NEW ZEALAND SCIENCE POLICY REFORMS: VOICES FROM THE GRASSROOTS OF SCIENCE

Jack Sommer
jwsommer@email.uncc.edu
The University of North Carolina at Charlotte

Several science and technology goal-setting exercises from the late 1980s engaged many in the scientific community and led, in 1995 to Parliament accepting RS&T 2010 as guidance for the future of science and technology for the nation. The "Foresight Project," to articulate goals and build consensus, began in 1997 and concluded in 1999. Performance measures to aid accountability and inform public management have been dutifully stressed, but these are hard to devise with specificity and/or monitor.

In 1996 a Survey of New Zealand Scientists and Technologists asked questions designed to provide benchmarks for some RS&T 2010 goals. In 2000, the Year 2000 Survey queried a sub-set of the original respondents. Responses to these surveys indicate whether there has been a perception of progress toward achieving goals, hence rudimentary performance indicators are introduced. Survey results can provide additional information for managing S&T, enhancing public understanding of S&T and, being an important voice for the science and technology community. Both quantitative and qualitative responses tell tales of hope and woe, and raise questions about the efficacy of zealous management of S&T.

1. Introduction

In the mid-1980s U.S. House Science Committee Chairman, Hon. Don Fuqua used a major survey of scientists undertaken by the scientific honour society, Sigma Xi, to focus debate on U.S. science policy [U.S. House of Representatives, Committee on Science and Technology 1986].

Sigma Xi, founded in 1885, used the results of the 1986 survey to chart a course for their second century [Jackson 1986]. Success of the 1986 survey in the larger arena of policy led directly to a more ambitious, better financed, and better organized survey in early 1988. The results of the survey were reported near year's end and caught the attention of the newly elected, 100th Congress [Sommer and Seltzer 1988]. Because both surveys involved random sampling of the Society's 110,000 members, made up primarily of Ph.D.s in all fields of science, the results could plausibly be described as "a voice for the scientific research community." Belief in that proposition, and knowing that a scientific honour society could not, and would not lobby legislators for any reason, the Chair of the House of Representatives Sub-Committee on Scientific Research requested a report on the 1988 survey to help Members determine what issues should become the subject of hearings. After calling on the entire membership of the Society to review the results of the survey and to submit comments and questions, their responses were reduced and incorporated in a report from the Society direct to the 100th Congress [Sommer 1991a].

The process just described was fair-minded, but the results of the survey and the report to Congress became a source of anger for some, angst for others, and affirmation for a few. The collective sentiment of ordinary scientists on sensitive issues brought new vigour into the debate on science policy. Anger was expressed mostly by science managers in various bureaus, and by some of the dons of Science who were accustomed to hearing their authoritative voices echoed back to them in policy settings. Angst was felt by some individuals who had committed their agencies to programmes the scientific community evidently did not support as forcefully as more specifically interested groups that had been successful in leveraging their own projects. Finally, a few persons, often former scientists who had been trying to advise policy from positions within government, found their views affirmed. Subsequently, the U.S. Office of Technology Assessment commissioned special analyses of the survey for a major report to Congress [Sommer 1991b]. The value of the 1988 Survey for science policy purposes was indisputable.

I chronicle these events here because it was these surveys, and the experiences surrounding their use that was the genesis of the *1996 Survey of New Zealand Scientists and Technologists*, and the *Year 2000* follow up[1]. These surveys, and what the results suggest for New Zealand science and technology policy is the subject of this article. The ideas expressed through the surveys, and the idea of the survey process itself, may be useful to other nations faced with the need for information to shape the policy debate.

2. The 1996 and 2000 Surveys

As a source of precise information it is well-known that surveys have limitations [Converse and Traugott 1986]. From the initial establishment of the population from which a sample is drawn, to the clarity of the questions and the response rate of the participants the ability to generalize to whole populations may be affected [Bloom 1998, p. 848]. Some limitations of the 1996 Survey related to identification of the survey population were addressed by the author in a 1997 publication [J. Sommer and D. Sommer 1997]. Doctorate-level, and other equivalent post-masters degree scientists from

universities, Crown Research Institutes (CRIs), government departments and Research Associations made up the population. The principal systematically excluded groups were the unemployed (unlikely to have been many), and those employed by private firms, a group that is probably on the rise as science-based organizations like Celentis and Genesis Research and Development Corporation have joined major long-standing firms like Fletcher Challenge and Carter, Holt, Harvey in employment of highly-credentialed scientists and technologists. We estimated, but do not know with certainty, that the population of this level of scientist in New Zealand is about 5000, of which 4241 made up the survey population. Obviously, there are many esteemed and productive members of the larger science community who did not meet the credentials threshold, and whose views are important. This limitation does, however, have the virtue of comportment with the earlier Sigma Xi surveys, thus permitting cross-national comparisons.

In 1996, 998 survey instruments were sent out to randomly selected individuals and 599 (60%) were returned, of which 576 were certified as complete. Of those who responded, 163 agreed to become panelists who would be resurveyed. Four years later, 127 of these 163 individuals were able and willing to be resurveyed, and 103 (81%) responded, of which 96 were certified as valid for strict comparison to 1996. These response rates were respectable, and post-survey validation procedures indicated no systematic or significant differences between the several groups. Checks on self-selection bias revealed no significant difference between the original population and the panel population. In both surveys qualitative comments were invited and received.

Questions for the 1996 Survey were vetted with focus groups and pre-tested, and many of these had previously been tested for the 1988 Sigma Xi Survey. The majority of the *Year 2000 Survey* questions were identical to 1996, particularly among those that sought to identify attributes. Most of the newly added questions sought attitudinal information and were vetted in a more limited way than in 1996 due to financial constraints. This resulted in several questions being removed from our analysis because rapid policy shifts made them irrelevant, or because the results could be easily misinterpreted. A report of the *Year 2000 Survey* is available from the author [J. Sommer 2000].

The majority of the attitude or opinion questions were framed as assertions, some positive and some negative, to which responses could be made using five carefully defined Likert scaled choices ranging from "Agree Emphatically" to "Disagree Emphatically." This is a standard device that permits acceptance or rejection of the assertion, and in light of the high educational level of the survey population there is little doubt about their ability to respond with understanding [Schuman and Presser 1981, especially chapter 8]. Indeed, even after the testing to which questions had been subjected, several thoughtful respondents pointed out nuances that could lead to misinterpretation. Such cooperation promotes improved survey instruments.

