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What Earth Scientists Think About NSERC's Star System

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Introduction

Last fall, I sent a short questionnaire to nearly 600 Earth Science professors in Canada. Over half responded. Its purpose was to elicit opinion on the introduction of the star system used over the past decade by the Earth Sciences Grant Selection Committee (ESC) at the behest of the Natural Sciences and Engineering Research Council (NSERC). As a part of an excellent and critical examination of NSERC policy trends some five years ago, Beck (1985) pointed out many of the problems that were already apparent in the implementation of the star system. Under it, small to moderate operating grants of many faculty have been cut or cut-off in order to fund a few very large grants. The response was overwhelmingly negative, with nine critics for every supporter. The data show some other features. For example, faculty in small departments feel that they have been savaged by the ESC in recent years.

Data Base

Questionnaires were sent to all 593 full-time Canadian faculty members listed in the American Geological Institute's 1988 *Directory of Geoscience Departments*. The *Directory* includes some Astronomy, Geography, Land Resource Science, Mining, Oceanography and other departments, so that only those faculty who could reasonably expect to be funded by the ESC were asked to respond. Also, some members of Earth Science departments are normally funded by other NSERC committees such as Civil Engineering and Computer Science. In addition, some faculty have undoubtedly retired or changed employers since the *Directory* was compiled and some have gone on sabbatical or did not receive the questionnaire for some other reason. Thus, the effective population reached by the survey is probably in the order of 450 faculty members.

A total of 293 survey forms were returned by December 18, 1989, and used for statistical analysis. The participation rate of 50% ensures a high level of reliability of the results. It also illustrates the importance to, and concern of, faculty with respect to ESC policy and decisions. Some 113 replies, including 24 forms arriving after the compilation date, added a few lines to pages of written comments. I have tried to encapsulate the gist of many of the thoughtful comments in this article, and accept responsibility for any resulting loss of accuracy and flavour.

The populations of faculty responses in four demographic categories are as follows: (a) years of tenure-track service: less than 10 (109 responses), 10-19 (97), and more than 19 (87); (b) location of department: eastern Canada (61 responses), Quebec (47), Ontario (103), and western Canada (82); (c) number of tenure-track Earth Scientists in the university: less than 13 (82 responses), 13-19 (85), and more than 19 (122); (d) current NSERC operating grant: \$0 (64 responses), less than \$15,000 (69), \$15,000-29,999 (82), \$30,000-60,000 (62), and more than \$60,000 (14).

The responses for each of the 11 survey questions were analyzed for each of the 15 subcategories and for categories by determining their means and standard deviations. These were converted to a scale ranging from -100 to +100 units, where -100 represents a minimum or entirely negative response and +100 represents a maximum or entirely positive response. The survey population includes about 44% of present NSERC operating grant holders. In general, two subcategory means are different at the 95% confidence level if they differ by 16 scale units.

Survey Format

The 11 questions asked if, over the past few years in Canada:

- (1) the level of activity in your research area has decreased (-100) to increased (+100) a lot?
- (2) the number of research publications *per capita* in your research area has decreased (-100) to increased (+100) a lot?
- (3) the number of refereed publications *per capita* in your department has decreased (-100) to increased (+100) a lot?
- (4) the research morale in your department has definitely deteriorated (-100) to definitely improved (+100) a lot?
- (5) your department has been a major loser (-100) to major beneficiary (+100) from the introduction of the star system?
- (6) your annual rate of publication in good journals has decreased (-100) to increased (+100) a lot?
- (7) your annual NSERC operating grant after adjusting for inflation has decreased (-100) to increased (+100) a lot?

(8) your level of research activity varies about linearly with the amount of your NSERC operating grant — definitely no (-100) to definitely yes (+100)?

(9) your NSERC operating grant fairly reflects your research performance relative to your peers — definitely unfair (-100) to definitely fair (+100)?

(10) the research output of the stars in your research area has increased in quality and quantity to match their increased awards — definitely no (-100) to definitely yes (+100)?

(11) the introduction of the star system by NSERC has been very deleterious (-100) to very beneficial (+100) for the Earth Sciences in Canada?

I agree with two criticisms of the survey format. First, no questions asked specifically about the quality of the publications. A common observation is that, although the number of publications has increased (questions 2, 3, 6 and 10), their quality has decreased. Also the paper-counting process has been distorted by a marked increase in the number of multi-authored papers, in the number of refereed journals, and in the splitting of data sets into shorter papers. Second, no question asked about the individual's amount of other research funding. About one-third of those with no NSERC operating grant noted by comment that they had a good level of funding from other sources, as did several with grants. Other non-grant holders noted that they had not applied for reasons such as heavy administrative duties or imminent retirement.

