Effective Priority Setting for Public Sector Research: CSIRO's Experience*

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1. Introduction

The successful research organisations of the future will be those that recognise and address uncertainties about the future, before they become problems of the present. Research organisations, like most public and private sector organisations, operate in a dynamic environment, where change is unrelenting. They are subject to the interactions of political, economic, social, technological and business factors. In order to survive, they must change and make themselves relevant. Priority setting is continuing need.

Public sector research organisations are under increasing scrutiny to justify and defend their roles. Such organisations continue to be important in three major ways. First, they provide a strategic science and technology base for the benefit of end users in industry, government and the community. Second, they provide authoritative and independent advice on scientific and technical matters to government for policy and other purposes. Third, they support national infrastructure through standards and other research. However, provision of these functions is not sufficient justification for a public sector research organisation's existence. Government's want better value for the tax payer's dollar, in all areas of public service. Public sector research organisations must demonstrate a positive contribution to national welfare and the nation's wealth.

Public research organisations will need to demonstrate to their government stakeholders and others that their research activities are relevant to the current and future needs of industry, government and the community and that they generate economic and social benefits for the nation.

Organisations use various planning and resource allocation tools and processes to help them achieve this aim. A key element in CSIRO's long-term research planning is its research priorities process. First applied in 1990-91, it is widely used throughout the Organisation to set research priorities, from corporate to project level.

The aim of this paper is to review the process of priority-setting in CSIRO and to examine the Organisation's experience of the past few years, drawing out some major lessons for similar public sector research organisations to CSIRO. Following sections address:

- critical success factors in priority setting for public sector research organisations;
- the CSIRO priorities process;
- effectiveness of the priorities process; and
- challenges for the future.

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2. Critical factors in priority setting

Typically, priority setting involves three key stages: preparation, determination and implementation. It is the last of these, implementation, that is the proof of the pudding. If the priorities process is effectively implemented and resource shifts occur as intended, then the process could be considered as successful. However, successful implementation is the result of a number of critical factors, which extend back to the very beginnings the process, including the preparation and determination stages.

Mintzberg (1994) has shown that the factors most instrumental in successful planning, are the level of **commitment** in the organisation to the process and its outcomes, and the **congeniality** of the internal climate of the organisation to planning processes and change.

For research priority setting commitment and congeniality encompass four critical factors. These have been grouped as follows:

Commitment	Congeniality
- Ownership	- Convergence
- Simplicity	- Utility

Commitment

The key factors in commitment are ownership and simplicity of the process.

While commitment of the top management team is necessary, it is not sufficient for success. An essential pre-requisite to commitment is **ownership**, by both top management and management and staff from lower levels. Participation by both management and staff in the priorities process will enhance ownership and result in greater commitment to the process and its outcomes. A common pitfall to avoid is that of the planners taking control and ownership of the process, with all other parties relegated to the role of mere implementors. Commitment is undermined in this situation.

Simplicity of the priorities process is also critical. A high degree of sophistication or complexity of the priorities process can detract from the level of commitment. This may arise where planners focus too much on the process itself and not enough on the needs of management and the organisation's external customers. The process should be jointly developed or adapted by management and staff with appropriate support and facilitation from planners. The simpler the priorities process or method, the easier it is to understand, the more amenable it is to a wide audience and therefore, the greater the participation of staff and management, which builds greater ownership and commitment. Simplicity also implies a robustness and a capacity to adapt to different applications.

