

## Technology and computing

## R&amp;D: More research and better management

WHAT do New Zealand, Portugal, Ireland and Greece have in common? They are the OECD countries with the lowest per capita income, and they are the countries that spend the lowest proportion of their GDP on research and development.

The per capita income of New Zealand has gone from about the second highest in the world 40 years ago — to between 20th and 25th today — depending on which countries are counted. There are many theories why this is so, but there is little research to test the reasons.

This is not surprising when we look at how little research and development (R&D) is done in New Zealand. Figures for most member countries are now available from the Science and Technology Indicators Unit of the OECD. To make these comparable they are expressed for each country as percentages of GDP.

The four diagrams show, total R&D, private, tertiary

The Government's summit conference spotlight will turn on technology next month. Among the crucial questions — do we spend enough on research and development and in the right places? In the first of four articles, David Penny, an independent and university researcher, examines the equations.

(university and polytechnic) and the Government sectors. There is also a small "private non-profit" sector which is not shown separately but is included in the total. This includes medical charities (Heart Foundation, Cancer Society, etc) and institutions such as the Cawthron in Nelson. The main conclusions are given with the diagrams.

The New Zealand figures were supplied by the National Research Advisory Council (NRAC). They come from Statistics Department surveys of the private sector, from the Budget (for Government science), and from assessing the

percentage of university funds spent on research. The OECD figures are the latest available but in many cases they date back to 1979/80. In most countries there is little change from year to year.

## No evidence

Statistics can be interpreted in many ways. There have been claims that we really do spend more but the private sector does not report all their work because of the tax structure. There is no evidence for a major effect here because these are the figures that the larger private companies thought that they were spending on R&D

and this is the important point — it shows the importance of research (or rather the lack of it) as seen by the private sector leaders.

The figure for the Government sector is better known but there is probably some additional research not included in the research budget. The universities' R&D expenditure is more uncertain and may even have been over-estimated.

New Zealand is a country with both a low R&D spending, and an unusual distribution of this — high in the Government sector and low in both the private and university sectors.

It is also necessary to study effectiveness of our R&D effort. A start can be made by examining the number of scientific and technical papers published by New Zealand-based research workers. All publications, however small, listed in the annual *Science Citation Index* were counted and allocated to the most appropriate subdivision. The results for the latest two years available (1982 and 1983) are summarised in Table 1.

## Medics dominate . . .

The two most striking features are the high proportion of medical papers, and the relatively good performance of the university sector relative to the Government sector.

Three conclusions can be made on this high proportion of medical research, and to some extent they are partly contradictory. The first is that it is perhaps misleading to use ratios here, it is not that we have too much medical research but, as already mentioned, other research is abnormally low by world standards.

The second comment is that many of the papers come from public hospital laboratories. A large proportion of this work is probably not the result of official research funding, but from professional development of highly motivated workers. We seem to be getting very good value for money in these cases.

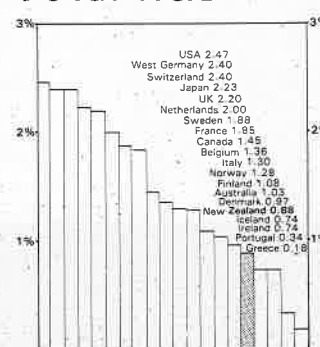
## . . . but unhealthy

The final conclusion is that despite this high proportion spent on medical research, the health and life expectancy of New Zealanders has become relatively poor by world standards. For example, infant mortality (deaths under one year old) is now considered the worst in the developed world. There needs to be more accountability from the medical establishment that they are spending the money in the most effective manner. For example, would health standards improve if more money was spent on research into health education, or from research on health delivery systems?

The second major point from Table 1 is the better performance of university science compared with Government science in proportion to money spent. There are many reasons why this conclusion may be too simple; there are other criteria of effectiveness besides publication. These include the number of patents awarded to each group, and the number of new varieties of plants developed.

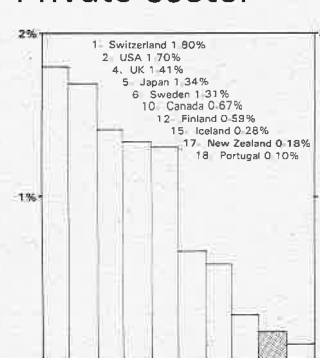
Unfortunately, the information needed for measuring the effectiveness of publications is not yet available in New Zealand. This aspect of the impact,

## Total R&amp;D



The percentage of GDP spent on R&D in OECD countries. The most striking thing for New Zealand is our 16th place. We are far below other "small" countries that we would like to compare ourselves with, such as Canada, Sweden and Finland (although Australia is not much better). Instead we are more like Ireland and Portugal. At least we can consider ourselves markedly better than Greece.

