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"STRATEGIC RESEARCH FOR INDUSTRIAL APPLICATIONS"

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Introduction

The year since the last AIRG symposium, at which my colleague and predecessor, Paul Wild, was one of the speakers, has been a full one for CSIRO. It was a year of change, culminating in the adoption of a new strategy for the Organization's development over the next five years and ASTEC's report to the Federal Government on "Future directions for CSIRO". I think the organisers have recognised this in inviting me, as the new Chairman of the Organization, to speak here today. I thank them for the opportunity.

I see a major task for the Organization as forging closer and more effective links with industry, particularly manufacturing industry, and CSIRO will be looking to the R&D managers in industry and your group in particular to ensure that our efforts are successful. I see an important task for myself in giving a strong and consistent message to CSIRO staff of the need to promote interaction with industry and involve industry people in the setting of research priorities.

I will be getting out of Canberra as much as possible and talking to people such as yourselves, as well as to CSIRO staff, so that our new policies quickly become new practices throughout the Organization.

The significance of 1986 for R&D extends well beyond CSIRO. We have this year the introduction of the 150 per cent tax deduction on R&D expenditure. And we have the recently-announced changes to the government's offset policy, giving more emphasis to technology transfer. Of particular importance is the decision to allow overseas firms to offset with a multiplier of three their expenditure on R&D and training programs against the contract value.

All of these developments, both within CSIRO and in Government, industry and elsewhere, have important implications for the way research is carried out in Australia.

In my talk today I want to cover several related issues:

- first, the respective roles of strategic and tactical research, and in particular the need to become more effective in exploiting strategic research in the development of new commercial products and processes.
- secondly, the need for industry and research groups to get together to specify and define research areas that will most benefit Australian industry, and to improve the evaluation of research. We are especially looking to industry to assist us in realistic market assessments of the actual and potential contributions which research can make.

- thirdly, the need for industry to adopt a view of R&D as a "vital strategic necessity" rather than a "reluctant tactical necessity", as is often the case at present, and to collaborate in strategic research, in order to be more competitive internationally. Other countries are doing this - shouldn't we be?

I realise that most, if not all of you, appreciate these points, and that the people who need to be convinced are the top management of Australian companies. Our commercial company, Sirotech Ltd, will be approaching these people on these issues, and I am also more than willing to take up the issues personally with them.

I want to turn now to the role and objectives of research and the steps CSIRO has taken to improve its effectiveness in its role as a strategic research organisation.

Strategic and tactical research

All major industrialised nations accept the need for an R&D capability. There are three broad objectives behind this involvement; economic, social and cultural. All are important, but the first is the most discussed, reflecting a general belief that the level of R&D significantly influences the national economy and that a low level leads to economic stagnation.

National economic goals include the generation of wealth and employment. This is achieved through using resources more efficiently, increasing export earnings and replacing imports while using less protection than at present. These goals can only be achieved with a satisfactory level of technological innovation and performance, and research is an essential basis for innovation.

While industry has the main responsibility for carrying out this research, there is a general acceptance amongst industrial nations that some government involvement is also necessary because of the tendency of industry to invest in R&D at a level below that considered to be in the best national interest.

Longer term research, especially, is often beyond the role and capacity of the private sector. The benefits cannot easily be captured by individual companies because of the non-proprietary nature of the research. The time-frames are often too great and the risks too high, while the fragmented structure of many industries means individual companies have neither the resources nor the expertise to carry out such research themselves. Furthermore, this research also caters for the future, addressing industries and markets which do not yet exist.

Scientific research is also categorised according to its objectives in another way: fundamental, strategic and tactical. Fundamental research is directed primarily towards adding to the pool of human knowledge rather than to particular applications. It corresponds with the cultural objective in the above classification.

Strategic research is mission - or applications - oriented, with a broad application and often of a longer timescale.

Tactical research is problem-oriented, involving the application of established scientific knowledge and methods to the solution of practical problems. Both the strategic and tactical categories of research can be applied to economic or social objectives.