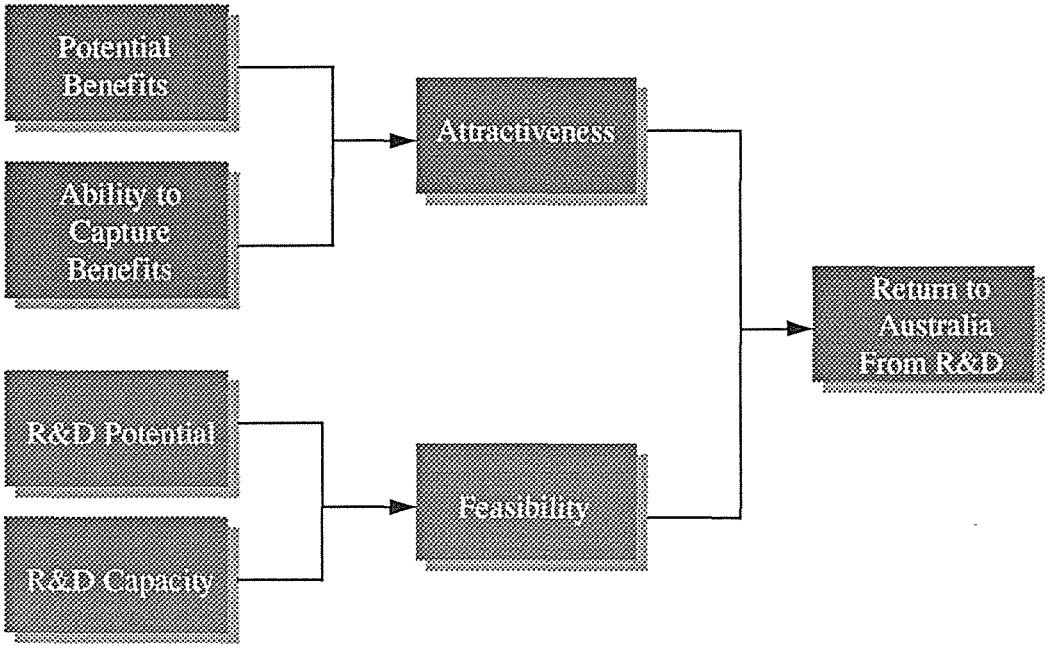
Congeniality

The key factors in congeniality are convergence and utility.

Mintzberg stresses the critical importance to successful planning (priority setting) of congeniality of the organisation's internal environment to priority setting and the changes that it hails. Change is generally not welcomed by nations, by organisations, or by individuals. **Convergence** is an important requirement in priority setting. The process should enable wide participation from across the organisation. Furthermore, it should engender sufficient leverage to cause changes which are more than incremental resource shifts within existing activity categories and simple extrapolations of the past. Priority setting should be challenging to existing mindsets and objectives, and should be firmly focussed on the long-term future. To this end, effective priority setting should be open and inclusive, involving participation from different disciplines and different areas from within the organisation, as well as being open to the experiences and perspectives of relevant external stakeholders. The process should allow consideration of different points of view. Within the organisation the process should encourage convergence of disciplines, ideas, experiences and perspectives.

The **utility** of the process is linked to its ability to enable the organisation to move towards its longer term goals and maintain flexibility for change. The priorities process should not lead to inflexibility in the organisation's activities and long-term directions. The process should identify the many influences on potential outcomes and the nature of change relevant to each influence. Priority outcomes should be largely consistent with the vision and broad goals of the organisation.

Figure 1: The CSIRO priorities framework

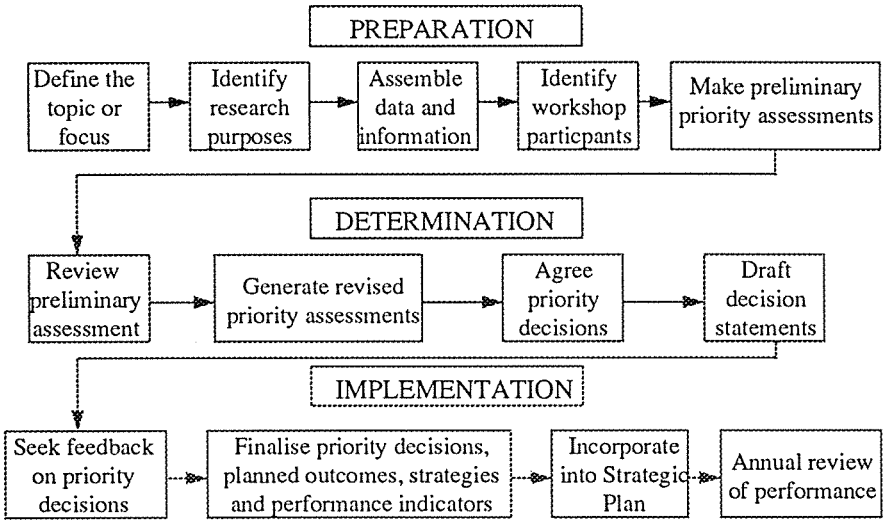


3. The CSIRO research priorities process

At the centre of CSIRO's priorities process is the attractiveness - feasibility framework, as illustrated in Figure 1 (see CSIRO 1991, and CSIRO 1993). As the framework has been applied to a wide range of applications at different levels within the Organisation, it is useful to distinguish its generic factors from its application-specific factors.