Two individuals considered the questions to be unfair and biased. Three more predicted a negative attitude to the star system because there are many more losers than winners, given an overall decrease after inflation in the available operating grant funds. Three others thought that "harder" data should be used than the opinion format, such as the use of the citation index. If I had the resources, I might consider doing such an analysis provided that self-citations, old citations, negative citations, etc., could be filtered out.

Years of Tenure-track Service

Young faculty with less than 13 years of service have the same attitudes and opinions as their older colleagues, on average. The young report significantly greater increases both in activity in their research areas in Canada and in their own publication rates, consistent with their departments hiring preferentially in new areas of research and with their establishing an active research program, than do senior faculty with over 19 years of service (+21 to +5 and +44 to +19, respectively, or a greater increase to a lesser increase in both cases). Conversely, senior faculty report greater decreases than young faculty in both the morale of their departments and in their NSERC operating grants,

consistent with a longer perspective and with the winding down of their research programs (-35 to -22 and -46 to -27, respectively, or a greater decrease to a lesser decrease in both cases).

Noting the use of NSERC grant records as criteria in promotion and tenure decisions for young faculty, concern was expressed over NSERC's shift to relatively large "starter" grants coupled with relatively quick cuts or cut-offs if results are not quickly published. This policy puts intense pressure to publish prematurely. It also means that some good young faculty are demoralized early in their careers. Thus, a lower "starter" rate and/or more forgiving assessments in their early years might well be a better policy.

Geographic Differences

There are two significant differences in the responses by geographic area relative to the rest of Canada. Quebec faculty believe their departments have lost most because of the introduction of the star system (-27 to -2). Ontario faculty report the greatest decline in morale in their departments (-37 to -18), perhaps reflecting, in part, their system's very low ranking in *per capita* student funding and very high ranking in students per faculty member amongst the Canadian provinces.

Size of Earth Science Group

Faculty in universities with 12 or fewer Earth Scientists report a much greater drop in both departmental research morale and NSERC

funding than those in intermediate and large groups (-44 to -17, and -47 to -31)(Figure 1). Not surprisingly, the small departments see themselves as major losers over the past few years because of the implementation of the star system and are very much more hostile to it (-51 to +13, and -63 to -37). Most small departments have minimal access to university research funds or high-cost equipment to compete for industrial funds. Thus, loss of their predominantly small NSERC operating grants has dried up support for local field-oriented BSc and MSc student research projects. This, in turn, has made it difficult to interest and encourage students to continue in graduate studies, leading to a loss of potential MSc and PhD candidates to larger departments. Obviously, the faculty are also discouraged. Part of the blame is directed squarely at the ESC membership selection process. Despite representing one-quarter of the Earth Science professorate, faculty of small departments have had only 4% of the ESC university representation over the past decade and feel savaged as a result.

Size of NSERC Operating Grant

When faculty are grouped by size of NSERC operating grant, significant differences are found for every question (Figure 2). The well funded wear much rosier glasses than the poorly funded. One can quickly see the larger negative influence of funding cuts or cut-offs at departmental and personal levels. The large majority of Earth Scientists with less than \$30,000 grants report very signifi-

cant drops in departmental morale, whereas the minority with over \$30,000 grants report a marginally non-significant increase (question #4). All groups reckon that they are publishing more research (question #6), yet only 5% have been rewarded with a significantly increased NSERC operating grant (question #7). Of the rest, 21% are about holding their own and the remaining 74% have been rewarded with significant decreases. Small wonder that most Earth Scientists view their assessment and award by the ESC as unfair relative to their peers (question #9). Note that no group believes that the stars have increased their research output in terms of quantity and quality to match their increased grants except for the 5% in the over \$60,000 group (question #10). Except for this same group again, all groups believe that the implementation of the star system has been deleterious or, in most cases, very deleterious to the Earth Sciences in Canada. The following sections attempt to summarize the issues and arguments raised in the responses.