A very few respondents (<1% in 1996 and <3% in 2000) claimed, despite the opportunity to accept, reject, or offer no opinion, that they felt "led to acquiesce to pre-ordained conclusions," as one might fear in "advocacy polling" situations associated with elections [Converse and Traugott, page 1094]. This was not the intent of the researcher, nor the perception of the vast preponderance of the participants in the surveys. Indeed, such a complaint seems implausible, given the structure of the questions and the failure to specify the direction in which one would be "led to acquiesce," therefore the burden rests on those who feel aggrieved to sharpen their criticism. Such criticism, if substantiated, can only help to improve future survey work.

3. Pertinence of the Survey Process for New Zealand

New Zealand has exhibited a willingness to introduce major institutional changes on several fronts, simultaneously. During the past two decades no other Western democracy has moved from a centrally directed to an open economic system [O'Driscoll, Holmes and Kirkpatrick 2000], altered its system of representative government to give greater access to minority participants [Hawke 1993], remodelled its system of accountability for public management [Nagel 1997], implemented an initiative to honour century and a half-old treaty commitments to First Nation peoples, and revised its framework for support of science and technology. It is little wonder that other small nations are curious about the effects of these whirlwinds of changes on society.

Within the S&T whirlwind there is a calm eye through which the direction of movement may be ascertained. The science and technology policy managers have approached this situation with deliberateness. The science and technology community has been invited by the Ministry of Research, Science and Technology (MoRST) to engage in several goal-setting exercises to gain their expertise and their support for changes that have recast government as the "purchaser" of science and scientists as the "providers" [MoRST 1998]. This is a model that differs from the "social contract" arrangement with which the wider scientific community had become accustomed [Guston and Keniston 1994]. In some respects, the starkness of the new relationship may have offended some scientist's sensibilities, but beyond rhetoric there are real questions of the efficacy of the reforms.

Government funds two-thirds of R&D in New Zealand. Government is on record to increase public science funding from the current 0.6 percent to 0.8 percent of GDP by 2010, placing it roughly with current levels in Italy, Denmark and Canada (but below Australia) among developed nations, and more generally on a par with the top half of the Eastern European nations [May, 1998; Koenig, 1999]. A recent estimate puts private R&D at 33% of the New Zealand total, and five-sixths of this is for development [Sci-Tech, 1998].

There are fewer avenues to alternative research funding in New Zealand than in the United States, UK, and other larger nations, thus limiting the flexibility of the scientific community but not their capacity to innovate. Growing government emphasis on "output" oriented research world wide, including the United States, establishes the New Zealand initiative as a

focus of international curiosity [Bloom, 1999]. Thus, the New Zealand government bears a special responsibility for the course of scientific development within the country, and its choice to focus resources on output-driven research establishes a clear framework from which policy consequences can be charted.

The New Zealand strategy is as simple as it is bold. First, there is the recognition that the population of the country is less than four million, and individuals who hold advanced degrees beyond the masters-level in the sciences, and who are active in scientific pursuits number only around 5000. It is accepted as unlikely that this scientific community can sustain basic research across all disciplines, or even several. There are many world-class scientists in New Zealand by virtue of the long tradition of excellence in education throughout the system and by virtue of immigration, however, the very limited number does not permit systematic coverage of all fields. Moreover, concerns have emerged over flagging student interest in science studies [RSNZ Membership Daily News, 11/1/00], and the emigration of scientific personnel [Ibid, 10/2/00].

The results of the New Zealand experiment will be observed closely by other nations with small numbers of scientists and limited resources, and by some not so small, such as Canada. It is important, therefore, that the policy process be monitored from its early stages. Performance monitoring requires cooperation from all parties. Under the best of circumstances, approached in New Zealand, both the policy framers and the public managers, or "purchasers," of science and technology accept responsibility for their performance and demand accountability for themselves and from the scientist and technologist community who are "providers." New Zealand's guiding science and technology goals document, *RS&T2010* makes explicit the requirement for performance indicators to monitor policy, even specifying that "[T]he attitude of the science community to the effectiveness of the science system, as a measure of system 'health'" be one such indicator [MoRST, 1995 page 18]. There remains, of course, the question of how to measure performance and to link this to accountability. Monitoring the effects of policy changes is a responsibility that is sometimes onerous, and it requires a variety of instruments to be effective. One such instrument is the serial application of a survey of scientists and technologists. The 1996 Survey was an attempt to initiate this process, and it provided a snapshot of the science and technology community as close to the beginning of New Zealand's major science reforms as was possible. The *Year 2000 Survey* was a promised follow up to gain insight into changes to the science community, and to encourage the institutionalisation of a survey process in New Zealand.

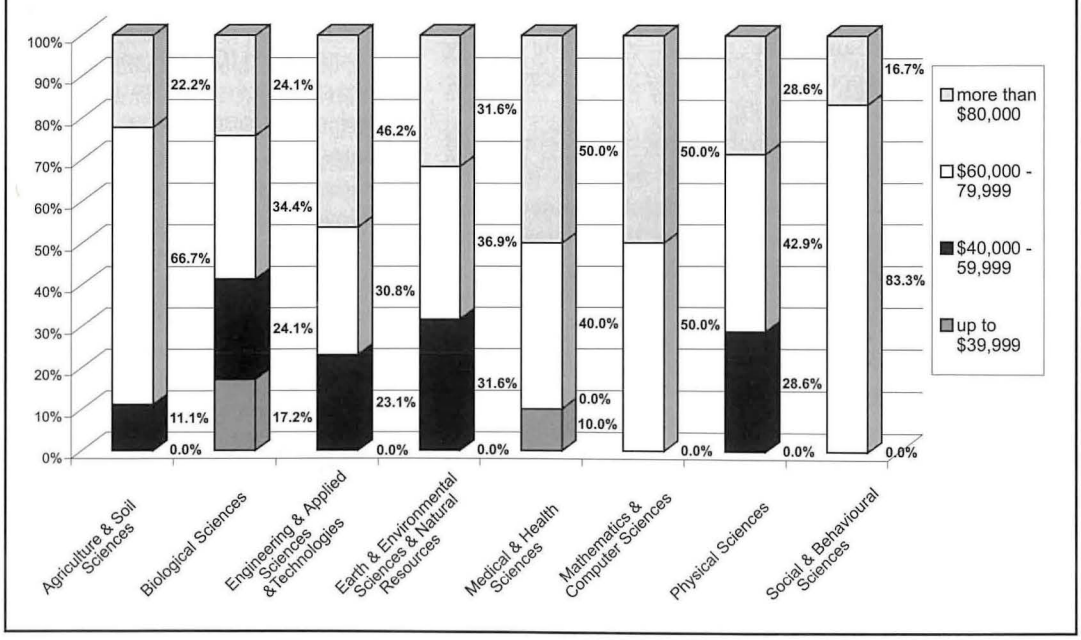
It is often joked in policy circles that two data points are all that is needed to create a trend; however, I prefer to think of the *Year 2000 Survey* as a device that sustains the potential for real trend analysis if the survey process is embraced by those in New Zealand who are truly concerned with directions of science and technology, and with the monitoring of policy initiatives. The Survey contributes to evaluation; it is not an evaluation.