## Private sector



The percentage of GDP spent by the private sector on R&D in selected OECD countries. For the countries chosen their ranking and percentage of GDP spent are given. New Zealand's ranking is now 17th, exceeding only Iceland, Portugal and Greece. The percentage of GDP spent on R&D at about 0.176% is only about 10% of that spent by the United States (1.70%). The average spent by OECD countries (weighted for the size of each economy) is 1.354%.

or effectiveness, of papers still needs to be done for New Zealand as a whole but the evidence available is a warning to those who allocate research funds. But before drawing conclusions a few notes should be made about which publications were counted and how they were allocated.

In any study of this type some decisions about allocations must be made. First the information is limited to what publications are included in *Science Citation Index*. Coverage of the medical area is more complete than for other areas, but possibly counterbalancing this is the allocation of publications to subjects. Any paper published in a general scientific journal (say *Biochemical Journal*) is not included in the medical total, even though the long-term aim of the workers may be medical.

A paper may be included more than once if its authors come from different institu-

TABLE 1 — TOTAL PUBLICATIONS BY SECTORS

|      | Government |         | Tertiary |         | Private |         | Total |         |
|------|------------|---------|----------|---------|---------|---------|-------|---------|
|      | Total      | Medical | Total    | Medical | Total   | Medical | Total | Medical |
| 1982 | 1276       | 449     | 1643     | 515     | 171     | 62      | 3090  | 1026    |
| 1983 | 1274       | 503     | 1709     | 635     | 124     | 23      | 3107  | 1161    |
|      |            |         |          |         |         |         | 6197  | 2187    |

The most obvious feature of this table is the remarkably high proportion of medical publications, over 35% of the total. This is much higher than expected when it is considered that the rest includes agriculture, horticulture, forestry, processing, manufacturing, building, geology, computing, native fauna and flora, all of basic biology, chemistry, physics and mathematics.

The other major feature is the high proportion of publications from the tertiary sector, which in New Zealand comprises largely the universities. This is despite the low proportion of funds for research in universities (0.15% of GDP as compared with 0.53% for Government). If we compare the ratio of publications to resources for universities and for Government science, universities appear to be over four times as effective in completing research.

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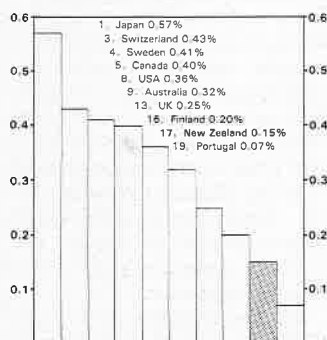
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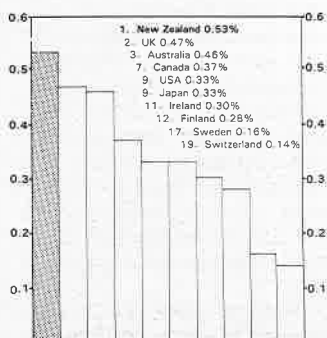
## needed

## Tertiary



Again the percentage of GDP spent on research in this sector (mostly universities in New Zealand) is shown for a range of OECD countries. Again New Zealand ranks 17th of the 20, exceeding Ireland, Portugal and Greece. However, the proportions are not so extreme as in the private sector with New Zealand spending about 0.15% of GDP compared with the OECD average of 0.37%, and Japan being the highest at 0.57%. Nevertheless it is still a poor performance.

## Government



The percentage of GDP spent by Government on R&D for a range of OECD countries. New Zealand now ranks as the highest, spending 0.53% of GDP. None of the other countries surveyed spends as much on Government research as New Zealand. The average spent on this sector in the OECD is 0.34% which is slightly less than the average spent in the tertiary sector (0.37%) and about one quarter of the average spent by the private sector (1.35%).

tions, departments or divisions. This is essential for a comparative study of this type but it will over-estimate the total number of publications from New Zealand. Institutions such as the Dairy Research, Meat Research and Wool Research organisations were included in the private sector even though they are partially financed by the Government. The private sector includes private non-profit organisations.

