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The Management of Science

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This address is a wide ranging description of a whole series of activities that take place from the establishment of national policies in scientific research to the supervision of a specific small research project.

Most research in New Zealand today is carried out by Companies or, as they are grandly called-Corporations of which the Crown Research Institutes are a big part. The natural outcome of this corporate-based research is the use of strategic planning, strategic action and strategic thinking. Strategy can be defined as "the decision making processes used to direct the allocation and application of critical resources in response to major opportunities and threats". For `critical resources' we could equally well say `scarce resources'.

A three - dimension pyramid can help conceptualize the inter-relationship - strategic planning leads to strategic action, while both of these activities are permeated entirely by strategic thinking.

FIGURE 1: Strategy – useful.

The success of a Corporation, whatever its function, hinges upon managers being able to crystallize their thinking and drive their companies to achieve some specific goals. To put it another way, the failure of promising managers to develop in a corporate structure can be attributed to: not becoming strategic in their thinking; not translating good ideas into action; not building a cohesive team for their staff, and translation of a high self confidence early in their career into arrogance later on.

The management of science has undergone many changes. It needs strategic management to assist in the adjustment to these changes. Strategic Management is both a **process** and a **philosophy** determining and controlling the science corporation's relationship to its changing environment. As a **process** Strategic Management defines approaches and techniques that help

management adapt to the dynamics of today's environment - in science and in life in general. As a **philosophy** strategic management changes how managers look at: competition, customers, markets and even the organisation itself. Its purpose is to stimulate management's awareness of the strategic implications of environmental events and of internal decisions.

Many of you work with AgResearch, so for the purposes of this paper I have taken AgResearch as the example of a Crown Research Institute to relate to. Through the use of objectives and strategies, strategic management endeavours to achieve efficient programmes to accomplish AgResearch's mission.

Strategic Management permeates all major activities and decision making by raising the level of consciousness, and providing valuable insights that are otherwise unobtainable. Overall strategic management is the best fully integrated approach for managing change.

In a paper presented to the MAF Technology Board in November 1990, Barbara Barratt, Geoff Asher, Vicki Carruthers, Peter Fennessy, Nigel Given, Stephen Golson and Ken McNatty concluded that "To produce quality, innovative research, science staff need to have clear research objectives which they feel strongly motivated to achieve. The reward comes from the satisfaction of achievement and recognition of this by the scientific community, and a sense of accomplishing something worthwhile for the country. "Their paper is talking about **effective strategic management**, for it is characterised by:

- clear direction and purpose
- objectives and strategies consistent with the business mission
- continuous monitoring of internal and external environments
- integration of operating budgets with the strategic plan
- continuous monitoring of progress with revision of plans and programmes as appropriate
- creation of a strategic atmosphere that fosters a team spirit
- Commitment of necessary resources and the development of systems to provide necessary management information.

Let's compare AgResearch's business plan and the recommendations of the Barratt group. AgResearch has 5 science area-business units each headed by a General Manager (science and technology). Each unit has defined research and

development focus. Within each unit, strategic national science areas have been allocated to leaders with an international standing in their research area. These national science leaders are responsible for developing scientific excellence and innovation targeted to capturing market opportunities.

This restructuring involves recruitment and training to direct the human resources and intellectual capital to new science areas. The general managers will be responsible for the creation of a work environment encouraging scientific excellence and innovation. The Barratt group states that there are no simple or direct ways in which innovative, successful research can be generated, but if the environment is right this will come automatically. Their first recommendation is to encourage, support and recognise excellence in science leadership and screen existing and new staff specifically for these strengths i.e.; matching skills to jobs.

Barratt et al. also call for recognised research leaders to have the freedom to assemble research teams and build flexibility into their programmes. The management structure of AgResearch is attempting to achieve this. The General Managers are regionally based and are responsible for the running on a day-to-day basis of all the work of their research centre.