Despite these caveats, there is much that can be gained by examining the responses to several questions that may be windows on the sentiments of the science and technology community and on government policies. In the section that follows, a profile of some key attributes of the S&T community are reported. These are followed by a discussion of the context and results of several questions that illustrate different functions of the survey, especially those that contribute directly to performance measures of policy.

4. Survey Results in a Policy Context: Basic Attributes of General Interest

Like most countries, New Zealand lacks an enumeration of scientists and technologists, therefore sampling of the carefully developed data base aids in identification of characteristics of the specifically defined population. Four questions of general interest will help to give a picture of the composition of the New Zealand science community: these concern the work location of the individuals, their field of science, their gender, and their age.

Figure 1: Personal Income by Field of Science



The chief employers of the entire 1996 survey population are universities 45.5 percent (panelists =36.4%) and Crown Research Institutes 43.6 percent (panellists=47.9%). These employment domains display interesting and notable differences in some attributes, and in many attitudes and concerns probed by the surveys. With respect to field of science the university and the Crown Research Institute scientists differ. CRIs are weighted toward agricultural and soil scientists and biological scientists, whereas universities have the greater proportion of health scientists, mathematics and computer scientists and social and behavioural scientists. When these institutional differences are pronounced it may aid interpretation of responses to other questions, and understanding these differences can be extremely important in the crafting of something other than "one size fits all" science policies. Figure 1 shows personal income with respect to field of science for Year 2000 panelists.

The surveys indicate that a little more than 1 in 5 New Zealand high-level scientists are female, a gender distribution similar to that of doctorate-level scientists in the United States. Also, the women are younger than the men. One advantage of a longitudinal panel study is the continuity of the respondents, but there is also the disadvantage that the population grows older and is not replaced, therefore, periodic resampling of a population is important. Discussion of gender in relation to age and field of science in the 1996 Survey has provided information that is valuable to all who are trying to mobilize the human capital of New Zealand to promote the highest quality science [Forch 1996].

The selection of the broad fields of science indicated in Figure 1, as with the selection of age categories, comports with international data standards to permit cross-national comparisons of the New Zealand science community with others. By knowing the baseline of distribution of scientists by field it will be possible to identify how policy implementation, such as categorical funding decisions, affect the composition of the science community. It is not surprising that New Zealand has strong representation in the Agricultural and Soil Sciences (12.6%) and in the Biological Sciences (21.9%), given its historical focus, but it may be a source of concern in an increasingly information-dependent world that human resources in Mathematics and Computer Sciences (7.4%) is rather thin. It is survey findings such as these on the attributes of the scientific community that can serve as a neutral source of data to inform science policy decision-making.

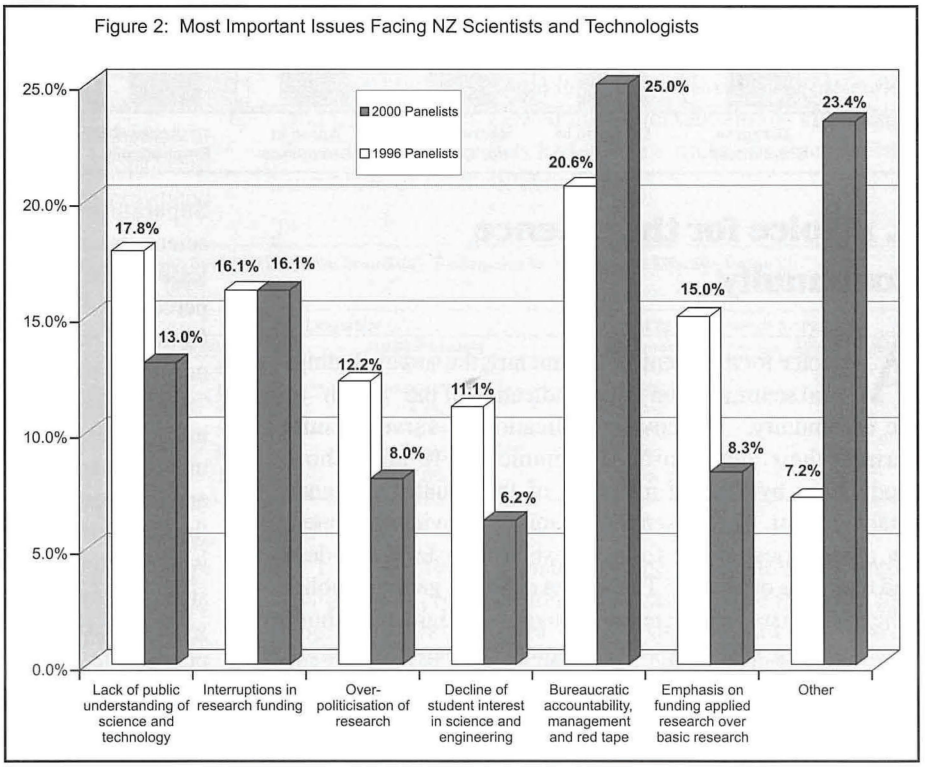
5. Aiding the Public Understanding of Science

National science communities everywhere lament that science is not well understood by the public, and the *Year 2000 Survey* suggests that is true in New Zealand. When asked if *"newspaper and television reporting on science issues in New Zealand is generally accurate and unbiased,"* two-thirds responded negatively and less than one-sixth were positive. And, when asked if the *"public can be trusted to make good decisions on science-related issues,"* the response was even more negative as 72 percent disagreed compared to 12.5 percent who agreed. These are the views of the scientists, of course, rather than the other way around. However, recent and on-going discussions in New Zealand of issues related to genetic engineering of plants and animals suggest that public trust in scientists to make good decisions on science-related issues also might be negative. Can information close the putative gap? Can journalists eschew sensationalism in favour of sober analysis?