In his Lady Masson Memorial Lecture at Melbourne University last October, the Minister for Science, Mr Jones, said that as a result of the debate about Australian R&D over the past few years, there was an emerging consensus on what needs to be done. This consensus view was that:

- . Australia needs at least to maintain its government funded R&D and substantially increase industry R&D.
- . Australia needs to increase the benefits from the research dollar by improving the quality and application of research. This will mean improved management of staff and resources, and more effective communication, liaison and collaboration between the performers of research, especially the universities, CSIRO and manufacturing industry.
- . Universities will do the bulk of fundamental research but their expertise would be made more available to help industry with its problems.
- . CSIRO will do a major part of the country's strategic research, but will increase its tactical research efforts for industry, particularly manufacturing. It will also improve the effectiveness of its work by improved management and greater consultation with user groups. However it should continue to maintain a significant basic, or fundamental, research capability.
- . Industry should substantially increase its R&D base, in order to reap the benefits of both its own research and government-sector research. Industry research, whether carried out in-house or contracted out to universities or CSIRO, will primarily be tactical.

I believe the ASTEC reports on CSIRO and public investment in R&D in Australia are in essential agreement with Mr Jones's comments.

The comments reflect what all of us here know: that the gap between research and its industrial application is the fundamental weakness in Australian R&D. It is worth pointing out, however, that this isn't just a problem of a strong research effort in the public sector, or the way it is structured, and a limited and declining private R&D capability. The same problem exists in the two most technologically powerful countries in the world.

A recent report in Nature stated that private sector research in Japan was booming as never before, with expenditure increasing 12 per cent last year. Industry now supplies almost 80 per cent of Japan's R&D funds.

Yet Nature reports that a new white paper by Japan's Science and Technology Agency, headed "New developments in R&D and the age of cooperation", discusses the low levels of collaboration between universities, government research institutes and industry. "This is a perennial problem, but the need to get something done seems more urgent than before," Nature says. By about mid-year, the Japanese parliament is expected to have cleared a new bill which should remove the legal restraints on cooperation between the public and private sector, and also make it easier to collaborate with foreign companies.

Similarly, in the United States business spends more than three times the Government expenditure on civil R&D. Last year, US business planned to spend almost US\$80 billion on R&D, compared with Australia's total R&D expenditure in 1983/84 of about US\$1.3 billion. Industry R&D spending in the US rose by 12.2 per cent a year during the first half of the 1980s, and is expected to continue growing, although at a lower rate, over the next three years.

Yet at last October's meeting of science and technology ministers at Ottawa, Dr George Keyworth II, who resigned a month later as President Reagan's science adviser, said, and I quote:

"In the United States, we're very good at doing scientific research, but we're considerable weaker in applying that science in technology. If I had to identify a single means by which we could become a more competitive nation, by which we could capitalise on those technology and talent resources we have, it would be to improve that linkage."

This brings me to CSIRO's place in Australian industrial research.

CSIRO's role

The ASTEC report on CSIRO has recommended an expanded role for CSIRO. It says CSIRO's strategic research should remain at close to its present level and that the level of appropriation funding for CSIRO be maintained.

However, ASTEC also says that the level of more directly applicable, shorter-term applied research and experimental development should be considerably increased, with the necessary funds for this work coming from industry and other users. As a result, ASTEC sees, and I quote, "a significant shift in the balance of CSIRO's research activities from one which has been primarily focused on the research process to one more equally focused on the application of the research." The balance of research in CSIRO already shows a shift in this direction.

Our role is "applications-oriented research". a term CSIRO suggested to ASTEC. It covers research that is at the cutting edge of science and technology (but with eventual application in mind) as well as research that is highly specific and problem-oriented.

The research mix has to be balanced, yet flexible. Tactical work enables us to learn the language of industry, get close to our users, and help to define the problem areas needing a strategic effort. But too much tactical work in the long run will cause us to degenerate into a second-rate research institution, overtaken and left behind by scientific and technological advances made abroad.

I want to stress here that the amount of tactical research CSIRO carries out will depend directly on industry's willingness to pay for it. As ASTEC states, this additional work will be "of the sort usually conducted by industry itself in more technologically developed countries." We firmly believe that the bulk of appropriation funds should continue to be allocated to strategic research of broad benefit to industry and the community.

It is also important that these longer-term projects are protected from the effects of fluctuating budgets and I hope we can have some stability in our appropriation funding, as ASTEC has recommended.

