by the Council each year; in the last competition (for 1984-85), the percentage switch was set at 15% (the switch is not necessarily the same for each committee). If the fund is not used, then at worst the money is completely lost and at best it is carried over (and presumably if it is carried over too often it would be lost anyway). What should the Committee do? Maybe by burying their principles for a while and giving some researchers more than they may really need or deserve, the earth science community might benefit in the long run and eventually be treated more equitably relative to committees in other disciplines. However, to do this some of the competent researchers may be eliminated from the system, people who are producing data on which "stars" build their theories and reputations, people who might well produce students who become "stars".

We might ask what a person would do with a grant of $150,000 per year. She cannot buy much equipment with it (anything over $7,000 must go through another line item). About the only way to burn up that kind of money is to buy people. So most of us would like a PDF and/or a technician. At the current rate, the above grant could carry two PDFs and two technicians and still have plenty left over for other things, including students. The grantee couldn't need much for herself because she would be spending most of her research time managing the group. I once made an estimate of what would happen if, over a three-year period, everyone received what they had requested and hired the people they had said they needed. In brief, disaster. First, there just isn't the manpower available in Canada; second, even if the manpower was available, departments would not be able to provide the space from their current space allocation, and some universities would need considerable enlargements to their buildings to house the influx. This leads me to another group of related topics.

An Endangered Species

The way we handle the concept of "funding of excellence" may have an unpleasant long term consequence for the leadership of Earth Science departments. If we look at the grant history of department chairmen, we can see in many cases a noticeable decline in research productivity and NSERC grant funds dating from the time of appointment, often at a time when these people are of a relatively young age and in a productive period. What seems to happen is that a young person rising in his field, say with ten years in the system, has the respect of his colleagues and is an obvious choice to lead the department. Consent is given without fully realizing just how legalistic and bureaucratic the universities are becoming, with great care having to be given to process lest an appeal against a decision or grade be won on technical rather than academic grounds. More and more time must be devoted to administration and research is necessarily consigned to a lower priority. The operating grants are reduced in magnitude, possibly put on a one-year basis, and chances of recovery are not great. Already this has become the cause of complaint from members of CUDGO. There are, of course, exceptions, but in some of these cases there seems to be an increase in multiple-authored papers and one senses that, in fact, the chairman is coasting in research, possibly with the aid of a PDF. Difficult as the situation might be for large established universities, it is worse for small universities; to its credit, NSERC is attempting to do something about this through a separate program.

The universities must also take some if not much of the blame for the resultant problems in finding willing chairmen of established reputation. Although we, as university professors, claim an equal devotion to teaching and research (40:40:20: Teaching: Research: Administration seems to be par for the course), in fact we seem to put more emphasis on research. If you do not have a large grant, you do not count for much. And how often have we seen the superb teacher with no established research reputation promoted to full professor as rapidly as those with an established research reputation and no reputation is teaching?

The solution to finding willing chairmen probably is for a candidate to have a colleague (Research Associate) to take the brunt of the research time necessary. Let us be blunt about it. To survive, the chairman must buy a pair of hands, but if he does not already have an operating grant of $30,000 to $40,000, he cannot afford it and is unlikely to survive. Maybe the potential chairmen should bargain with the university for a research associate before consenting to the appointment; but universities are finding less and less room to manoever. The solution may be that NSERC should make a special grant available to departmental chairmen which they could use to hire a PDF, or to apply to some other important area of the department (e.g., some central equipment facility) if that has a higher priority in the chairman's view. The NSERC response to this would be, quite justifiably, that it already gives a block grant to the Presidents of Universities and the funds should be taken from this. Unfortunately, not all universities play by the same rules. Some do distribute the funds *pro rata* to the departments, while others do not. For consistency, the "Chairman's Grant" should be a direct grant to the chairman.