Figure 2 presents the main stages and steps in CSIRO's priorities process. Within each stage there are a number of key steps which have to be accomplished if effective priority determination is to occur. The following discussion addresses important aspects in most of the preparation and determination stages.

Figure 2 Stages and steps in the priorities process



Generic factors of the priority setting process

The priorities framework itself is the principal generic factor. Key discriminant questions relating to the four priorities criteria, data and evaluation sheets and the priority assessment procedure are important complementary factors.

The priorities framework

The priorities framework brings together assessments of the **attractiveness** and the **feasibility** of a research purpose[1], providing an overall assessment of the 'return (to Australia) from R&D' for that research purpose. Attractiveness measures the likely benefits (to Australia) of successful research and is based on assessments of the 'potential benefits' and 'ability to capture' the benefits (for Australia). Potential benefits

[1]A research purpose is defined as the principal socio-economic objective (SEO) to which research may be directed. SEOs correspond approximately to sector and industry groupings. CSIRO bases its research priorities assessments on the Australian Bureau of Statistics' Socio-Economic Objective research classification. Selection of research purposes is discussed further under strategic factors in research priority setting.

are the maximum economic, environmental and other social returns possible (for Australia) from technical improvement in the industries comprising the research purpose. Ability to capture is defined as the ability of (Australia's) companies, organisations and utilities to convert technical progress into commercial and other returns (for Australia). Feasibility measures the ability to achieve technical progress (in Australia), and is based on assessments of 'R&D potential' and 'R&D capacity'. R&D potential is a measure of the technical potential of relevant fields of research and development, indicated by the maturity of the fields, the closeness of technical and physical limits and the prospects for scientific breakthroughs. R&D capacity is a measure of (national) research capability, in terms of the quality and quantity of resources available to achieve the R&D potential in a timely way.

Figure 3: The Attractiveness - Feasibility Screen

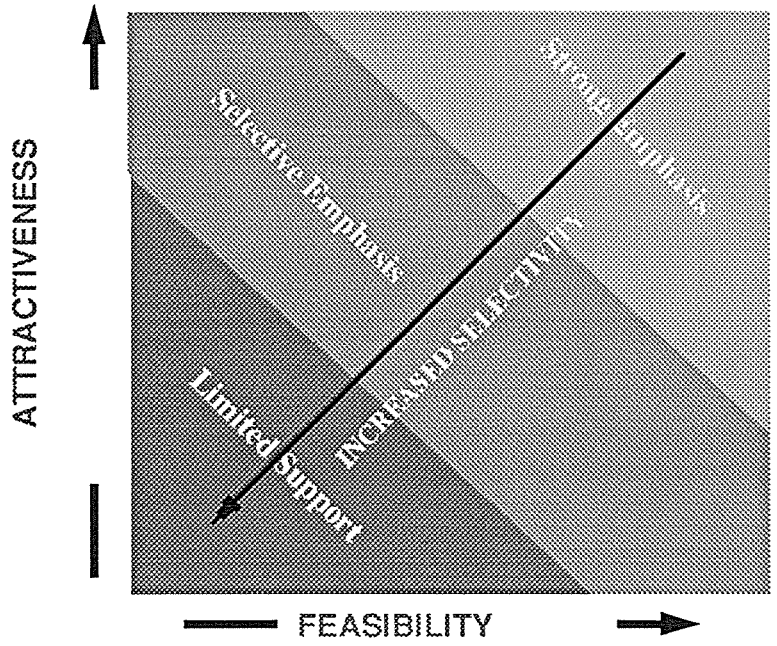


Figure 3 presents the screen on which the composite attractiveness and feasibility scores are plotted. Emphasis in choosing research purposes is increasingly selective as both attractiveness and feasibility fall. Strongest emphasis is given to those research purposes for which the likely benefits of successful research are high (ie high attractiveness) and the research has a high likelihood of achieving a high level of technical success (in Australia) (ie, high feasibility).

Key discriminant questions

Key discriminant questions are posed for each criterion to aid consistent and accurate assessment. The questions also assist in clarifying differences between the criteria and impressing their independence. Box 1 presents the respective questions posed for the priorities criteria as used for CSIRO's assessment of national research priorities in 1993.