Exposure of virtually any of the results of the survey in thoughtful layman's language should increase the public understanding of science, but that does not guarantee amelioration of sentiments. All of the questions in the surveys may be of some interest to some of the public, but as Miller has noted in his studies of public understanding of science and technology, most will be of no interest at all [Miller 1983].

Nevertheless, simply revealing what are the major concerns of scientists may be helpful in increasing dialogue with the informed public on science issues. The two surveys asked scientists about *"the most important issues facing scientists and engineers today."* In 1996, eleven issues derived from focus group meetings with New Zealand scientists were listed. In the *Year 2000 Survey* this list was reduced to the six most cited in 1996 [Figure 2].

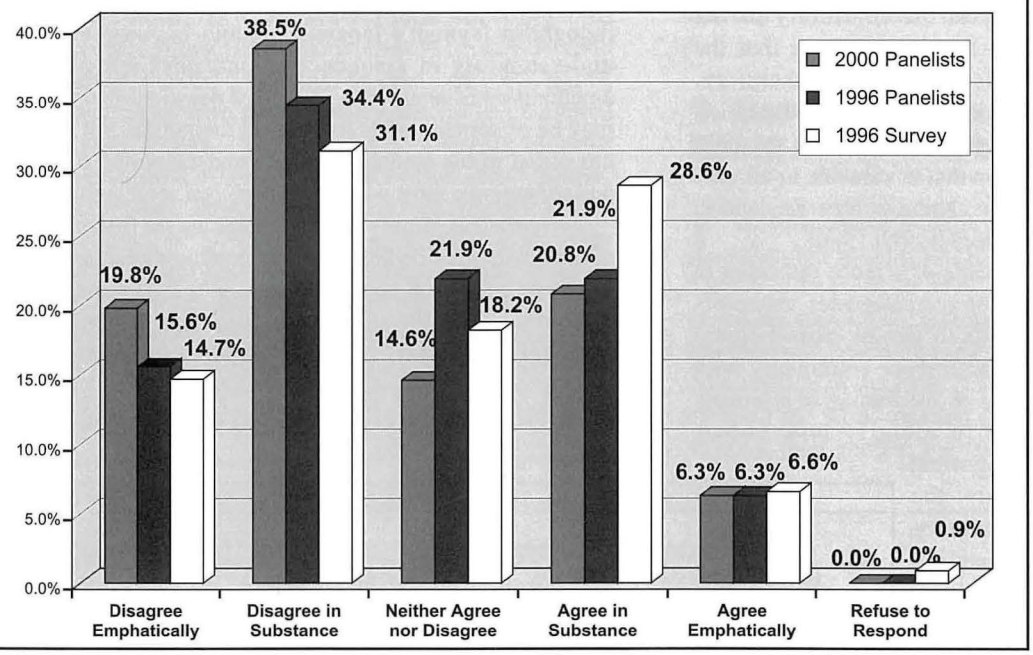
Figure 2: Most Important Issues Facing NZ Scientists and Technologists



Concern over public understanding of science and technology increased slightly over the four years, as did concern about decline of student interest in science and engineering, and emphasis on funding applied research over basic research. On the other hand, concern over the bureaucratic aspects of science declined slightly, although remaining the most important issue.

This is hardly the stuff of high interest to the general public, however informative it may be. Two questions aimed to inform the current discussion about genetic engineering are of more immediate and wider interest. On the question of whether "*GE research should be suspended because it is a threat to the ecosystem or human health,*" respondents were two to one against (48.3% to 22.9%), and on whether the "*government should invest as much in research on "organic" foods as it does on genetically modified foods,*" responses were nearly reversed (47.9% in favour to 27.1% against). For the diligent journalist there is information in the surveys that will surely pique the interest of the public.

Figure 3: Recommend a Career in NZ Science



6. A Voice for the Science Community

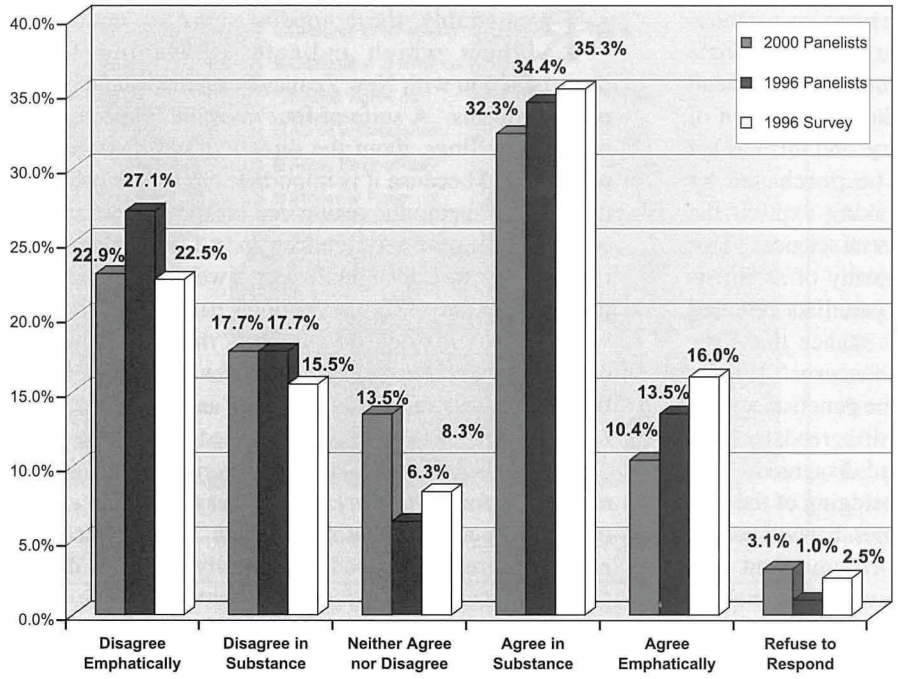
As a voice for the scientific community, the survey findings reveal sentiments on issues indicative of the "health" of the community. Moreover, publication of survey results permits their views to be communicated to all without modulation by leading members of the country's science establishment. In this sense, the survey provides an open, yet anonymous, forum for scientists to register their ideas and concerns on issues. The results offer the general public, other scientists, and science managers insight into those concerns in a way that is less controlled than information derived from consensus statements of groups and organisations, or pronouncements by institutional leaders.