CSIRO takes the view that our role is basically unchanged, and what ASTEC is advocating is more effective performance of this role through greater interaction with industry, particularly manufacturing, more attention to dissemination of research results, and a higher level of contract research.

Strategic research remains our primary role, but we are increasing our efforts, and working with greater urgency, to develop from this research technologies which could form the basis of new products and processes.

This is the fundamental objective of the policy initiatives CSIRO has taken over the past few years and of our 5-year strategy, adopted by the Executive last August.

I won't detail all the new initiatives we have taken. They are outlined in a new booklet we have just published for the manufacturing sector, and which I have great pleasure in - well "launch" might be too grand a word - in introducing today.

It also gives details of how people can establish contacts with CSIRO and some examples of recent achievements. Please pick up a copy of it after the session. We have also just issued a new edition of "CSIRO in brief". This describes CSIRO's structure, role and work. Copies of this booklet are also available.

However I would like today to take up just a few specific issues.

CSIRO's new technology transfer and commercial assessment company, Sirotech Ltd, was launched by the Minister for Industry, Technology and Commerce, Senator Button, just two days after last year's AIRG symposium. I believe that even in its first year of operation, Sirotech has shown it will be very successful, having already notched up several major achievements. These include the setting up of two joint venture companies, one with ICI Australia and the other with Du Pont Australia.

One of Sirotech's projects is to manage our new Manufacturing Industry Collaborative Program. This program has a budget of \$750,000 this financial year, increasing to \$3 million in 1987-88. Sirotech has advertised the program widely over the past few months and we have been pleased with the response. There have been 50 responses to date, of which we are seriously following up about 30. In quite a number of these, there are prospects of immediate collaboration. This represents only part of the program. There are also a number of marketing projects directed at particular industry subsectors such as automotive components and agricultural engineering. These also look promising.

Industry is expected to pay full cost for the tactical work undertaken through the program. That contribution will, however, be eligible for the 150 per cent taxation concession for R&D expenditure.

What industry will get as a bonus is the benefits of the strategic research carried out as part of the program and CSIRO's research management skills. So the program will provide value for money as far as industry is concerned, and it will bring together the strategic and tactical programs.

The program will act as a focus for CSIRO's efforts to identify the research needs of manufacturing companies and to encourage more contract and collaborative research. It will also provide the industry with a more direct say in how part of CSIRO's budget is used.

By providing access to CSIRO's research facilities, the program will allow companies to work on projects they otherwise may not have considered. At the same time, it will give our research scientists a better understanding of industry's more immediate needs.

So that is one specific program to bring us into closer and earlier contact with industry. Another program is intended to improve links in the other direction. CSIRO is expanding its collaborative program with universities and a few of the colleges of advanced education.

This program, which is funded jointly by CSIRO and the particular tertiary education institution, involves joint projects which are selected on a competitive basis by joint CSIRO-tertiary institution committees.

At the other end of the spectrum, that of broad policy, is the strategy for CSIRO's development to 1990 and beyond. Its objectives include more systematic identification of priorities; greater focus and concentration of our research effort; and more thorough evaluation of research.

In the area of research evaluation, we have set up a committee, headed by a part-time member of the Executive, Professor Adrienne Clarke from Melbourne University. Its objective is to come up with a set of mechanisms and procedures for evaluating the benefits of research before, during and after it is undertaken.

One aspect of this work to which I have asked the committee to give special attention is the evaluation of specific applications arising from the more broadly-applicable strategic work. The emphasis here will be on evaluating the commercial benefits of such applications more rigorously.

The ideal situation is one where a company becomes involved, carrying out a thorough market analysis and providing a fair share of the funding. But in many instances, we will need to take the research to a more advanced stage before companies will become interested, and here CSIRO, or Sirotech on our behalf, will need to commission a commercial evaluation.

Recently the consulting company McKinsey's evaluated for the Victorian Government the commercial prospects of some specific projects being undertaken at our Division of Plant Industry and Professor Clarke's Plant Cell Biology Research Centre at Melbourne University. We will be looking more closely at this sort of evaluation. In fact McKinsey's will be giving us a presentation on their approaches to commercial assessment in Canberra tomorrow.