The National science leaders on the other hand have a responsibility to fund and oversee nationally the work in their specific areas. They are, in a sense, the budget and quality controllers of a given research programme and, in effect the GM and the Scientists on a given site work for the National Science leaders. The latter control the money and can, if dissatisfied, cut it off. They are not responsible for the people doing the work in research centres (other than their own), but they do have control of the dollars.

This approach satisfies the Barratt group's second recommendation to improve efficiency of the science administration and management by stringent rationalisation. They claimed an urgent need for management to become more accountable to science leaders. The unique management structure of AgResearch should achieve this service to Science Leaders as well as creating a more rational and coherent implementation of research programmes. Barratt et al. called for flexibility to pursue expected scientific discoveries and adequate resources, funding, staff and equipment to carry out quality research once a programme has been approved.

An objective of AgResearch is to generate sufficient profits from new and existing business operations to adequately finance the necessary repositioning of science to ensure its long term viability. If this is achieved, flexibility becomes possible, as does stability and the scientific integrity of the organisation, another characteristic called for by Barratt et al.

Protection from excessive external bureaucracy and distraction from science was another recommendation of the Barratt group. This unfortunately, has not yet been achieved. 60 - 80% of AgResearch's funding at present comes from PGSF administered by Fund for Research Science and Technology (FRST). My view is that AgResearch will work hard with FRST to reduce the bureaucracy that does exist. This will occur as scientists make their bids and report back to FRST during the course of a programme. FRST is here to stay because it is Government's determined Policy that we should compete for the research funding that comes from the taxpayer.

Two other recommendations sought by the Barratt group within the science area were; an acceptable career structure, and intellectual stimulation by facilitating travel, scientist exchanges, and support for Post Graduate students and Post Doctoral Fellowships. At an AgResearch board meeting in February 1993 the Chief Executive Officer reported the establishment of 2 committees on science both consisting of bench scientists. One has been commissioned to report on the science capability of AgResearch, its strength, weaknesses and needs, and the other has been requested to identify the key elements of career structures which are attractive to scientists in terms of recruitment and retention. As it happens these two committees are chaired by two of the authors of the Barratt group report.

A recommendation for AgResearch's board consideration developed by the GM's, was the establishment of a number and range of Research Fellowships and Scholarships. The Board gave approval in principle for their establishment subject to funding availability in the 1993-94 budget. It is fair to say there was enthusiasm at Board level for the proposal and it will be strategic planning and action that brings about the funding necessary to achieve this worthwhile objective.

The AgResearch business plan mentions corporate loyalty, open participative style of management and prudent financial management. Some of these concepts will be foreign to some scientists and technicians, especially perhaps the idea of corporate loyalty. They will, however, be a natural outcome of getting the environment right (as called for by the Barratt group). Both the AgResearch Board and the Barratt group agreed on the necessity of science staff having clear research objectives which they feel strongly motivated to achieve.

The management of scientists is difficult as it involved working purposefully toward goals yet requires the capacity to think and act laterally. Important also is the need to have the flexibility to pursue unexpected scientific discovers.

I quote from two sources that describe this difficulty. The first is by McMeekan in his address to the Animal Production Society in 1958: "The main needs of New Zealand science are but three: the right atmosphere, adequate facilities and reasonable remuneration". He said "Scientists are peculiar beasts. To the extent that they deviate from the average they are all a little mad. Their deviation takes the form of intense curiosity. To be worth their salt they must be dedicated. Though modern science has little room for the lone worker, every scientist is at heart an individualist, playing his hand not for himself, but for knowledge. Because of these peculiarities, he just has to be treated a little differently if society is to get the best from him. The best place for him is probably a monastery - hardly practicable in these materialistic days where the State rather than the Church grants asylum to those who are different. Above all things the Scientist cannot be organised except in a free and easy way. The perfect scientist research organisation, with clear cut responsibilities, with each researcher in his predestined niche,

with no overlapping or duplication, and with purposeful direction from the top, may be a bureaucrat's dream - but it would be a sterile one. Science requires inspired flashes. Like lightening, no one knows where or when they will strike. It will be a sorry day for science in New Zealand if the control of research ever passes to the hands of people who do not appreciate this. The day that work is prescribed, healthy competition stifled and scientific freedom denied, will be the day that true science will die in this country. The right atmosphere is easy to secure. It is one where scientists organise themselves so as to get all the advantages of group research without losing scientific freedom so vital to the individual researcher".