In Figure 2 we have seen what scientists view as the most important issues facing scientists as a collective, so we may now turn to two questions that illustrate depth of concern for scientists at an individual scale.

The responses to one question that goes directly to the heart of the sentiments of scientists might be characterized as a voice of woe [Figure 3]. In the *Year 2000 Survey* participants responded to the assertion, *"The way things are going with scientific and engineering careers in New Zealand today, I would recommend such careers to New Zealand youth,"* by an aggregate response of 58.3 percent disagreeing, either somewhat or emphatically, and 27.1 percent agreeing. In 1996, the same individuals registered 49.9 percent disagreement and 28.2 percent agreement. While the increased aggregate negative response is a signal of unhappiness with current conditions in New Zealand, it masks the fact that the level of emphatic disagreement doubled for CRI scientists over four years. When comparing responses between the university and CRI scientists one finds that CRI scientists are much less willing to tell a New Zealand youth that they should take up a scientific career in New Zealand than are their university counterparts: in 2000: 67.4 percent (56 percent in 1996) CRI scientists disagree with the statement, whereas among university scientists the figure is 56.7 percent (37 percent in 1996) [Sommer 2000].

A second question addressed the subject of job security by asserting: *"I feel my job is reasonably secure for the next five years."* In the aggregate, roughly two-fifths of the respondents fell on each side of the issue [Figure 4]. Separate examination of the differences between CRI scientists and university scientists reveals that CRI scientists lessened their disagreement between 1996 and 2000 from 54.6 percent to 43.5 percent while university scientists increased from 24.4 percent to 37.8 percent. The *Year 2000 Survey* did not probe the reasons for this shift. However, hearing these "voices" in the aggregate and separately from CRIs and universities, one may be led to speculate on the future as university scientists are increasingly exposed to the unfamiliar, and more competitive, policy-driven forces that have guided the CRIs over the past decade. My conjecture is that there will be more turbulence in the system before it becomes smoothly operating – and there will be more expressions of woe. For example, an announcement of increased government pressure to promote convergence of CRIs and universities has brought forth new expression of concern [NZPA, 1998].

Figure 4: Job Security - Reasonably Secure for the next 5 years



7. Performance Measures for Managing Science: Hope and Woe

One important outcome of the *Year 2000 Survey* is the opportunity it affords those whose responsibility it is to manage science for the public good to monitor changes in the New Zealand science system. Nearly one-third of the questions in the 1996 survey are derivative of the *RS&T 2010* document from the Ministry of Research, Science and Technology [MoRST, 1995, 1996]. Questions were designed to serve as monitoring devices upon repeated asking in subsequent surveys. The 2000 survey instrument retained 47 questions from 1996 and added 17 new questions to tap sentiments on issues that had developed over four years, and to try questions that might be used by a subsequent survey. Thirty-three questions from the 1996 survey were dropped in 2000, however some of these could be reinstated in future surveys with populations greater than the group of 96 panelists.

Hope

The surveys of 1996 and 2000 recorded some hopeful signs in the New Zealand S&T community even though woeful responses are all too evident in the preceding section on "voices," and in the section that follows. It is notable, however, that of the 47 identical questions on both surveys 10 indicated positive shifts in attitudes. Compared to 1996, in 2000 there were positive increases in appointments to boards of directors of private firms and Crown-owned companies, patents awarded, access to equipment and to staff to aid research, participation in international science, and support for increased efforts to recruit Maori into scientific careers. These are all related to *RS&T 2010* goals, and although these did not represent large changes, the changes were in a positive direction.

Two questions, decidedly positive, that registered the most significant shift in a "paired difference analysis" among all the pairs of identical questions, relate to collaboration between social scientists and physical scientists, and the way scientists view their "calling" in relation to national concerns.

Interdisciplinary collaboration has been an important matter on the agenda of the Foundation for Research, Science and Technology (FRST) as it seeks to have "providers" address research questions from the perspective of more than one discipline. The following statement resulted in Figure 5: *"During the past two years I have participated in, or directly witnessed, an effective research collaboration between social scientists and physical scientists."* This is a straightforward assertion derived directly from conversations with the Social and Behavioural Sciences Section of the Royal Society of New Zealand. In 1996 the results raised questions about the degree of difficulty in developing collaborations, but they also provided an excellent baseline from which to monitor changes in collaborative efforts. In 1996 three-fifths of the panelists disagreed with the statement and one-fifth agreed. In 2000 a little more than half disagreed, and more than a quarter agreed. Many who neither agreed nor disagreed in 1996, particularly at CRIs, moved to the agreement side in 2000. Whereas, in 1996 university scientists and CRI scientists viewed this statement almost identically, by 2000 CRI scientists had become more convinced of the incidence of such collaborations.