The Rise of the Adjunct Professor

Another potentially serious problem is the number of adjunct professors who are being appointed and who also request research support. Some years ago the argument was made that adjunct (or part-time) professors could do just as useful work as full-time professors and therefore should be eligible to apply to NSERC for a grant. There is nothing particularly wrong in this. Unfortunately, a number of universities saw in it the opportunity to increase their grant base, particularly when it came to supporting graduate students, by appointing adjunct professors and having

them apply for amounts that run from relatively small to ridiculously large sums. To be fair to NSERC, it is aware of the problem and is trying to control it, but it cannot tell a university president to his face that it does not believe him; if the university president, or his designate, signs a document stating that this person is a genuine adjunct professor who fulfils all the normal requirements of the university appointment procedures, etc., there is nothing NSERC can do about it, even if it is rather suspicious. For a while, the group of adjunct professors consisted mainly of what I took to be consultants, who may well have contributed something useful to the graduate school; more recently it appears that there is a move to have public servants appointed as adjunct professors. This means that those universities that are close to provincial or federal capitals could appoint large numbers of adjunct professors some of whom, because they spend all their time on research, may in fact be extraordinarily productive relative to the regular university professors who have numerous other duties to perform. The problem here is that some adjunct professors have been extremely effective indeed, perhaps contributing more than the regular processors, but on paper their qualifications and positions in the university appear similar to others who appear to contribute little.

Increasing Complexity and the Slide to More Central Control

If one simply looks at total funding then it would seem that since NSERC took over from NRC things have improved considerably. The universities had been falling behind in terms of research funding and the situation has definitely turned around in recent years. But it is interesting to examine the details of this turnaround. Funds for the basic operating and equipment grants, necessary for the intellectual health of universities, have certainly increased, but what has increased far more are the funds for a whole host of new programs which can be classed under the general heading of targetted research. In the good (bad?) old days, we simply had operating grants, equipment grants and even major equipment grants, and that was about it. Now we have a whole host of programs, such as collaborative special projects, programs designed to improve industry/university cooperation, strategic grants, university research fellowships (one of the best ideas to come out of NSERC although the universities [provinces] could do more to help), improved scholarship programs (part of the manpower training philosophy), various exchange schemes, and so on. If we look simultaneously at the increased complexity of the NSERC system, and increasing the complexity of a system makes it more susceptible to bureaucratic control, and at the policies of various governments (for example, the make-or-buy policy of the federal government and the large numbers of funds available through the DSS for targetted research, similar programs operated by the provincial governments, etc.), there is apparently a concerted effort to reorient the research capability of the university system so that it becomes little more than a group of research institutes devoted to undertaking specific research initiatives that are regarded as in the national interest. In other words, it seems to me that we are gradually being directed, very subtlely, into policies devised by federal and provincial bureaucrats.

The universities are not blameless in all of this, since they have not resisted the pressures as much as they might have. Senior university administrators, who should know better, rush around creating institutes of this and that in order to capture more funds necessary to keep the universities going. The rationale is that sinking a few principles and playing the high profile game is the price we have to pay in order to bring in large sums of money to the universities; some of this can be bled off to keep the basic university functions going, and then those who wish to undertake low profile, curiosity-oriented research on relatively low level funds will be able to continue to do so. I am not even sure that there always is a net gain; in some cases it seems to me that the institutes cost the university more than they bring in. Of course, it is important for universities to have a role, and an important role, in matters of provincial and national (and international) concern, but it should be a case of intellectual choice and not economic coercion.

Unfortunately, individual researchers are beginning to follow this lead. We have pushed to such a great extent the idea of judging the quality of the researcher by the size of grant, that for some people it is a matter of self-esteem to obtain large grants; therefore, to receive large grants you should not worry so much about the Operating Grants Program, but take aim at a CSP or Strategic Grant. Proposals in these programs are judged by a different set of criteria from the Operating Grants. Moreover, they are not judged by the GSC concerned, although one or more members may act as individual referees; perhaps the GSCs should be more involved. Therefore, if you can rephrase a research proposal to indicate that what you are doing might be relevant to solving a problem with a current, high public profile, for example, toxic waste disposal, you practically have to run the kilometre in under three minutes to avoid being crushed under the dollars that start falling on top of you. I have seen strategic grants awarded which do little more than augment what is being done under a normal NSERC Operating Grant. Even worse, I have spoken with people who are listed as co-investigators on strategic grant proposals who have little or no idea of how the funds have been spent by the principal investigator. I have seen DSS contracts awarded which were, predictably, a waste of money in terms of scientific research or development, but might have had some value as propaganda in the sense of making it appear that advances were being made in a high profile area.