The second quotation is from Eric Ash, Rector of Imperial College, London.

"How should academic scientists be managed"? Ash asks "My personal stance would be to say barely at all. People embark on an academic career for a number of reasons. They will enjoy teaching, they will be fascinated by research, they will probably be workaholics, they will not be particularly concerned about getting rich. There is, however, an additional trait which I believe is a factor for many recruits to acadaemia. They want to enjoy a great deal of personal freedom. It is one of the glories of the concept of the University that no-one really bosses anyone else. When you ask what sort of orders a Professor, a Head of Department or a Rector can give, it turns out to be few or none. The whole system is a persuasion business". He talks of course of University staff who are involved in research as well as teaching. I believe CRI scientists behave similarly.

Regardless of his or her background the scientist must consult with colleagues and with the community he/she services. Imagine for a moment that I am a scientist. I might say to myself; While I rightfully demand some research elbow room in my work to cover my lateral thinking, I need to regularly explain where I am going to my peers, to my science manager, to my spouse, to some people in industry, to some farmers. The moment my pursuit of knowledge becomes indivualistic, I lose my balance. Without the knowledge of other peoples views, indeed without the courage to ask for their views I become a loner. I have lost my relevance to society, to say nothing of my usefulness.

Science Managers and the Corporate Plan

Can scientists head science corporations and have the vision of the kind of organisation they would like to have in 5 years time? Can they share that vision with others at the top of the organisation and further, have the necessary lengthy and difficult discussions with their senior people so that the vision is really shared? If they can then management could work out the organisations purpose and mission over a 5 year period and from that, establish objectives and strategies for achieving them to enable the organisation to write a corporate plan. Douglas Hague, Associate Fellow of Templeton College, Oxford writes in "The Management of Science" "the benefit to be derived from corporate planning in scientific research is that it leads to a strong sense of common purpose arrived at through the process of argument and counter argument which leads to a shared vision of the organisations future. The resulting vision is simple and yet inspiring. A plan must establish the future direction for the organisation, not retravel the past".

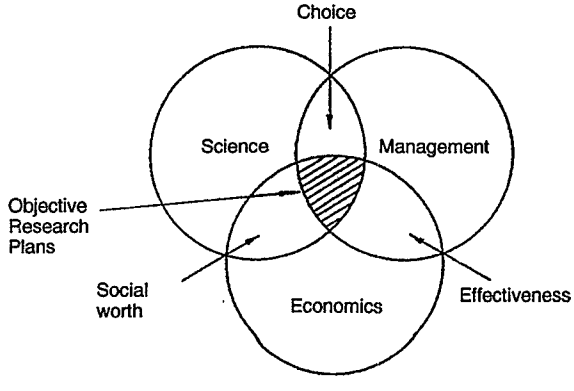
If the corporate plan is a living document, then those affected will look at it regularly to remind themselves of their commitment to achieve in particular fields and to judge the appropriateness of proposals for new expenditure against the priorities established in the plan. This is a discipline that generates in some scientists resistance to corporate plans. However, the corporate plan is the way the scientist and a CRI can demonstrate that they are performing well.

A science research organisation is enormously complex. It has strengths and weaknesses relating to its particular research work. It contains large amounts of information in fields of research it covers and in work already done by other organisations. According to Hague the merit of a good Corporate Plan is to reduce complexity in a way that clarifies the intentions of the organisations to everyone within it rather than concealing those intentions. He believes a corporate plan composed largely of sums of money cannot give a sense of purpose or direction to anyone and, while the plan must reduce variety in a purposeful way, it must not suppress it. A good plan must be succinct, crystal clear and keep reference to sums of money to the necessary minimum.

Given a good plan the organisation now requires good decision making and problem solving techniques. A role for management based upon the disciplines of the economist; a knowledge of concepts such as "cost benefit analysis" and "opportunity costing". The knowledge that resources of money, people and facilities are scarce, is vital to successful decision making, and drives the science manager to make choices.