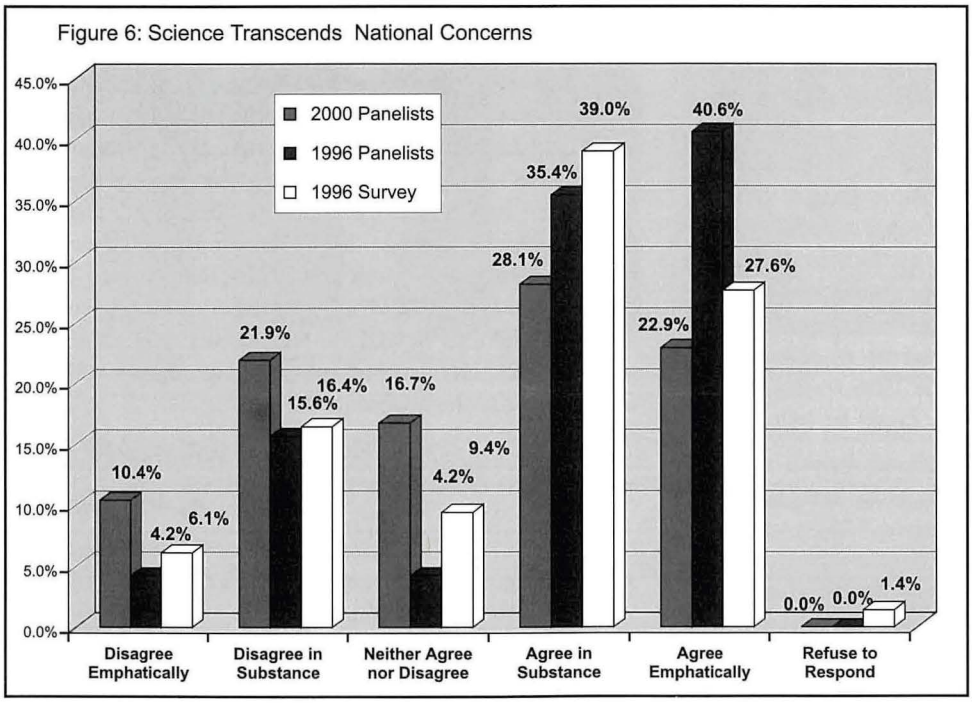
Figure 5: Collaboration Between Social and Physical Scientists – Participated in or Witnessed Effective Research Collaboration over the Past 2 Years

	University		Crown Research Institute	
	2000 Panelists	1996 Panelists	2000 Panelists	1996 Panelists
Disagree Emphatically	40.5%	47.1%	39.1%	46.0%
Disagree in Substance	18.9%	20.6%	19.6%	18.0%
Neither Agree nor Disagree	5.4%	8.8%	13.0%	24.0%
Agree in Substance	18.9%	14.7%	19.6%	8.0%
Agree Emphatically	10.8%	5.9%	4.3%	4.0%
Refuse to Respond	5.4%	2.9%	4.3%	0.0%

It is worthwhile considering the implications for inter-institutional collaboration in the cases where there are few social and behavioural scientists in Crown Research Institutes. On the one hand, this could be described as an ideal situation of complementary talent awaiting mobilisation; on the other, lack of contact continues to make it difficult for

individuals in either institutional setting to comprehend what the other is about.

For a national policy objective to have meaning for those toward whom policy is directed the policy should resonate with the sentiments of the individuals affected. New Zealand science policy has been predicated on the development of public goods for the benefit of the country, and this has led to the specification of "outputs" to be purchased by government from "providers," thus making explicit the primacy of "national science" over "universal science." This perspective may be irritating to the majority of scientists ("providers") but after four years the panelists relented somewhat in their strong universalistic stance that *"the pursuit of science transcends national concerns"* [Figure 6]. In 1996 more than three-quarters of the panelists agreed with this assertion and less than one-fifth disagreed; by 2000 just over half agreed, and nearly one-third disagreed. This shift in outlook might be construed as a bridging of the gulf between the policy goal of research outcomes that will benefit New Zealand first, and the scientist's commitment to a "calling" without borders. However, a more detailed analysis reveals that university scientists and CRI scientists differ significantly in their outlooks, with the former being more likely to agree that science transcends national concerns. The level of agreement with the statement by university scientists did fall from 94.4 percent in 1996 to 70.2 percent in 2000 whereas CRI scientists went from 60 percent agreement to 37 percent.



Hope may be claimed in both of these questions. Collaboration between social scientists and physical scientists is an important policy goal, and in the broader question of science and the nation one can find a hopeful (from the point of New Zealand's S&T goals), if implicit, indication of the success of policy orienting scientists toward the national context.

Woe

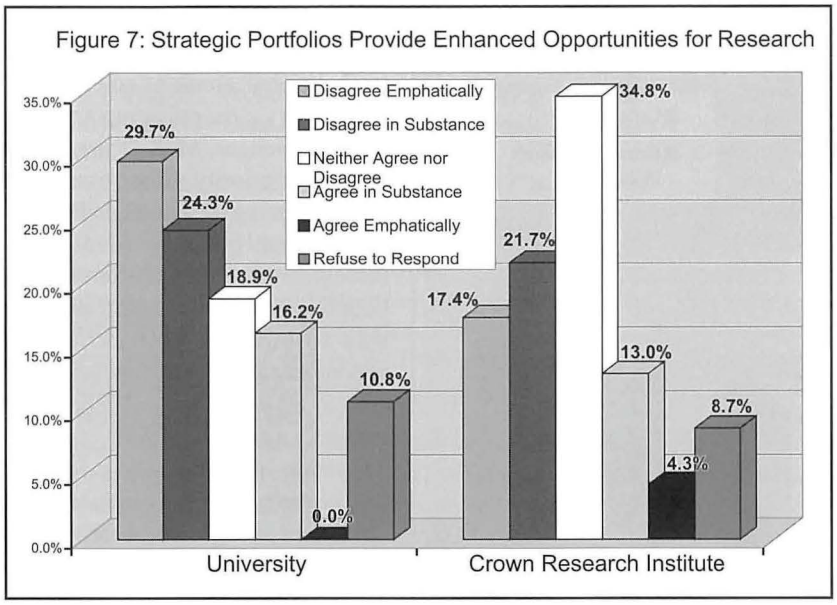
Regrettably, these hopeful signs are countered by others which indicate a stunning level of dissatisfaction with New Zealand's science and technology policy reforms. A suite of four questions captures intense negative feelings about the direction and management of science, and because it is important to know in what sector trouble is brewing the results are presented with respect to work location at a university or a CRI. Consider the responses to the Foresight Project, a well-advertised process that engaged only 32.3 percent of the panelists. The panelists were roughly divided on whether *"the process was open and inclusive of a large segment of New Zealand scientists,"* but the largest response category as *Neither Agree nor Disagree*, indicating a lack of knowledge about the process.