Industry's role

We see earlier and closer contact and collaboration with industry and other users as an essential factor in achieving our strategy objectives. For example, the criteria to be used to assess research areas cover factors such as:

- . the potential of the industry which would benefit from the research to generate employment and wealth, including export income.
- . the promise the research holds of major scientific advances and the likelihood that those advances would be taken up and used to the national benefit.
- . the availability of resources and skills in the research area under consideration.

Clearly industry must make a contribution to this process of priority-setting and evaluation if CSIRO's research, and the Australia's R&D effort in general, is to be focused on those areas where Australia can most benefit and best compete.

In particular industry must assist by providing realistic assessments of market prospects. As Jan Kolm told you last November, this is a vital component of research planning that CSIRO and universities do not have the expertise to contribute. And as he also pointed out, 'academics' are often three to four years behind what goes on in the international field of corporate technology.

This is the challenge for Australian industry. If it is to make this contribution then the firms that make up the various industry groups will have to cooperate and collaborate in setting strategic research objectives for those groups. It's happening in most other industrial nations. But there is as yet little sign of such cooperation here in Australia among manufacturers.

The PA Technology survey of senior executives in Australia, the US, West Germany, Japan, Britain and Belgium, released last September, found Australian companies grossly underestimate the strategic importance of technological investment and resources compared with their competitors.

In general, the Australian business community viewed R&D expenditure as "a reluctant tactical necessity" rather than a planned and strategic component of economic growth.

This attitude in Australia contrasts with the situation in the leading industrial nations where not only is corporate R&D spending rising, as I've already discussed, but where there is growing collaboration between competing corporations in the area of strategic, precompetitive, R&D.

Overseas we are seeing the growth of a new type of collective industrial research organisation. Traditional industry organisations undertook research in noncompetitive areas such as basic research, education, health and safety. The newer groups aim to develop a stronger technical base to improve the productivity of their members by carrying out "precompetitive" research.

According to a paper in the November-December 1985 issue of the Harvard Business Review, headed "Cooperative R&D for competitors", two pressures in particular have prompted this change in the nature of collective industrial activity. These are the intensity of international competition in technology-based industries, and the awareness by every country and every company of resource limitations, both financial and technical.

The authors of the Harvard Business Review paper, two science and technology policy analysts from New York University, surveyed collective research organisations in the US. They see the rise of collective industrial research as one part of a general trend towards developing linkages between a company's internal R&D and external sources of technical activity. They write, and I quote:

"Reaching out and teaming up is pervasive throughout a wide range of industries and across national boundaries. Traditional market growth, investment opportunities, and new technologies explain much of this activity. Another important factor, however, is the current stage in the evolution of the international technical structure.

"Two features have marked the steady growth and complexity of technical activity worldwide. First, sources that generate new science and technology exist in all countries and in thousands of institutions. Second, the increasing technical sophistication of new products and processes draws on, and is affected by, a growing range of technical areas.

"The result is that corporations are becoming less self-sufficient in their capacity to generate the science and technology they require for growth."

The authors note that collective industrial research still represents only a small percentage of the R&D effort of any single industry.

Companies are coming together in cooperative programs in much the same way, they say, as porcupines reportedly make love - very, very carefully. Nonetheless they see the development as one of emerging importance.

The new collective associations operate in a variety of ways. Some have their own facilities or use those of their members or sponsors; others contract out research to universities, government laboratories, independent nonprofit institutes or commercial research companies.

This sort of cooperative research activity is also found in Australia: in the Rural Industry Research Funds, which draw their money from a research levy on farm products, matched dollar for dollar by the Federal Government; and in the Australian Mineral Industries Research Association. I might add that with Government encouragement, 5 of the 16 rural industries operating the rural research funds are increasing their levies by 15 to 100 per cent, with others likely to follow suit.

As far as I am aware there is little cooperative research towards strategic objectives in most areas of Australian manufacturing. Manufacturing and service industries are pressing CSIRO and universities to do research relevant to their needs, yet they invest little in that research.

Its a question of the difference between involvement and commitment, and it reminds me of a story I heard the other week. A pig and a hen wanted to set up a joint venture to produce bacon and eggs and were discussing the equity. "I think it should be 50-50," said the hen. "Oh no," said the pig. "I want 90 per cent. You see I'm committed."