## Funding

The current system is far too easy for Government science. They get, with little question, the bulk of Government funds available for science. Many of our best scientists are in Government laboratories. Their complaint is about lack of incentives in their career structure.

The new Government MP for Hawke's Bay, Bill Sutton, entered Parliament after a distinguished career as a government scientist. In a recent speech he was very critical of the lack of incentives.

"Give them a challenge, they will respond", was his message. One challenge could be that funds be equally available to other research groups and that best performance wins. In many cases this will be a government department — good research groups are hard to establish.

However, more private sector and university research is needed and there must be increased accountability from the Government sector. Government money must not automatically go to Government science, it must be used in the most effective manner possible.

by Stephen Bell

WITH its new "transnational" structure (NBR, March 25) leading local software and hardware company Progeni is turning its attention particularly to the United States and China.

Progeni has recently concluded a \$750,000 contract with one American customer; but getting into the lucrative United States Government market is a more difficult, perhaps an impossible task for a New Zealand company, said managing director Perce Harpham.

Barriers to United States Government contracts arise from that country's Trade Agreements Act and the legislation known as the Buy America act.

This had shut Progeni out of a recent tender for the United States Department of Internal Revenue. "If it were not for that, we would have had a major hack at it," he said.

The New Zealand Government had not proved much more encouraging to its own companies, by way of direct tenders.

Dissatisfaction with the local market had been part of the motive for Progeni to take a more transnational view of its marketing prospects, he said. On the positive side there were clearly excellent market opportunities in the United States and Australia, and growth potential in Progeni's business with China, where it has cracked the market with orders for its Poly education and training system.

As part of a progressive adoption of more western trading practices, the Chinese Government now allows individual districts and corporations to conduct their own negotiations with overseas concerns, rather than purchasing through a state agency, which Harpham described as "a flea negotiating with an elephant". Now Progeni could relate to entities nearer its own size, he said.

China would become more receptive to imported high technology, Harpham said, as a logical outcome of the dilemma of keeping its population under control and supporting a large population of older people on the strength of a smaller working population.

The latter "cannot be done using current technology", he said; hence a push for technology-driven productivity improvement.

The transnational Progeni does not yet have a permanent base in China, but this would happen "at some time", Harpham said, declining to be more specific.

A transnational company could be contrasted with a multinational in that the former involved separate and largely autonomous companies in different countries, rather than every operation being viewed as a subsidiary of the home company.

This change has been formalised in Australia with the founding of Progeni Pty Ltd, to replace an operation which was effectively a branch office. The United States operation is already a separately identified Progeni Inc.

Management has been reorganised with managers for the different locations — Auckland, Wellington, Lower Hutt, Christchurch, Melbourne, Sydney and Los Angeles — and managers supervising the various business areas across national boundaries. Progeni's

## Progeni gains US deal but battles still to be fought

business has been formally divided into control systems, general systems, software production, learning systems and the Polycorp subsidiary, maker of the Poly and related hardware.

"I would like to be doing a lot more in New Zealand," said Harpham, but "if we are to go on growing, we have to go to the places where we can grow".

New Zealand could be a good "pilot-scale" market for the development of local innovations, in a co-operative learning process with the Government.

"But when you make a proposal, they always want to know where else it is already being used.

"Here, every purchase is assumed to be independent of everything else. The longer-term effects of placing an

order with a local firm are not considered . . . we are giving away our learning opportunities and using them to train overseas suppliers to do their job better."

There were some encouraging exceptions, he said. The development of automatic electronic test equipment for the army was a fruitful partnership between Progeni, Delphi Industries of Auckland and an idea which had originated in the defence scientific establishment.

The Ministry of Defence was probably the most co-operative of government departments, he said, despite Progeni's annoyance at a contract for army microcomputer systems going to another

company without competitive tender.

Joint development projects perhaps offered better hope for local industry in partnership with the Government than responding to regular tenders, he said.

The extent of preference given to local companies in Government tenders is unknown, being a part of non-public Government Stores Board procedures. But weighing in favour of local contracts is reputed to be 10%.