There is other evidence of what I believe is a conscious effort to bend universities to the purposes of state philosophy. For example, the ESGSC (this may not be true of other committees) was regarded as a little odd because of the small number of government personnel sitting as members; there are always at least two members from industry (who, incidentally, I have found to be very effective indeed). This is another of the areas in which, superficially, the principle (university – government – industry co-operation) seems eminently sensible, but I must admit to some resentment that what we regard as "our" body puts pressure on us to operate by adding government members to the Committee which decides on the quality and usefulness of proposals largely from universities, and yet there is very little movement in the opposite direction for external peer review of many of the research proposals by government departments, whether they are done in-house or by contract.

Grants in Aid

It is always stressed that the NSERC grants are "grants-in-aid" of research; they are not meant to cover all the costs of research. For most people this seems reasonable; the universities pay for the professors, for the building costs and much of the running costs of the laboratories. In other words, if the universities (the provinces) support the basics, then NSERC (the federals) will give a grant to aid research. Several years ago, in better times, this seemed reasonable, but with the tremendous fiscal pressures on universities these days they can no longer handle their side of things. In fact, it may be more sensible to look on the arrangement as role reversal. The provinces, through universities, are supporting federal objectives. The time has probably come when, if we become more involved in government research objectives, NSERC grants must cover the true cost of operating a research program; if true overheads were charged, it might mean doubling most grants.

A Lost Opportunity

The one exciting time when university earth science departments really got together to discuss ways of infusing new life into an aging university population was at a meeting organized by the CCCESD to discuss megaprojects. It was a time of profound hope for a new universities initiative and the outcome of that meeting was LITHOPROBE. However, university professors, who are sometimes a little naive, felt that they should show a willingness to co-operate by involving government and industry. That was not a bad idea, but perhaps they were a little too generous by agreeing to a steering committee consisting of people from these three groups but without a clear university majority. Gradually, the emphasis changed to basic costs being shared roughly 50-50 between NSERC and DEMR, with the industry chipping in whenever they could; the net result is that, rightly or wrongly, the whole project is perceived to be more a part of DEMR strategic planning than as an initiative of the universities. As an example of this, we might look at the program of supporting geoscientific investigations of Lithoprobe Phase I.

Calls for proposals went out early in 1984, and in that call was the statement that an *ad hoc* evaluation committee would be set up, consisting of eight people and with the implication that a number of these would be from the ESGSC. The Chairman of the ESGSC was not consulted, and only after telephoning each Committee Member did he discover that one member had been asked to serve and that, in fact, decisions on applications had been made some time before the GAC meeting in May 1984; confirmation that there was, indeed, only one ESGSC member on the evaluation committee was received after this article was submitted.

As originally proposed, Lithoprobe created excitement among the various universities; it was to be an integrated geophysical, geological, geochemical attack on a specified area with, most importantly, a follow-up drilling program. It was thought at the time that we would be in the cost region of tens of millions of dollars – a genuine megaproject with commitments at least as large as those for OPAL and HERA or, closer to home, as will be required for the CLBA. However, fundamental research could still be undertaken by individuals on their own grants, either alone or within a focused framework of solving major problems concerning the crust and upper mantle. The scale of the project was such that it obviously could not be undertaken on the regular NSERC allocations but rather would require a separate allocation, probably requiring special approval at Cabinet level. Although we may have had differences of opinion about details, few, if any, people doubted the validity, originality or importance of the concept. Now, since the proposal has been scaled down to the size of a micro megaproject and is perceived by some as being little more than a part of the overall federal government program, it is also felt that no part of it will go ahead without DEMR approval. The big mistake was for the group of university chairmen to relinquish control of the whole thing. We should have formulated well thought out plans for a national program of university research devoted to the problems of the lithosphere, which may or may not have had economic benefit, and which may or may not have interested government and industry groups, but the principal purpose of it should have been to stimulate activity and interest in university Earth Science Departments – not just on the part of the existing and new faculty members but on the part of graduates and undergraduates as well. We will undoubtedly have something which is called Lithoprobe, but it will be a pale imitation of what it could and should have been for universities and for earth sciences.