The contrasting attitudes to R&D is reflected in the contributions three industry sectors make to CSIRO's research. In 1984/85, CSIRO spent about \$135 million in research related to the rural sector, about \$50 million to minerals and energy, and about \$115 million to manufacturing and services. Rural industries contributed almost \$10 million of this expenditure, while the total contribution from Australian companies was just under \$4.5 million. Of this about \$3 million came from the minerals and energy sector, with only about \$1 million coming from the manufacturing and service sector.

The Federated Tanners Association of Australia has quite recently formulated a development plan for the industry and has had discussions with CSIRO on the implications of the plan for research. I would like to see other subsectors of manufacturing do the same.

I appreciate that the structure of the industry - its fragmentation, its high level of foreign ownership in some areas, its orientation towards a small domestic market - militate against such cooperation.

But I believe, too, that its absence reflects the view in this sector of R&D as "a reluctant tactical necessity". I regard it as a major challenge to CSIRO to help change this view to one of R&D as "a vital strategic necessity".

I believe there is also a challenge to you, the AIRG. Your company boards have agreed to spend money on R&D, but how many believe it is a vital strategic necessity?

Until this happens there will always be a gulf between us and the top management of your firms. Once this change of attitude occurs, however, I believe CSIRO, and other Australian research institutions, have an enormous amount to offer Australian manufacturing.

The CRA/Kloeckner Process

As an example of collaborative research which demonstrates the inter-relating roles of strategic and tactical research, I have chosen a new iron smelting technology being developed by CRA and a West German company, Kloeckner, in collaboration with CSIRO and others.

When CRA joined Kloeckner to develop this process, CSIRO had very little expertise in iron smelting, although the Division of Mineral Engineering had developed a new smelting technology for non-ferrous metals, Sirosmelt. This has been taken up by four companies in Australia for the smelting of lead, tin and copper.

The Division had just become involved in iron smelting through a NERDDC grant and, in its collaboration with CRA and Kloeckner, was able to combine this effort with long standing research activities in process control, modelling and development on full scale plants.

At present, the Western world's iron and steel is produced by two well known routes: conventional blast furnaces; and electric arc furnaces. Both involve several processing stages to turn iron ore into iron and steel.

One of the most significant avenues of improving either process involves techniques of injecting cheaper primary energy in the form of coal - a cornerstone of the CRA/Kloeckner technology. More exciting, however, is the possibility of a radically new direct route to steel.

The direct smelting of fine iron-ore and coal to produce iron and steel has been a challenge for some time. This route should become commercial reality in the next few years using the CRA/Kloeckner technology.

The benefits are immense:

- . The possibility of using fine forms of raw ore rather than the more expensive lump and agglomerated ore presently required for blast furnaces, and for producing direct reduced iron for arc furnaces.
- . The possibility of using low-grade coals rather than coke.
- . The ability to operate small units economically rather than the huge blast furnaces dictated by current economics.
- . The possibility of Australia's producing a raw iron and steel to sell competitively on world markets.
- . Finally, the possibility of Australia selling the new technology and know-how on world markets and being in a commanding position to invest in overseas steel-making companies that require the new technology.

The CRA/Kloeckner technology group has obtained patents and experience in critical areas of this new technology over a period of about 10 years. This knowledge has not been easily won; it resulted from research and development programs in various steel-making plants around the world, backed by laboratory model studies by CSIRO, Kloeckner and other, and extensive computer simulation work. CSIRO has also been involved in process control, modelling and instrumentation development on full-scale plants operating with this new technology.

In other words it is a long-term research project, a genuine team effort, spanning work that is essentially fundamental (though with application in mind) to that which is specific, problem-solving work.

The technology will not only benefit CRA, it could benefit the entire industry. The benefit to Australia is this: instead of the likely decline and possible demise of industries worth billions of dollars in export income, the iron-ore and coking coal industries, we are likely to see the growth of an existing industry in new areas such as the supply of raw iron and steel to international markets.