Box 1: Key Discriminant Questions

POTENTIAL BENEFITS

- Who are the potential users and customers and how will they benefit?
- What parts of industry and/or the community will benefit from successful research?
- How will R&D contribute to industry growth and improved competitiveness?
- What is the size of potential markets in Australia and overseas, in value terms, and what are their growth prospects over the medium to long term?
- Are there any other important benefits, direct and indirect- environmental (degradation avoided), social (social amenity, health, safety), employment creation?
- Are there spillover benefits to other industries?

ABILITY TO CAPTURE BENEFITS

- How will successful research be captured in Australia; what is Australia's ability to exploit the results?
- Are there potential commercial partners?
- Can the benefits from the research output be protected?
- What are the incentives/imperatives for adoption by commercial or public sectors?
- What is the industry's and/or community's commitment to R&D and technical innovation?
- Can Australian users compete internationally?
- Are there factors and conditions likely to promote or impede uptake, such as regulations, industry structure, physical conditions, ethical, cultural/social, environmental or political factors?

R&D POTENTIAL

- How close are the physical and technical limits in the relevant R&D?
- Are fields mature or developing? (Where is current technology on the S-curve?) - ie., is the rate of change rapid, moderate or slow?
- What are the prospects for developing commercially valuable intellectual property, scientific breakthroughs, or major improvements in mature technologies and fields?

R&D CAPACITY

- Would the proposed research effort (in terms of the quantity and quality of resources - critical mass and quality of researchers) be internationally/nationally competitive in the research field?
  - What is the competitive advantage(s) of Australia's (CSIRO's) research effort?
- Who are the major international (national) research competitors?
- Does Australia/CSIRO have the capacity to deliver the research, in terms of adequate skills, facilities, and time frame for effective application?

Box 2: Scoring Procedures

Prior to the workshop

1. Score all research purposes **prior to the workshop**, record scores on summary score sheet.

2. Note each **criterion definition** before proceeding to avoid confusion when making assessments.

3. When making a judgement, refer to the **Data and Evaluation Sheets** and other relevant input material provided.

4. Use the key discriminate questions as a guide when making your assessments.

5. For **each criterion** assign a score of between 1 and 10 to the research purposes. Record the score on the research purpose score sheet and note supporting reasons as well as any questions or relevant issues that you would like to raise at the workshop. First score all research purposes for potential benefits, then score for ability to capture, and so on.

6. **Review the scores**, using the summary score sheet as a guide. Check for consistency within each criterion, score the research purpose that judged as the highest a 10 or thereabouts and the research purpose judged as the lowest a 1 or thereabouts. The same criterion score can be given to two or more research purposes if they are assessed of equal ranking.

The pre-workshop scores are collected from participants entered into a spreadsheet to generate the preliminary attractiveness-feasibility.

During the Workshop

7. Taking each criterion in turn, the research purpose **expert gives an overview.**

8. Pre-workshop scores are surveyed to locate **outliers** within the group - those whose scores deviate most from the group mean.

9. Following discussion and debate participants may **rescore** if they assess it to be necessary.

10. Participants complete score checks, the **revised scores** are entered into a spreadsheet and the revised screens are produced (Attractiveness, Feasibility, R&D Return).

11. The group reviews the **screens** to check that the relative positions properly depict the outcome of the discussions.

Data and evaluation sheets

Data and evaluation sheets are prepared for each research purpose or Socio-economic objective to assist in the formulation of criterion assessments. The data sheet includes data trends and analyses and other relevant industry and research information for each research purpose or socio-economic objective. Much of the data and information relate to the key discriminant questions, supplemented as appropriate with details on component industries and groups within the socio-economic objective. The evaluation sheet is organised by the four criteria. It presents an evaluation of the relevant data and information contained in the data sheet in the context of the key discriminant questions. Data and evaluation sheets are prepared by individuals with expertise in the particular SEO area. Sample data and evaluation sheets from CSIRO's assessment of research priorities for 1994-95 to 1996-97 are contained in Attachment A to this paper.

