

Selecting, Promoting Technologies

Ground rules, procedures for identifying and choosing R&D projects are outlined

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Australia's move into high technology is seen as the salvation of the manufacturing sector of our industry. Both political parties have as planks in their platform the support of key or high-technology industries. The government policy of support for 16 so-called "sunrise" industries is of particular interest to this conference session since some form of selection process has been used to arrive at the 16 industries chosen.

Much has appeared in the media on the importance and problems of technological development. It is a popular topic for discussion in academic and research circles and of course it has been discussed in a number of government inquiries.

There is much confusion in all this discussion. It is not clear whether the salvation of the manufacturing sector is to come from the development and manufacture of high technology, as implied in the government party policy, or in the use of new technology, as perhaps implied by some union responses to that policy, or both.

From our experience, however, it is clear that making the move into sophisticated new technology is an immensely complicated task. This is often glossed over and has led to facile comment.

In this paper I will define terms and set down the ground rules, outline standard procedures for identifying and selecting research and development projects, and outline what AMIRA is doing in selecting research and development topics for the mineral industry. Finally, I will try to make some constructive observations about the general Australian scene.

DEFINING TERMS AND CONCEPTS

The general principles apply equally to a company, an industry or a nation, but it must be recognized that there will be changes in constraints at these various levels. The first concept is that new technology is developed from research and development through a process of innovation. This process involves such considerations as research, development, engineering, production, marketing and finance.

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It should be noted, however, that this is not the only route to the use of high technology. The technology can be copied or bought from others. Licenses for manufacture can be negotiated thereby avoiding much of the research and development phase. In many uses this is the appropriate course of action. As an aside, I see where IBM in the U.S.A. last year discovered that there were other more dubious ways of obtaining new technology!

So I want to make it clear that, while the innovation process is the only route to the development of new technology, it is not the only means of entering into the use and manufacture of high technology nor in many cases is it the best route.

Having said this, I will concentrate on the innovation process.

Where does the drive come from for innovation? In the main it has two sources: technology push and market pull.

In the present Australian context this might be interpreted as the creation of new markets giving rise to opportunities for new industry units to be established, and the enabling of existing industry units to survive through the use of new technology.

Constraints

But much of the public pronouncement has concentrated on technology push with little consideration for market requirements. Who will buy the industrial ceramics or the custom-made chips if we are successful in developing them under the government policy?

It must be remembered that various social and political constraints act on the motivation for innovation. The social consequences of introducing new technology could be increased unemployment. It could also mean the survival of some industry units that might otherwise be forced to close. Automation is often seen as the vehicle for increased unemployment. Yet a remotely controlled loader can be used to extract ore from places underground where it would be unsafe for men to work. If the new technology is not used that particular parcel of ore will not be extracted. The use of office automation is claimed to lead to unemployment. And yet in our own office efficient use of word processing has enabled us to contain staff levels and maintain considerable expansion. Without it, costs would have risen markedly and expansion slowed.

In selecting and using new technology we must maintain a balance between technology push, market pull and the many constraints that act on the innovation process. What we are looking for is a rational and balanced approach which would lead to strategic

innovation giving rise to appropriate technology.

TECHNIQUES FOR SELECTION OF RESEARCH AND DEVELOPMENT

We need to recognize that there is a well established set of techniques for project selection. Although there are many variations the basic approach has been used in technically-advanced companies for a long time. Generally it is considered to be a three-stage process:

1. Scenario Building—Scenarios are internally consistent, plausible accounts of possible futures which help management to understand the futures and assess the possible consequences of various actions. This sets the general framework within which detailed planning must proceed. It involves some aspects of technology forecasting and a degree of input of social, political and economic perspective of the world, the local region and the country. It is a dynamic exercise and requires constant updating.

2. Strategic Planning—This defines the key areas of technology in which the company should be involved. It is interesting in the present climate of recession in the steel industry to note the recent press announcement by CRA of its \$11 million spending to gain access to new German steel making technology. This is surely the result of careful strategic planning.

3. Project Selection—This is the final stage in the process where individual topics are selected from alternatives.

There is not time in this paper to detail the variety of techniques developed for these planning processes. Let me remind you of some of the key factors that are involved.

Apart from the general socio-political ones already mentioned, we need to look at:

1. The characteristics of the company—
 - What is its research and development capability?
 - What is its general level of technical competence?
 - What market skills does it have?
 - What management skills are available?
2. The market characteristics—
 - What is the competition?
 - What is the time scale required to meet the market demands?
3. The financial implications.

The innovation process is one of high risk. Therefore the company needs to manage that risk carefully. A range of projects must be selected to provide a balance between short-term and long-term projects, between basic and applied research, between research and development, and between different product alternatives. In this way a portfolio of research and development topics is built up much like a share portfolio.

Superimposed over all this planning function is the assumption that the company has done its corporate planning. In doing this project selection the research and development manager needs to know:

- What business the company is in.
- What business it intends being in.
- What resources are going to be available to him to achieve these goals?

Innovation planning and project selection needs the benefit of a clear set of corporate objectives and the

understanding and support of senior management.