A Word of Praise

If I have been quite critical of NSERC it is because others have sung its praises, but I do want to single out one good aspect that hasn't changed since the days of NRC, and it is something which grantees in other countries envy: the relatively relaxed attitude towards the spending of grant funds. An applicant makes up a budget of many line items, which should be carefully attended to and well justified, and a grant is awarded which is usually considerably less than that requested. There is no requirement that the grantee report in advance how the funds are to be spent; it does not have to be *pro rata* among the requested line items. This flexibility is probably one of the major reasons for the efficient way in which researchers in universities conduct their research and why we are not in much worse trouble than we already are.

Some Proposals

It is always much easier to point out perceived problems than to propose solutions. Nevertheless, some answers were implied above and others are suggested below.

A frequent argument presented to justify more government control of universities is that since universities are using public funds they should be responsible to the public for their use; few would disagree that we are responsible to the public. The question is, should those funds be spent on high profile research which has clearly identified short term economic benefits, as defined by public servants and politicians, or should they be spent on something less defineable but equally, or more, worthwhile. Somehow we must convince the public and politicians that curiosity-oriented research is worthwhile from both the cultural and economic points of view. We can never predict who is going to produce the great advance which benefits us as a nation, or the world as a whole, or even what the great advance will be. About the only thing that is predictable is that among the major problems we will be debating a decade from now will be some we haven't even dreamed of yet. Therefore, we must back a number of people and projects and many of these will turn out to be losers in the sense that their production will not be spectacular. Perhaps if we are lucky as many as 10% will really produce something revolutionary; the other 90% may contribute something useful, but not startling, on which others may build – or perhaps one of the researcher's graduate students may become a "star". That is simply the price we must pay for the frailties of human nature and the predictive processes.

Let us reduce the complexity of the system. For example, do we really need a separate Northern Logistics Committee? Surely we have enough experience to consolidate the funds within the principal committees concerned and to let them make the final recommendations.

Maybe the complexity would be reduced if a clear distinction is made between the bodies that dispense the curiosity-oriented (basic) research funds and those that dispense the targetted (applied) research funds. This may mean that the only funds that NSERC, "our" body, handles will be those for curiosity-oriented research. Strategic grants, specific research contracts, etc., should be handled by some other appropriate government funding agency, but with a clear hands-off policy, i.e., another QANGO. It might not be a bad idea to have personnel in government departments apply to this organization, on the same basis as do the industry and university sectors, for funds to pursue targetted research of national importance, a policy now followed with some success in the United States.

It would be useful to have NSERC continue to handle the so-called Manpower Training Programs (but could we find another name for this?), such as the Scholarships and Fellowships schemes. Industry-Government-University co-operative programs should be handled by the other QANGO, and perhaps in very specific cases by an appropriate government department.

Within this framework, I would on principle give any new applicant to NSERC a three-year grant (unless reports from referees are uniformly bad) and critically analyze the performance before renewing the grant for one or more years; the problem here is

that some new applicants are clearly sabbatical replacements and their continuation at the university is not assured – but maybe a three-year grant would encourage universities to find a way of renewing the appointment.

The Earth Sciences are definitely underfunded relative to some other disciplines; however, rather than correct this by allocating large sums to the operating grants program with the objective of producing "stars", I would prefer to see a considerable expansion in the Infrastructure programs to support large infra- and inter-departmental facilities. All of us are coming to depend more and more on sophisticated equipment, even at the undergraduate level. With proper support for this equipment, stars and the merely competent alike could get along with less, and who knows, perhaps some of the merely competent will become stars (or at least the holders of large grants).

How to Make It to the Top

If asked my advice on how to become the holder of a large grant, I would respond as follows:

Refuse to take on any graduate students; instead, use your grant to buy a good technician and, as your grant increases, a PDF and so on. Try to avoid teaching duties and devote yourself entirely to research and write numerous papers. Refuse to take on any serious administrative duties in your department and never serve on Senate. Do not take part in any aspect of the organization of science, but do take advantage of the work of others by attending conferences, giving oral presentations, etc.

You should become a big wheel quite quickly, but if you should ever want to move, don't apply here for a position; you belong in a research institute or government department, not in a university.

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