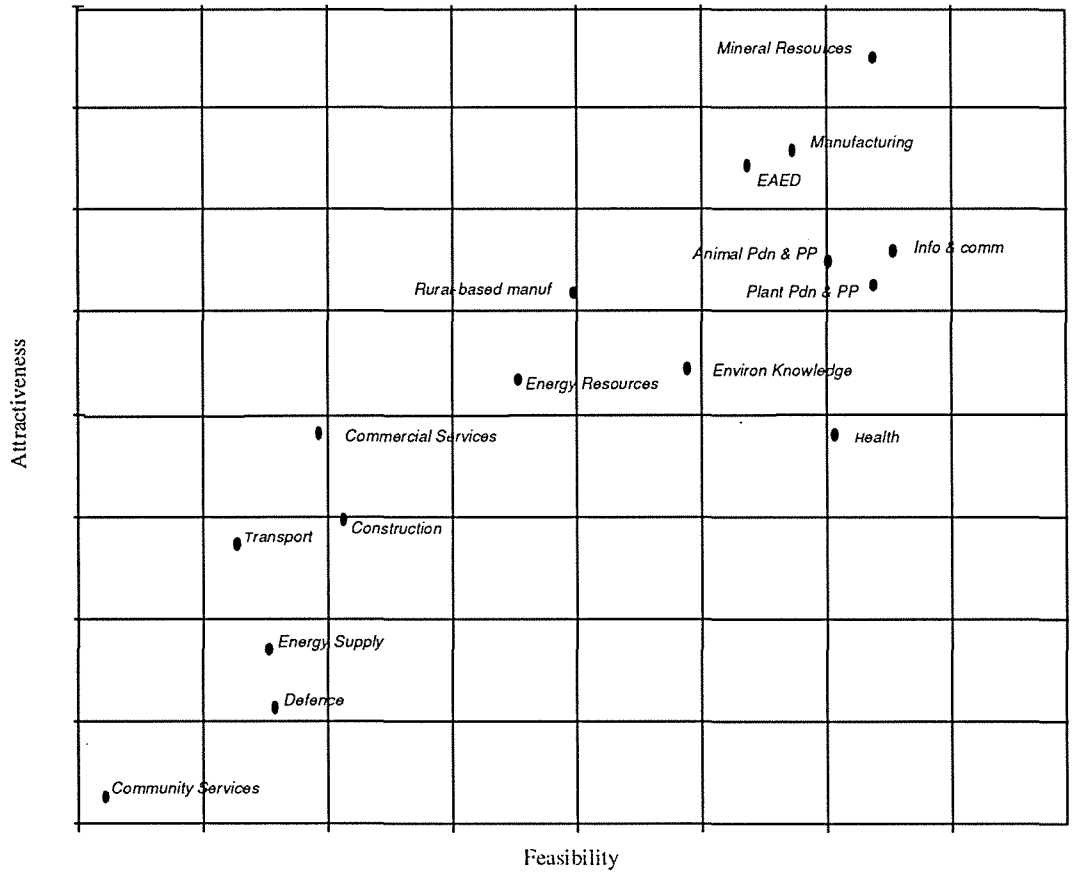
The priority assessment procedure

The priority assessment procedure is largely workshop based, with workshop participants selected according to research management responsibility and/or relevant industry and research expertise. Following agreement on the set of research purposes to be prioritised and on suitable key discriminant questions, industry and R&D data and information are assembled. Next, data and evaluation sheets are prepared for each research purpose. These are collected into a single document which is provided to each workshop participant. Prior to the priorities

workshop, participants make preliminary priority assessments. Using a simple scoring mechanism participants make judgements based on the quantitative and qualitative information contained in the supporting data and evaluation sheets as well as on their own knowledge and experiences. Details of the scoring method are presented in Box 2. From these scores a preliminary priorities assessment is established for the group. This assessment provides the basis for the priorities workshop.

At the workshop, which may run for two to three days, each criterion is assessed in turn. Following extensive debate and discussion on each research purpose for each criterion, participants may rescore. Revised scores are collated and the final priority assessment plotted. Figure 4 presents the final attractiveness - feasibility plot for CSIRO's assessment of national research priorities for 1994-95 to 1996-97, which was conducted in March 1993.

Figure 4: CSIRO's Assessment of National Research Priorities



Having reached a set of prioritised research purposes the next step is to translate them into resources allocation decisions. Procedures for this stage are best determined by the particular organisation as there are often other information and assessments which may be included with the priorities to determine research strategies and resource allocation decisions. CSIRO summarises these later stages together with relevant details from the earlier stages in role statements or decision statements for each SEO research purpose. The role statements are key inputs to CSIRO's strategic plan, providing the Organisation's research strategies and broad resource allocation decisions for the five year term of the plan.