Concluding Remarks

As I said in my introduction, much has happened in the past two years to heighten awareness of the significance of R&D to Australia, and to stimulate R&D activity and make it more effective. Our Minister, Barry Jones, said in his Lady Masson Memorial Lecture: "Australian science could be poised at the brink of the most important and most productive period in its history."

And yet, as I have also indicated, I am still seriously concerned about Australia's industrial future. The Government deserves credit for Australia's current healthy rate of economic growth. But I believe that the lack of recognition by Australian business of the strategic significance of R&D - not only in producing new technologies, but also in producing highly-trained and expert technical staff and in enabling industry to assess and adapt technologies developed elsewhere - bodes ill for the long-term competitiveness of our manufacturing industries.

In his AIRG speech, Paul Wild said there needed to be more engineers at the top of Australian companies.

His remark prompted one journalist, writing in the Financial Review, to observe: "Management Schools will immediately diagnose a strong case of operational obsession. That's been at the heart of the problem in CSIRO since 1945."

The comment reflects the philosophical gulf that has existed between CSIRO and top management of manufacturing enterprises, and indeed management training. And if CSIRO has tended to put too much emphasis on the scientific and technological, it is also true that manufacturing has seriously under-rated them, and that has been at the heart of its problem since 1945.

The PA Technology survey I referred to earlier, shows clearly how lacking in technical expertise Australian boards are compared with their overseas competitors. According to PA, most Australian chief executives have no systematic or planned approach to monitoring key technology developments. For example, less than 10 per cent of the Australian companies surveyed vested responsibility for monitoring technology in a member of the board or the head of a technical department, compared with almost 60 per cent of Japanese companies.

Professor Peter Farrell, talking at the National Science Forum in October of his period in Japan working with Japanese industry, noted that key ingredients of Japan's industrial success included a long-term outlook, an emphasis on productivity and the supremacy of engineers and scientists over accountants and lawyers.

According to 1981 statistics, Japan had 1 lawyer, 6 accountants and 400 scientists and engineers per 10,000 people, he said. Australia had nine times as many lawyers (9), three times as many accountants (22), but only one ninth the number of engineers and scientists (46).

If we had more technical people on the boards of Australian companies, then we may get more emphasis on investment in new technology and productivity, and rather less on property speculation and take-over operations. While takeovers can have a useful role - keeping management on its toes, improving efficiency and pooling resources - I share the growing concern that takeovers in Australia have reached a point where they are acting against the national interest.

Boards cannot give long-term planning the attention it deserves when they constantly have to battle takeovers. Long-term industrial growth is being sacrificed for short-term survival.

I am concerned because R&D is one area which can suffer in this climate.

The pattern of R&D in Australia contrasts starkly with that in the leading industrial nations. I have no doubt that this situation has contributed significantly to our declining competitiveness and falling standard of living compared to other western nations.

Overseas, companies have been boosting R&D expenditure and cooperating with each other and with universities and government laboratories in strategic research because they recognise technological innovation and skills are the key to international competitiveness.

Countries like Japan and the US have R&D budgets which dwarf Australia's - in fact the R&D expenditure of each of their biggest companies is much larger than Australia's total R&D spending. If their industries are increasing R&D efforts, and collaborating with each other in order to get the most out of their research activities, then surely Australia must do likewise.

And given our relatively tiny R&D effort, it is vital that Australia ensure this effort is effective. This means being highly selective in setting long-term research objectives. This means, in turn, industry getting together with research institutions to identify and evaluate these objectives and companies cooperating with research institutions and with each other in strategic, precompetitive research directed towards these agreed objectives.

I believe that the AIRG could play a major role in seeing this happen by providing a key link between industry and research institutions and between companies. You could, for example, establish subgroups in various areas of technology which would provide a valuable interface between industry and CSIRO.

Industry and CSIRO also need to explore other ways of focusing our differing perspectives and talents on the problems I mentioned. Certainly CSIRO is looking to our Divisional advisory committees, of which some of you are members, to make a valuable contribution. We are also considering establishing other broader, industry sector committees to assist us in our priority setting.

As I said, I believe CSIRO has an enormous amount to offer Australian manufacturing, and we are committed to making this contribution. But we need the industry's cooperation and assistance.

I look forward to closer involvement with you in this area. Thank you.