Scarce resources have a price, and these can be built into budgets so that different research activities can be measured against each other. The opportunity cost of a given research activity is measured, not in terms of money, but in terms of the alternative research opportunity that has to be foregone if the new field is entered. Therefore, in managing science there are three specialities involved; science, economics and management. Because economist, managers and scientists largely operate within their own disciplines, they are largely separate - but there is some overlap. The overlap between science and economics gives social worth, with cost benefit analysis the classic tool for establishing this.

FIGURE 2:



Nowdays FRST and science managers are endeavouring to look at both costs and benefits, as they realise cost alone is not a measure of the worthwhileness of a research project. An evaluation of benefit or output is more difficult to give, but it is the only question to ask in making decisions about what to fund in the future.

The other two overlaps are between management and science where the overlap represents choice and between management and economics where the overlap represents effectiveness. The triple overlap between science, management and economics is the area from which objective plans develop. Such research planning implies teamwork and humility on the part of the scientist. Humility through accepting they can avoid the necessity of becoming experts in management and economics by working in teams with people possessing these skills. This sort of team leadership and management is essential to the running of a successful science organisation. While some scientists have the ability to learn all three disciplines, in most cases they are likely to achieve more for research if they stick to science and readily accept the contribution of people with the other skills.

The effective scientist will will ensure the discussion about the role of science in society includes the lay public. If scientists are to argue that scientific research is of public benefit, they need to bring the public to the table.

Scientists need to become advocates for the idea that science is a national resource that is critical for meeting societies needs in the 1990's. They need to learn more about public decision making, needs and values to help prepare them to discuss the issues behind scientific needs and values with many audiences. Some of these groups are the secondary schools and Universities creating tomorrows scientists, the animal welfare groups, and people concerned with clean food and sustained environment.

Roberta Miller, the Director of the Division of Social and Economic Science at the National Science Foundation in Washington DC, claims that scientists are accustomed to operating on the assumption that science is an intellectual activity far above Politics, which is considered to be uncertain at best, and unsavoury at worst. "Many scientists", she ways "would prefer to keep science in the laboratory". Unquestionably that would be easier for scientists. But science became part of the political process when scientists first began to accept public monies for research. At this point it is inextricably part of the political system.

Ultimately future support for scientific research will only be obtained if science is widely recognised as being in everyone's interest. This means the general public, as well as those in positions of responsibility in the country, must be persuaded that science is a valuable investment of public funds. No one can make that case better than the scientists themselves.

Roberta Miller describes the understandable tendency for scientists to know more about the **content** of their discipline or specialty than about its **functioning**. However, ultimately the health of every field of science depends upon a conjunction of non substantive factors, including the numbers of trained researchers and graduate students, the quality of undergraduate departments that produce new recruits for scientific careers, the availability of instrumentation, training for both students and scientists in advanced research technology and the capacity of the field of endeavour to support and reward inter-disciplinary and multi-disciplinary research as well as traditional disciplinary research.

The problem is, resources are limited and not every good scientific project can be supported. We need scientists to find new ways of managing resources and to discover flexibilities in sharing those resources within and across laboratories and even institutions.

Scientists should have ideas on strategies for maximizing the limited resources we have. The costs of a CRI are easily defined and are divided into overhead or fixed costs and variable costs. Fixed costs go on however much work is being done whereas variable costs are in direct proportion to the amount of work being done and therefore the number of people employed and the amount of materials used. In quoting for contract research work the science leader will sensibly base his costing on a fair average allocation of overheads added to the variable costs of carrying out the research project. Science managers with the backing of people with financial and economic skills in their research institute, will cost fully fixed and variable expenses and then quote a given research project on the basis on what the market can stand. It will remain a challenge for AgResearch and all the other CRI's to keep their overheads down to a sensible minimum.