THE AMIRA EXPERIENCE

AMIRA was set up in 1959 by the mineral industry to do a number of things. One was to initiate, coordinate and manage jointly-sponsored research and development on behalf of the member companies of AMIRA. There are more than 90 member companies in AMIRA. They are drawn from all parts of the industry.

We have chosen to contract all our work to universities, Divisions of CSIRO, company research laboratories and other appropriate groups. We have not had problems finding suitable people to do the work. AMIRA has therefore not needed to set up its own laboratories and can concentrate its efforts on other parts of the whole process such as project selection and technology transfer.

I need to point out by way of introduction that the mineral industry's needs are oriented to using new technology for survival rather than the development of new technology for sale. For instance, it might be decided that to improve the efficiency of coal washeries we need to measure the ash content of the coal on line. The coal industry might be prepared to fund the development of such a system until it was proven in plant trials and units available for its own use. The commercialization and marketing of the system, however, is not seen as the primary responsibility or objective of the coal industry.

At present we have some 50 projects current and they cover a wide range of topics such as exploitation-related matters, underground mining, mineral processing, metallurgy, analytical problems, engineering problems, environmental problems, and many others. We work primarily within the metalliferous industry, but we also have a significant number of projects in coal.

We would expect that in the current financial year almost \$3 million dollars will be spent through AMIRA on these projects. Most are of two or more years' duration. We expect roughly a third of this would be spent on projects relating to the development of new exploration techniques and basic understanding of ore genesis processes. A further third would be spent on mining projects, particularly relating to design and support of openings underground and improvements in fragmentation of rock.

Examples

Let me give you a few brief examples of the work we are doing. Australian geology is rather special. Much of the continent is covered with overburden which tends to be much more electrically conductive than say in Canada. This means it is much more difficult to detect targets when using geophysical methods of exploration.

We set up a project with CSIRO several years ago to develop a new geophysical instrument which would be much more sensitive than was available from overseas at that time. Development was successful and the instrument is being marketed worldwide by an Adelaide-based company. Meanwhile, we have continued development of further instrumentation and tech-

niques for interpretation of data obtained from the current instrument. There are nearly 20 companies involved in support of this work.

The design of underground openings in metalliferous mines is a most complicated problem. How large can we make them without risking failure of roof or walls? Can we devise new approaches to reinforcing the roof and walls to minimize unexpected failure? We have a series of projects with CSIRO, universities and consultants on these problems. Many of them involve extensive field work in the mines themselves. The work has required development by CSIRO of special new instruments to measure stress and strain in the rock mass. We are trying to develop new techniques to measure the state of the rock mass. Is it fractured? Is it under stress? The work is far from complete but has been most successful—so much so that we have companies from Sweden and U.S.A. funding the work through AMIRA.

Production of metal concentrates from ore is generally achieved by crushing and grinding. Then mechanical separation of the components is achieved using flotation or gravity concentration. The plants in which these processes are carried out are complex and difficult to control. For many years we have been working with the University of Queensland to develop means for optimizing and automatically controlling these plants.

The work entails careful sampling of all the streams in the plant followed by the construction of a mathematical model to describe the plant operation. Such models can then be used as the basis of computer simulation which can lead to optimization of the plant and a strategy for its automatic control. Very good progress has been made and there are quite a few grinding plants throughout the world operating on automatic control as a result of this Australian work.

There is still a way to go with flotation and gravity concentration plants, but again there are already examples of parts of some flotation plants being operated under automatic controls. There are 18 companies supporting this work with six of them having operations based in North America. This gives you an idea of its international importance.

Most research associations generate an annual sum of money by levy of their members. That money is divided up among the projects by the research association. In the case of AMIRA we have chosen to use a funding system which forces each new project to stand on its own feet financially and attract support from members. Once a new proposal has been prepared it is circulated to all members who might be interested. If sufficient of them are prepared to put funds into the project it will proceed. This puts the responsibility on members to make the decision about which projects are supported. This makes the whole process of project selection much more market sensitive.

Secretariat

The AMIRA secretariat consists of three technical people, a company secretary, and three secretarial staff and it is funded largely by an administrative charge placed on each project. This means that to survive, AMIRA must keep generating new project

proposals which are attractive to the industry. In our case, success in project selection is a question of survival. Let us look at how we do it.

Our project development activity has been guided by reasonably evaluated selection of strategic areas. For instance, in the late 1960s it was clear to us that we needed to increase effort in the underground mining area. Similarly in the early 70s it became evident that effort should be devoted to the development of special geophysical exploration techniques for Australia. Energy became very important to the industry in the mid 70s. These general observations guided the thrust of much of our project development in those periods and we increased the number of projects specifically related to these areas.

The development procedure has been to identify and clearly define problems that are of common interest to a number of companies. To do this we have used a variety of techniques. We have held various forms of technical meetings with the industry. We have set up workshops in certain fields. We have carried out state-of-the-art studies to help define needs. We have sought from our members their views on the key problems and then attempted quantitative evaluation of the many topics suggested. For instance, we have tried to give the topics a rating on the basis of chance of success and on the basis of the effect on the industry if they were successful. This has provided us with priorities with which we can work with both industry and potential contractors to develop proposals for new work.