Specific factors of the priority setting process

The specific factors of priority setting are those which provide specific focus to the exercise, encompassing the external environment in which the organisation operates including markets and customers and the organisation's internal environment, including its culture, its vision and the way the organisation operates.

The main specific factors are:

- selection of the research purposes or research areas to be prioritised;
- selection of the workshop participants; and
- the specific focus of the exercise, reflecting the directions of the organisation.

Research purpose selection

Research purpose selection is a critical factor in research priority setting. It is the first key step on the path to successful priority setting and implementation. CSIRO bases its selection on the SEOs of the Australian Standard Research Classification, adjusted to better represent CSIRO's research focus. Within CSIRO, some Divisions, programs and projects have adopted the CSIRO SEO research classification for their priority setting, while others have chosen alternative structures. When selecting research purposes it is essential that the final set be:

- mutually exclusive,
- exhaustive,
- consistently based, and
- outcomes oriented.

Research purposes should be totally independent of each other if they are to be effectively assessed and compared. The set of research purposes should be comprehensive, including current research areas and areas in which the organisation could be involved in the future. The priorities process should be relevant to the future and therefore it must include assessment of areas and activities beyond the current set.

Consistency of definition of research purposes is also critical to meaningful comparison. CSIRO's use of socio-economic objectives is an example of the application of definitional consistency. Socio-economic objectives allow the organisation to focus on the outcomes of the research, rather than the means or process by which the research is conducted or how the objective is achieved. For

CSIRO, this has been a significant factor in generating the commitment of management and staff to the priorities process and the outcomes.

Those responsible for managing and implementing the outcomes of the research priorities exercise should be involved in the selection or determination of the set of research purposes which meet these and other relevant criteria. This may be achieved with the aid of a workshop involving these individuals and with reference to relevant existing research classification structures and the like. To keep the process manageable the group should aim to contain the number of research purposes to around 12 to 15. This workshop is also an opportunity to introduce the group to the overall priorities process and to discuss subsequent steps.

Workshop participation

Representation from the following groups should be considered when selecting participants for a priorities workshop:

- Internal management, especially those responsible for implementing priority decisions and those accountable for the achievement of planned outcomes.
- External stakeholders, including representatives from industry, government and the community.
- Current and future customers and users of the research outputs of the organisation.
- Staff

In addition to these factors consideration needs to be given to:

- the level of representation for each research purpose; and
- the numbers involved.

CSIRO has conducted workshops ranging from those involving representatives from all 4 key groups noted above, to those involving internal managers only. Experience has taught us that external participation is highly rewarding. It adds credibility to the outcomes of the exercise, it builds good relations with customers and stakeholders who value their role in assisting the organisation set its priorities and directions, and it allows a mixing of minds, broadening the scope of the exercise beyond a purely scientist's perspective. Experience has also taught us that pairing each internal expert with an external representative allows them to work together in the workshop, which reinforces the benefits noted above. Ideally, there should be one internal (expert), and therefore one external representative, for each research purpose.

When inviting people from outside the organisation the field should not be limited to those individuals, companies and organisations with whom the organisation presently deals. In addition to known customers and stakeholders, invitations could be extended to individuals who may not be directly linked to the organisation at present, but who could be of significance in the future and who could make a valuable contribution. The aim is to cover those elements of the priorities framework where the organisation is weakest. Typically, for a public sector research organisation these would be on the attractiveness side and would include individuals with specific industry and market knowledge, knowledge of the role of government and policy instruments, and/or awareness and understanding of social and community attitudes and issues.

Focus of the priorities exercise

The priorities exercise may be focused to address particular needs. For example, priorities could be set in the context of the specific directions or the vision of an organisation. Ignoring this aspect may create a risk of the outcomes being an extension of the past with only marginal differences in planned activities from current activities. Key elements of the organisation's vision may be factored into the priorities criteria, ensuring that the priority outcomes are consistent with these directions of the organisation. Setting priorities in the absence of a long-term vision or goal can result in losing sight of long-term research opportunities and of not reconciling the researchers' objectives with the organisation's (Contant and Bottomley 1988, p.7).

4. Effectiveness of CSIRO Priorities Process

CSIRO's priorities process has performed reasonably well against the critical success factors cited in Section 2. However, while there has not been a rigorous evaluation of the process against those factors, it is possible to identify a number of significant instances which indicate favourable performance. The following table presents relevant instances selected from across the Organisation.