On the question of whether *"The new strategic portfolios developed from the Foresight Process provide enhanced opportunity for my kind of research"* more than twice as many disagreed as agreed. University scientists disagreed (54%) more vigorously than CRI scientists (39.1%) [Figure 7].

Scientists seem to be suspicious of, and discontent with those who manage science, and in a question, used both in 1996 and 2000 this discontent was high and did not decrease among the panelists over four years [Figure 8]. The statement, *"The management systems now in place are appropriate for the effective advancement of research,"* evoked 69.8 percent disagreement in 1996 and 70.9 percent in 2000; in 1996 8.4 percent agreed and in 2000 the figure was 8.3%.

This question was placed in a sequence related to the science reforms of the past several years so there is no ambiguity that the restructuring is viewed badly by the scientific community, particularly by those who are employed at CRIs [Figure 9]. Seventy-six percent of the CRI panelists disagreed with this statement in 1996, as did 61.1 percent of the university panelists. By 2000 CRI disagreement had risen to 78.3 percent and university scientists to 72.9 percent.

Responses to the statement, *"The changes in the organisation of New Zealand science over the past four years have enhanced my situation/conditions for performing innovative research,"* brought forth a nearly identical response by the panelists in 1996 and 2000: 65.5 percent disagreed in 1996 and 68.8 percent disagreed in 2000. In 2000, 73 percent of university scientists and 71.8 percent of CRI scientists disagreed with the statement. For the CRIs this is consistent with their response in 1996 but for university scientists it is a sharp jump from 55.6 percent [Figure 10].



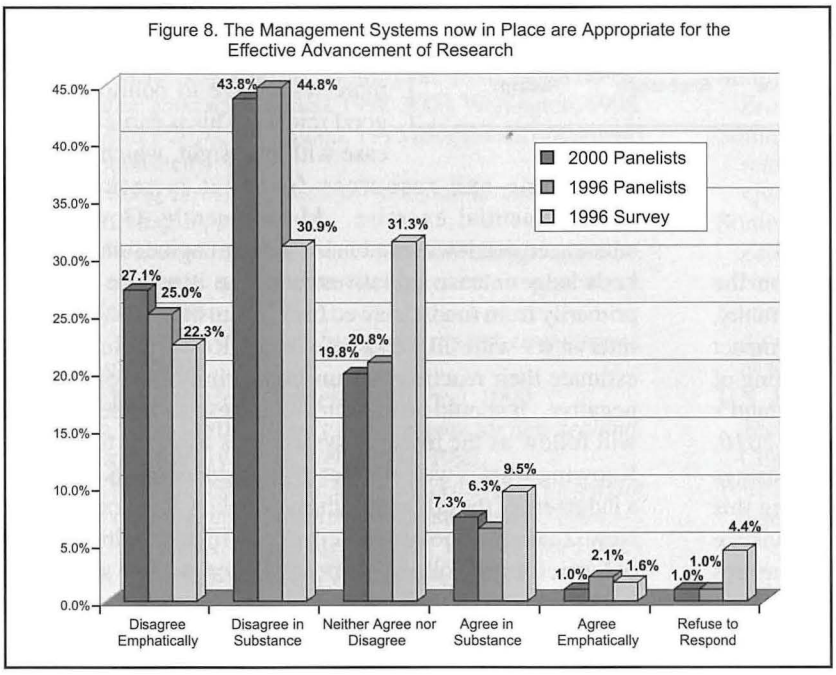


Figure 9: New Zealand Science Management Systems Appropriate?

	University		Crown Research Institute	
	2000 Panelists	1996 Panelists	2000 Panelists	1996 Panelists
Disagree Emphatically	32.4%	16.7%	28.3%	34.0%
Disagree in Substance	40.5%	44.4%	50.0%	42.0%
Neither Agree nor Disagree	24.3%	27.8%	13.0%	16.0%
Agree in Substance	2.7%	8.3%	6.5%	6.0%
Agree Emphatically	0.0%	0.0%	2.2%	2.0%
Refuse to Respond	0.0%	0.0%	0.0%	0.0%

Figure 10: Science Reforms Enhance my Ability to Perform Innovative Research

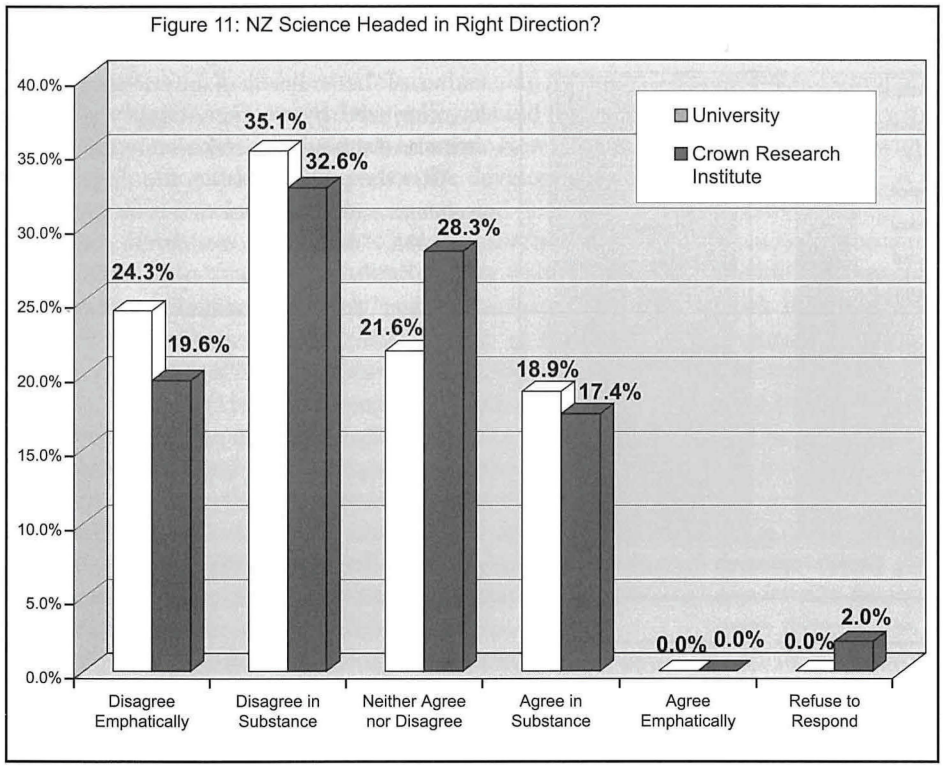
	University		Crown Research Institute	
	2000 Panelists	1996 Panelists	2000 Panelists	1996 Panelists
Disagree Emphatically	51.4%	27.8%	28.3%	30.0%
Disagree in Substance	21.6%	27.8%	43.5%	38.0%
Neither Agree nor Disagree	10.8%	30.6%	10.9%	14.0%
Agree in Substance	5.4%	11.1%	15.2%	16.0%
Agree Emphatically	5.4%	0.0%	0.0%	0.0%
Refuse to Respond	5.4%	0.0%	2.2%	0.0%