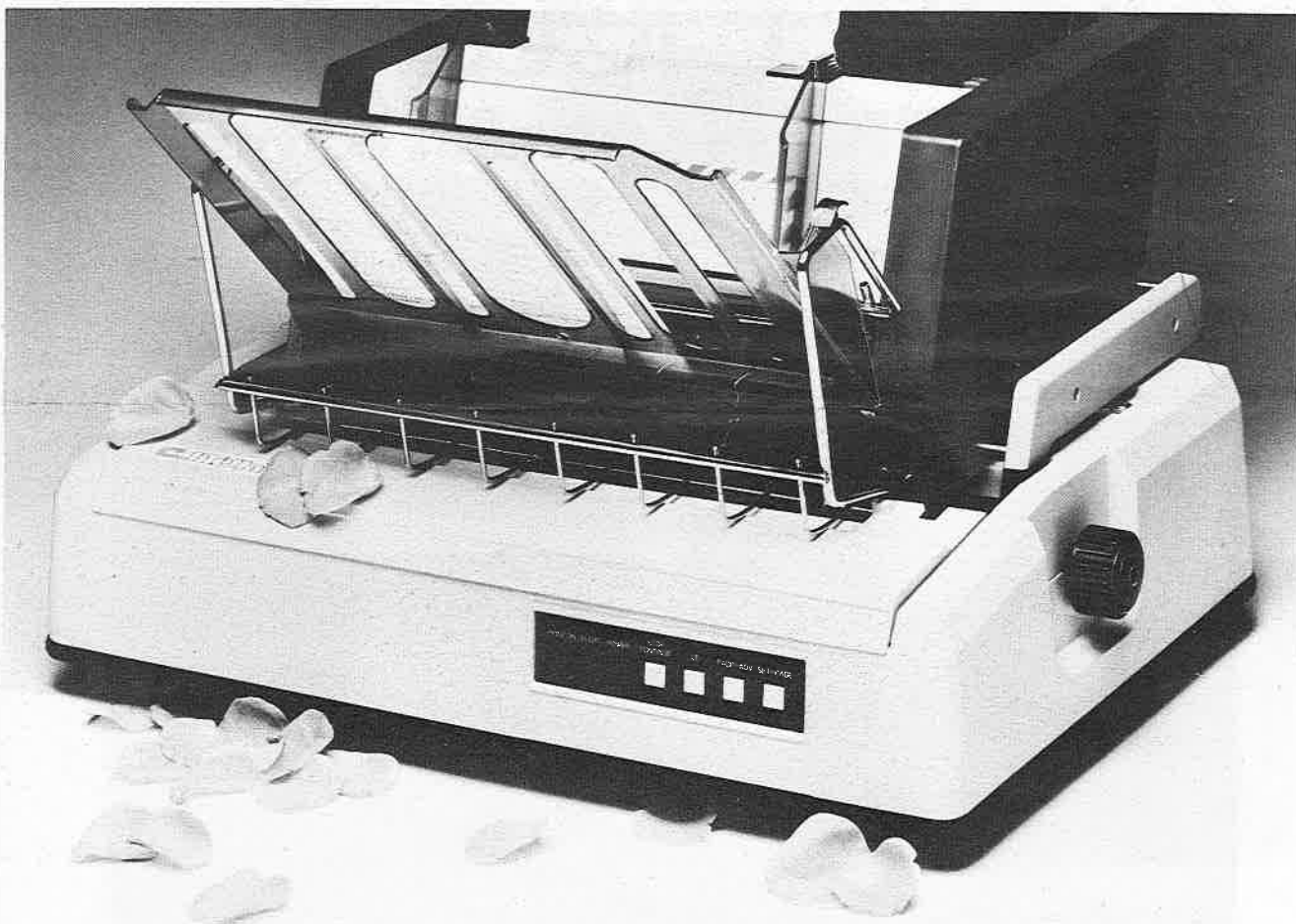
Margins of preference accorded by Australian states to products from other Australian states and New Zealand were in some cases higher than this, Harpham said.

"So in a lot of circumstances, the Australian federal and state governments will give more preference to the New Zealand company than the New Zealand Government gives."

Australia was also more helpful and less rigid and secretive about tender negotiations than New Zealand, he said.

Australian Government authorities "will meet with you and put you through a feedback process. They will ask 'you suggest doing it this way; how much could you save if you did it like this instead?' Or even 'one of the other contenders suggests doing it this way; why can't you?'"

"It is a process of dialogue, a process of education. In New Zealand, it's all done in the dark."



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