Critical success factor	CSIRO's performance
	COMMITMENT
Ownership	• The priorities method was developed iteratively with the active involvement of the CSIRO top management team. • The process/method has been diffused within the Organisation, down to project level in some cases (eg, see Institute of Industrial Technologies project data sheet). • Involvement of CSIRO Institutes and Divisions in priority setting exercises at lower levels prior to the CSIRO exercise; outcomes were fed into the corporate exercise (see CSIRO 1993). • Championed by the Chief Executive from the very start. • Broad recognition by Government stakeholders of the Organisation's use of the process and acceptance of the outcomes. • Balanced consideration of factors relevant to the internal environment with factors from the external environment.
Simplicity	• The four criteria are simple, yet comprehensive; clear definitions aided by key discriminant questions. • The process is systematic and staged, supported with standardised data and evaluation sheets which facilitate comparison. • It is largely workshop based and participative. • Allows consideration of quantitative and qualitative inputs • Is able to generate useable results at the workshop, based on the judgments of participants. • Is robust and adaptable to new situations, although its successful application is dependent on generic and specific aspects of the process discussed in section 2 of the paper. • The process has been effectively transferred to many organisations outside CSIRO, through workshops and seminars. It does not require special computer software to implement.

Critical success factor	CSIRO's performance
CONGENIALITY	
Convergence	• Wide consultation with staff in Institutes when preparing data and evaluation sheets, and involvement of external stakeholders in priorities exercises at the SEO level, such as though the use of Institute Advisory Committees. • Common meeting ground for different disciplines and perspectives, including scientific, economic, commercial and social. • Able to effectively accommodate internal and external representation - pairing by SEO or research purpose, especially at Divisional level. • Process leads to reduction of conflict and shared views on outcomes. • Able to effectively accommodate consideration of research purposes outside the current range of research activities. • Method can be adapted to assess the current portfolio of research projects against the priorities outcomes - (see CSIRO Corporate Planning Office 1993a,b.)
Utility	• Change from a resource allocation process based on 'equal misery for all' to one based on favouring areas of highest return (ie, high attractiveness and feasibility). • Flexibility of resource allocation enhanced through the expansion of multi-disciplinary programs in recent years from less than 10 to over 35 across CSIRO. • Faced with a budget fall of around $1.6 million over the next 3 years the Division of Tropical Crops and Pastures has departed from traditional resource allocation mechanisms where all areas get roughly equal treatment to one which bases the distribution of government appropriation funds to SEOs in accordance with the Division's assessments of the relative attractiveness and feasibility of the SEOs in which the Division works (see Clements 1994).

5. Future Challenges

CSIRO's priority processes have fulfilled a useful role in the past few years and should have a continuing life in guiding the Organisations' activities. At the same time these processes will need to evolve to ensure their continuing effectiveness. An ongoing task will be to ensure the freshness of the approach, its adaptation to changing needs and its capacity to aid the flexibility of the Organisation.

Several challenges present themselves in considering the future usefulness of the priorities process.

Ownership is an ongoing task, and one that cannot be taken for granted. For CSIRO in the mid-1990s this will mean broadened use of the process and strengthening common ownership of the language and its concepts. In one of CSIRO's six Institutes, the Institute of Industrial Technologies, all projects now conform to a one-page project data sheet which summarises key information relevant to the project, according to the four CSIRO priorities criteria. At another level the participation and ownership by external stakeholders and customers is likely to become still more important in order to ensure alignment of CSIRO thinking with that of its key customer groups. This is likely to mean greater stakeholder involvement in preparation and decision processes.

Adapting to Changing Needs: The increasing globalisation of industry and R&D means that research priority setting has to have regard to the international competitiveness of research and the way research outputs are taken up and used by industry, government and community users. The priorities process will increasingly need to take this into account in its language and analysis - the international competitiveness of research groups and of prospective collaborating agents.

Information and Analysis: Flexibility will also be needed in respect of supporting analysis and data to assist decision making. Possible options include the use scenario analysis techniques and technology forecasting as supplements to current technical and economic information.

Regional Research Priorities: The growth of the Asia Pacific economies has been accompanied by a fast growing awareness of the importance of effective international collaboration for mutual benefit. Equally there are likely to be increasing opportunities in coming years for fruitful international research collaboration on areas of common or major regional concern. A shared priorities process based on some of the principles and practices set out in this paper could be a an efficient way of establishing priorities for multi-national projects of mutual benefit.

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