It does not appear that much progress is being made on achieving the RS&T 2010 goal, cited earlier, of "better health of the science system" as measured by an increasingly positive attitude of the science community to it.

After the previous observation it probably comes as a mild surprise that response to the assertion, *"All things considered, science in New Zealand is headed in the right direction,"* found that only slightly more than half (53.2%) of the respondents to the *Year 2000 Survey* disagreed and nearly one-fifth (18.8%) agreed [Figure 11].

This simple question presents information that will be particularly important to track over time. In theory, responses to the question will become more positive as the most disaffected scientists drop out of the system or become accustomed to it. If this is not the case, there will undoubtedly be more demands for rethinking of the restructuring effort.

These performance measures find a warrant in the *RS&T 2010* document, and their deployment has unveiled feelings of hope and woe, in unequal measure, within the New Zealand science community. The two surveys of New Zealand scientists can not claim a level of precision beyond the limitations spelled out at the beginning of this article, but it seems quite undeniable that the sign on the state of the science system is negative, and sufficiently so, to be concerned about it's "health." Continuing with the therapeutic metaphor, it seems that the patient's pulse should be taken regularly by a qualified agency. In my view, that agency ought to be a largely independent and distinguished New Zealand scientific organization, institute, or group, separate from Government but regarding of the public interest. It should become the source of systematic information about change in the New Zealand scientific community. The principal science management institutions, MoRST, FRST, the Association of Crown Research Institutes (ACRI), research associations, universities, scientific societies, and private firms must be assured of the neutrality of a body which collects, categorizes and communicates fundamental information about the health of the science community. With such a body in place, these institutions would be relieved of the burden of defending findings that might be seen as self-serving, or of failing to ask sensitive questions. Also, the public can make more informed inquiries of the science policy makers and managers on their progress in meeting objectives.



New Zealand, like most small nations is faced with many challenges in the global arena of science and technology. Stepping up to meet these challenges, MoRST organized a series of priority setting exercises, the latest being the Foresight Project. The project gathered ideas from throughout the scientific community, both to inform government and as a way to build consensus for the actions that government agencies will take to allocate funds. Preliminary results indicate that further adjustment of priorities and modalities for meeting goals may induce more discontent in segments of the science community. Indeed, to many scientists it seems as if a permanent state of change of programs and portfolios has been instituted in New Zealand, and that these changes are more responsive to politics than to good science. This is particularly the case with Foresight, which required much time and resources for what is reckoned an inconsequential exercise. More recently, Government announced that it will establish a venture capital fund to target knowledge-intense initiatives, and that it will be financed primarily from funds "clawed back" from the CRIs. From my interviews with all heads of Crown Research Institutes I estimate their reactions to run from grimly ironic to highly negative. It should be expected that these and other debates will follow as the research system tries to adjust to change. Knowing what is won and lost in these adjustments is vital to a judgment of the efficacy of the new policy directions. Some New Zealand scholars anticipated difficulty with science policy reforms [Bollard, Harper and Theron 1987] and others have documented their own dissatisfaction, thus contributing to a growing policy debate that is likely to continue [Galbreath 1998, Edmeades, 2000, and contributors to Sommer and Sutherland, 1998].

From the dialogue over these changes and from the two surveys has emerged a pertinent question concerning what a small country with a small science community might contribute to the global science community beyond the best science of which it is capable. It is no exaggeration to suggest that New Zealand is making a major contribution through its experimentation with a purchaser/provider funding method that may be appropriate to countries with limited resources for investment in front line basic research. On the other hand, this experiment, as with many in science, may fail. It is to the high credit of New Zealand scientists and their government that they are willing to monitor their experiment and to make modifications as it progresses, even to the point of rethinking the entire system [Davenport and Bibby 1999]. It is of interest to the global community of scientists to follow carefully the progress of this experiment, both for its possibilities and its hazards.

Conclusions

This paper reports on two surveys of New Zealand scientists that provide unique, baseline data on the attributes and attitudes of New Zealand's science community, particularly with respect to scientist's views of the impact and efficacy of science reforms initiated at the beginning of the last decade. Questions derived from New Zealand's science and technology goals document, *RS&T 2010*, respond to its stipulation to develop performance measures to gauge progress toward meeting the goals. By using this baseline data from the surveys future changes in the science community may be monitored, and performance measures developed. The surveys may also serve as a source of fundamental data for public or private policy making, a voice for scientists, and an instrument to enhance public understanding of science and technology. Each of these survey functions can contribute to different aspects of the continuing effort of New Zealand to make the best use of limited resources and highly skilled personnel. The strong response rate to these surveys should give confidence to those who might fund future surveys on a regular basis.
Some of the results of these surveys may have a disturbing tone, but it should be remembered that the real value in asking these questions will be found in repeating them over several years; to do otherwise would ignore the intent of *RS&T 2010*. The two surveys are, after all, just two data points on a barely understood trajectory of change that may be measured only in a limited way, yet they do offer some useful insights. Recognition of this utility has led to a major research proposal by Australian scientists to build on this survey for a more extensive study of human resources in science and technology. Discussions with the Irish Science Council may lead to a similar effort.

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[1] The tabulated responses to the 1996 and year 2000 survey questions are shown on the NZAS web site at http://www.rsnz.govt.nz/clan/nzas/