Departmental Research Activity and Morale

An increase in research activity and morale in a department may stem from many factors that are unrelated to NSERC grants such as the hiring of some young "turks", the start of a new provincial research fund, or the moving into a new building; and similarly a decrease may stem from increased teaching loads or a poor chairman. Nevertheless, NSERC

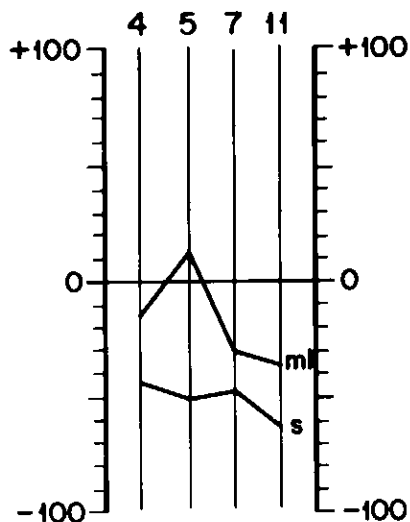


Figure 1 Response to some survey questions as a function of the number of Earth Scientists in the university, where *s*, denotes small units with less than 13 members (number of responses: 82); *ml*, denotes medium plus large units with 13 or more members (number of responses: 207). The questions are given in the "Survey Format" section of the text. The scale units range from -100 (minimum or entirely negative) to +100 (maximum or entirely positive).

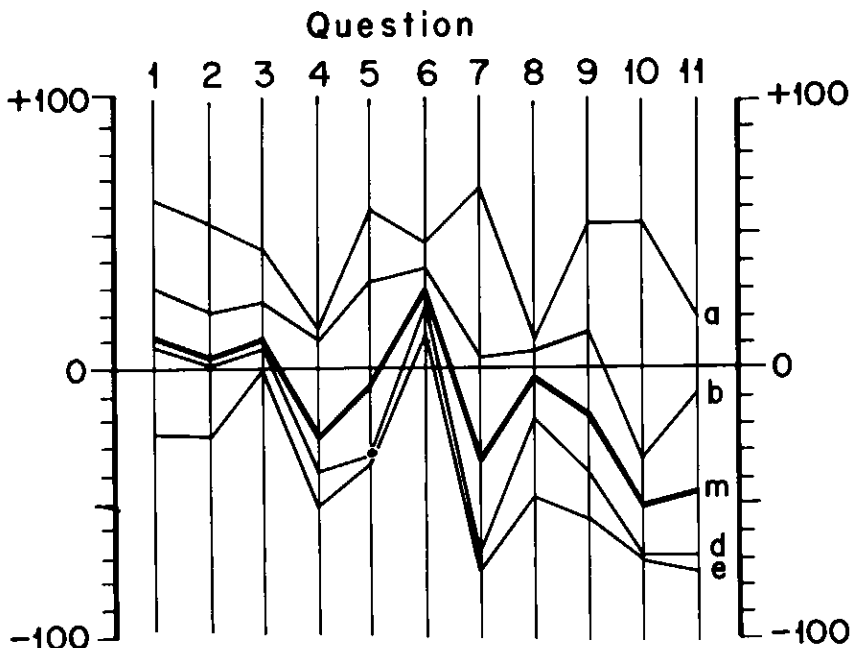


Figure 2 Response to survey questions as a function of size of operating grant, where the grant is (a) over \$60,000 (number of responses: 14); (b) \$30,000-60,000 (62); (c) \$15,000-29,999 (82) is not shown, but is very close to *m*, the mean of all responses; (d) \$1000-15,000 (69); and (e) no operating grant (64). Units as in Figure 1. Note that the over \$60,000 grant group respond positively to all questions, whereas, excluding question #6, the unfunded respond negatively to all questions.

grants do play a major role. The shift to the more elitist star system is splitting many departments into stars, players and nobodies wherein only the stars are happy and the rest are demoralized, as shown by the overall -26 rating. The demoralization is attributed to the anxiety and frustration at being cut or cut-off despite an improved publication record and some "excellent" or "outstanding" referees' reports. The reduction, in turn, leads either to much more effort to prepare applications for generally smaller grants from other sources which tend to be directed to "applied" research only, or to quitting research with a "why bother" attitude.

Is Research Activity Proportional to Funding?

This question drew a "more or less" response with wide deviations in each group. Comments focussed on the extremes where the loss of the last few thousand dollars can mean scientific death and the diminishing return of adding many thousands to already large grants. An obvious observation was that most faculty simply adjust student support to match the available funds. Therefore, this limits students' choices both by reducing the number of research areas of specialization and by reducing the total funds directed by faculty to student support. Others observed that Canadian Earth Scientists are doing well internationally despite relatively low government funding because of the broad base of committed researchers, and that cutting the base will cut the overall contribution. The need to find new sources of research funding to offset the decline in NSERC operating funds was noted.