Important to our success is a well-established network of technical contacts that we have in the industry and elsewhere. This has been built up in a number of technical fields over many years. It takes considerable time to establish these contacts and build up confidence in a new area. Because of this, moving into a totally new technical area is slow.

The system adopted assumes that this technical intelligence network is sufficiently competent to be aware of new technological developments and that we can use the network to define the technical problems requiring solution. In the main we have been quite successful but I must stress that any industry is not homogenous in its level of technical competence. We, therefore, do not always get support for projects that we think are important.

Nevertheless, we have a broad portfolio of work in progress and this is constantly being built on and changed as a function of time and as our perception of the industry's needs change. As well as a wide spread of technical areas we try and maintain a balance between short-term goal-oriented work and longer term work of a more basic nature. This is difficult to do when the industry is facing difficult economic times.

Let me again emphasize that the controlling factor in this selection process is the demand of the market, i.e. the needs of the industry. AMIRA must be sensitive to and help develop this market. You should note how important is the role of industry in the definition of the problem areas that we need to tackle. AMIRA has established a very strong bridge between potential research and development people and the technical people in the industry. The extension and maintenance of this bridge is the key to our continued success.

THE AUSTRALIAN SCENE

We have shown that the general principles we highlighted for successful innovation in a company can be applied to an industry. If we now try to extrapolate this experience to the Australian scene as a whole we recognize that there are a number of special circumstances that must be carefully considered. Some of these special constraints will make it especially difficult for successful innovation in Australia.

1. We have a splendid research base but the majority of it takes place in government funded organizations.

2. We have a very low level of IR&D.

3. These two facts mean that we have limited experience in the other parts of the innovation process such as marketing. It will be very difficult to provide a bridge between the research and marketing functions in Australia.

Let me as an aside show you the type of problem you can encounter if this bridge is not in place. We have been working for almost three years to develop a new piece of equipment for exploration. Twelve sponsors have put over \$300,000 into the work and the university where the work has been done has put in considerably more. It has been a difficult project but a prototype has been in the field for several months now operating quite successfully.

A few weeks ago we got some information that a similar instrument is about to come on the market in North America. We have no details yet and it may not be able to do what we need. If its specifications and price is acceptable our development has been superseded.

Our sponsoring companies have not wasted their money since they have learned a lot about the technique and the interpretation of results from it. They are in a uniquely sound position to take advantage of the new instrument.

However, if our objective was solely to develop a new instrument for the marketplace, we failed. What we should have done is double the resources being put into the research and development to shorten the time to commercialization. You can see why sound market intelligence is critical to successful innovation and why the bridge between research and marketing is so important.

4. We have small local markets so our marketing effort must be in the international area where our experience is not extensive.

5. We have limited experience in IR&D management and management of the innovation process. Much of our industrial management is involved with:

a. Companies supplying parts to large companies such as the car industry. These companies require no significant marketing skill of the kind needed for innovation.

b. Overseas-based companies whose marketing strategy for new products is developed outside Australia.

c. Industries like the mineral industry which sells to an international marketplace but is a user of technology rather than a marketer of it.

Putting this into context, I see that there are some reasons for confidence that we can solve the problems of moving into the development and use of new technology in Australia. These grounds are:

1. We have a very fine research base on which to build the innovation process.

2. There are some splendid examples of successful innovation in the past.

3. A number of industries have shown themselves to be very efficient users of new technology over the years.

However, there are some grounds for expecting that we will have more trouble in coming to grips with this problem than in some other countries. I have listed some of these earlier under the general heading of lack of experience in the innovation process. Let me add two others to the list:

1. The process of selecting and promoting new technologies is essentially long term. It often takes more than a decade from the inception of applied research to the entry to the marketplace. As a nation we seem to have difficulty in establishing long-term plans. Indeed our three-year election system dictates against such planning.

2. The process also implies some form of community consensus. As a nation we need to decide that this is the business in which we want to be. We need to do our "corporate" planning! Again this seems difficult for us to do, and again our political system which is basically adverse in kind does not help.

CONCLUSION

I have studiously avoided commenting on the matter of promotion of new technology although it is in the title of the session. In my view it is all too easy to promote a concept by talking about it and that is what has been happening in Australia. Making the concept work is a different matter. No one should expect any simple panacea. It will require an immense effort from dedicated, experienced and intelligent people.

I have hinted at some of the areas where I believe we will need creative effort. Let me briefly list these:

1. We need to involve industrial management at all levels of planning.

2. We need to bridge the gap between our strong research capabilities and the rest of the innovation process.

3. We must improve the marketing part of the innovation process.

4. We need to strengthen our management skills both in IR&D and the management of the innovation process as a whole.

If I had to put these points in order of priority I would suggest it is in the reverse order to how they have been listed. The motivation and stimulus for the move into high technology must come from management.

In the case of the minerals industry, management generally has made this commitment, and AMIRA, in a modest way, is getting on with the job of selecting and promoting new technology for the mineral industry.