More and more CRI's will collaborate with commercial interests in research work. Ground rules are being developed on intellectual property rights and confidentiality. There is a strain on a scientist, anxious to publish his findings, when the commercial company funding much or all of his research effort strongly desires confidentiality. Intellectual property rights will, I predict, be shared in collaborative research in proportion to the amount of funding put up by each party. CRI's will establish limited liability companies to identify and exploit intellectual property rights. CRI's already have the ability to obtain patent protection, and create the financial capacity to back this commercial end of their activities.

Collaboration in research will grow between CRI's, industrial companies, Universities and even farmers. For different projects there will be different fits. Each of these groups has an important role to play and can leverage off each other to increase research value. Strategic links will be created with specific research groups overseas. Douglas Hague talks of an "international division of labour" as being one way in which we can get better value from the money we spend on scientific research and "science must be managed". We could choose to abandon some fields to scientists in other countries while they choose to leave other fields to us. This emphasises the need for choice which is fundamental to all management.

In his Presidential address to this society, in 1983, Fennessy urged more fundamental research in genetic technology and other areas. His heart would have been gladdened if he read the description in Business Week, September 28th 1992 of the work at the Hitachi Corporation's advanced research lab in Japan written by journalist, Neil Gross. He describes his personal experience on visiting this laboratory where pure science calls the shots. "Listening to Takeshi Sakamoto talk about his work at Hitachi Ltd advance re-

search lab I have a sense of unreality. The 33 year old PhD physicist is obsessed with a light sensitive protein called Rhodopsin extracted from the retina of an octopus. He is training powerful microscopes on it and probing it with nuclear magnetic resonance and X-Ray crystalography. He has studied it gene sequence, pondered its 455 amino acids, synthesised the genes chemically, and mass produced them in colonies of E. coli bacteria. Asked what all the excitement is about Sakamoto coolly replies "this protein responds differently to red and blue light. I need to understand why".

Some of Sakamoto's colleagues are using gene splicing techniques to speed up the growth of plants such as saffron and stevia, a sugar substitute. I can't help wondering, asked the journalist, why Japans premier integrated electronics firm is sinking precious funds into octopus retinas and saffron at a time when so many of its principle products are slumping. The answer according to the laboratories General Manager, Shojiro Asai, is hidden in the question. Precisely because main frame computers are no longer making money, Hitachi needs to make quantum leap beyond them and the basic research is the only way. Biology could turn out to be the ultimate shortcut. Just think, says Asai of the vast amounts of genetic information that living cells pack into fantastically small dimensions. Unlocking is secret would revolutionise data storage. There are no funding constraints on this laboratory, and amazingly there is no fortress type feel to the place. In fact the lab is a mecca for Foreign scientists, and Asai, the manager, constantly nudges his young staff to present papers at international symposiums. Asai claims that it is critical for people to go out and get feed back from the worlds top scientists".

And what about the Society of Animal Production in 1993? The founding President, J M Ranstead, was a dairy farmer at Matangi. In his Presidential address in 1941 Ranstead expressed the view that the new society should embrace people from a wide range of disciplines - from soil chemistry, geology, plant research, together with those with interests in animal health, breeding, feeding and management. Jury in 1990 stated that this society will have a continued relevance to the industry if it has a strong membership drawn from all of its sectors. Despite this he noted that Ranstead's view of the society drawing together those from widely divergent disciplines was not really being fulfilled. In the NZSAP newsletter of December 1992, Archie Campbell wrote to the editor and described APS as the premier animal science and animal science publishing body in New Zealand. He said it was not a farmer's advisory service and indeed as technology became more complicated the results of research into nutrition physiology, genetics etc. are going to be vastly more difficult for the layman to comprehend. He said these results are going to have to be chewed, digested and assimilated by technical intermediaries before they can be regurgitated for farmer consumption.

It may be that I am the last farmer President of the New Zealand Society of Animal Production. I do need an intermediary to explain to me some of the very specialised papers I have heard at this conference, but then I suspect so do some of you.

Finally, Jock McMillan persuaded me into this job. If you think I've done well, tell me. I'd enjoy that. If you think I haven't tell Jock. It's alright. He doesn't feel pain.