Pros and Cons of the Star System

About nine Earth Scientists criticize the star system for every one who supports it. The result is a "very deleterious" rating of -52 overall (question #11). Even the over \$60,000 grant group gives it only a marginally positive +18 rating.

Supporters of the star system argue that funding competent, but uninspired, research is wasteful, that Canada needs well-supported laboratories, that the relatively few large grants take little out of the NSERC pot, that the government should set NSERC policy in accordance with its priorities, that expensive research might produce breakthroughs, that some projects have high minimum thresholds such as northern fieldwork, that increased selectivity is necessary given diminishing NSERC resources, and that it is too soon to try to judge the impact of the star system's implementation.

Recognizing that the ESC has to optimize a skewed distribution between the unacceptable egalitarian extreme of equal grants to all Earth Science applicants and the more unacceptable elitist extreme of granting all the money to one Earth Science superstar, some

potential supporters felt that the star system would have been all right if it had not been badly implemented. They observed that escalation of the big grants had been too rapid, leading to obvious waste; that the system was apeing too many of the undesirable characteristics of the American National Science Foundation system; that too many good scientists had been hurt by unjust cuts; that some stars were political, rather than scientific, choices; that implementation would have been acceptable if real extra funds had been infused, and that reversing the implementation process would simply cause additional damage to the Earth Sciences in Canada.

Detractors of the star system noted that big grants do not necessarily lead to good science, pointing out that neither Wegener nor Einstein would have qualified as stars! They argue that cutting grants and cutting out researchers cuts diversity and creativity in research; that a better return is usually to be had from several moderate grants than from one supergrant; that good research at a modest level of output should be proportionately rewarded to good research at a high level of output; that the weak ideas of the stars are researched whereas the best idea of the others may not be; that it is important in educating students to have as many professors involved in research as possible; that rapidly escalating grants quickly lead to the onset of diminishing scientific returns, that stars may be discernably better, but are rarely many multiples better, than good researchers; that small grants are important as seed money for items such as computer programs for those who get most of their funding elsewhere, and that real stars with good ideas should be able to get their extra funding easily from elsewhere because of their management, entrepreneurial and self-promotional skills.

Quantity-Quality of Stars' Research

Except for those with a grant of over \$60,000, no group believes that the stars have earned their oats by increasing their research output to match their increased grants. Many commentators suggest that there has been an increase in quantity, but a decrease in quality. They see numerous potboiler papers reporting "focussed" mechanical research from an assembly line of graduate and post-doctoral students who are repeating similar themes. The kindest comments were that the stars are doing the same amount of good research as they have always done, and that there may be some increase in the sophistication and scope of their research. Many critics observed that the stars that they know are spending more time managing rather than doing research, travelling to meetings, and working on high-profile university and national committees. The time for these activities has come, in part, from practices such as hiring graduate students to teach

their undergraduate courses, hiring technicians who are more cost-effective than additional graduate students, begging off departmental committees and duties, and refusing to direct undergraduate projects and theses.

NSERC-ESC Procedures

A number of comments, some impassioned, were directed at the operations of NSERC and the ESC. They were criticized for imposing the star system in response to a small group of vociferous elitists without explaining or justifying it. Given that the star system has magnified the imperfections in the grant review process, they were criticized for allowing a biased representation on the ESC in favour of specific departments and research areas. The self-perpetuating process of selecting ESC members was identified as a problem. It was suggested that NSERC should adopt regulations to limit the charge-backs for services used increasingly by university administrators to tax grants. Consideration should be given to banning the use of operating grants to pay for postdoctoral fellows (PDFs) who are then vulnerable to exploitation. Rather, the numbers of direct grants to PDFs should be increased so they can work with whomever they wish. Also, the ESC should look more closely at the cost effectiveness of a grantee's research and try to reward the efficient ones.

What Next?

It is clear that the star system enjoys little support in the Canadian Earth Science community. Even the unpopular Conservative government in Ottawa is doing much better in the polls! Most academics feel, either moderately or strongly, that the system's implementation has damaged both the research and teaching functions of our geoscience departments. A more sophisticated (expensive?) poll of the community would not lead to a different result, if that were its aim, because the negative bias is statistically so highly significant. The only legitimate course for the ESC, or NSERC if it forced the implementation, is either to give evidence to show that the star system has been beneficial for both Earth Science research and teaching in Canada or to admit that it has been a bad policy and to reverse it.

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