SPACE MAPPING COMMERCIALISATION: AN ANALYSIS OF THE MANAGEMENT OF REMOTE SENSING IN AUSTRALIA.

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Abstract:

This paper examines the challenges associated with the management of remote sensing technology in Australia. Models are presented that provide valuable guide-lines for the commercialisation of remote sensing technology.

The study utilises a systems approach to provide a framework of analysis that is sensitive to both technological requirements and human factors. It describes a new range of problem solving skills that are appropriate where the situation is complex and poorly defined.

The paper argues that systems modelling is a valuable method for developing strategies for the proper management of remote sensing.

Key words: Remote Sensing, Space Imagery, Mapping, System Design

INTRODUCTION

Remote sensing is a technology that has developed along with the information technology revolution of the Twentieth Century. In the 1990's remote sensing is a synthesis of communication systems, space science, computer systems, applications development, commercial endeavour and government policy. It encompasses issues that range from international cooperation for space exploration to the development of individual farm management systems and local land care programmes. The components that make up remote sensing systems generally have high costs of initial establishment, yet they have the potential to be cost effective tools for the technologically advanced society that Australia aspires to become. For these reasons the study of the commercialisation of remote sensing offers a better understanding of the transfer of a complex technology and an insight into how remote sensing can be effectively incorporated into the developing technological infrastructure of Australia.

This paper presents a systems approach that is currently being used within a research programme to develop functional models for successful technology management in Australia. The project seeks to develop strategies to achieve effective technology transfer between academic institutions and Australian industry. The technology that the research focuses upon is remote sensing.

BACKGROUND TO THE PROBLEM

An Australian study (Bureau of Industry Economics, 1990) indicates that successful commercialisation of new technologies is dependent upon the linkages that exist between the public sector research organisations and industry. This emphasis on linkages is supported by the findings of Prager and Omenn (1980) and Boyle (1986) and is expressed by the following questions:

- How can linkages be developed and maintained between industry and public sector research organisations?
- How can industry effectively identify and specify research needs and know what relevant research is taking place?
- How can industry be involved at an early stage of research, so as to be able to participate in the research definition stage?
- Are public sector research organisations prepared to support industry in the commercialisation process?
- How to erase preconceptions that build barriers to successful technology transfer?

The negative perceptions of the last question include:

- The "not invented here" and the "not one of us" syndromes. This attitude is particularly prevalent where a technology is used by a number of specialist disciplines. There is often a great reluctance to accept the experience of other disciplines as being relevant to the problems of a specialist.
- Many managers in industry believe that universities still live in an ivory tower world and as a consequence cannot have any understanding of the needs of the 'real world'. It is perceived that academics are unable to appreciate the needs of industry, which is reflected in research that is inappropriate to industry. This problem is compounded by the belief that universities generally overstate the market value of their research.
- Major sectors of Australian industry have not taken sufficient advantage of commercial opportunities from public sector research. This is attributed to a mismatch between these opportunities and the capabilities of local industry rather than a failure to recognise the commercial opportunity.
- Much of Australian industry lacks a commitment to innovation, is not prepared to take risks, and concentrates on short term operational planning to the detriment of longer term strategic planning.
- Many public sector research organisations

have not been sufficiently entrepreneurial in transferring technology to industry. This is often based upon the claim that research scientists are reluctant to become involved in commercialisation of research, particularly if they operate in an environment that does not allow the payment of incentives.

Studies of the technology transfer process for remote sensing have been undertaken by Ferns and Hieronimus (1989), Forster (1990), and Specter (1989). Reports of particular relevance to this study are those of the Australian Space Office (1989, 1992) which identify the weaknesses in the commercialisation of remote sensing in Australia. More detailed analysis of these reports is found in Finegan and Ellis (1991) and Finegan (1991).

SYSTEMS CONCEPTS

The traditional systems approach to problem solving is based on the technique of reductionism, which solves a problem by fragmentation, one stage at a time. This technique is appropriate for complex and highly structured problems that are able to be well defined, particularly in terms of inputs and outputs.

The problems associated with technology management and technology transfer, however, are complex, unstructured and poorly defined. In these situations, a holistic rather than a reductionist approach is recommended.

A holistic approach to problem solving is provided in a methodology developed by Peter Checkland, Professor of Systems at Lancaster University. This is variously known as the Checkland Method, Lancaster Methodology, or the Soft Systems Methodology (SSM). The concepts were developed through practical application and experience in a wide variety of complex managerial systems. The methodology is designed to allow the human element of such systems to be incorporated into system design work. It is not easily assimilated or applied, and **its apparent simplicity may be deceptive.** It may be used to analyse any problem or situation, but it is most appropriate for the analysis of systems that are not well defined.

The Soft Systems Methodology is described by Wilson (1984) as "a seven stage process of analysis which uses the concept of a human activity as a means of getting from finding out about the situation to taking action to improve the situation" (p.64). These seven stages are illustrated in Figure 1. This figure represents the pattern of activities in the methodology, it does not necessarily impose a sequence in which it should be applied. As Wilson says: "The analyst may start with any activity, progress in any direction, and use significant iteration at any stage" (p.64). The dotted line between the real world and the systems thinking is significant in that it defines the boundary between the use of everyday language (real world) and the systems language.

APPLICATION OF METHODOLOGY

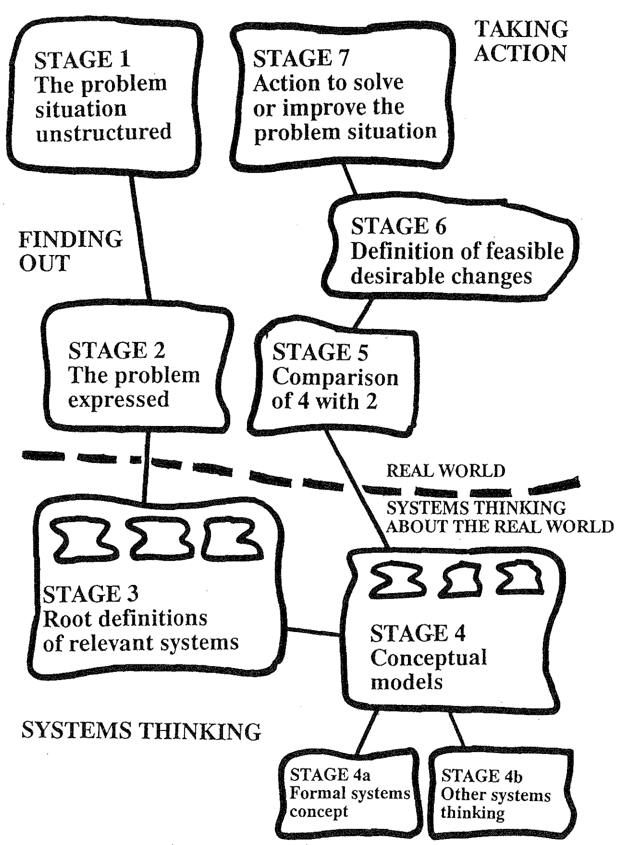

Figure 1: The Soft Systems Methodology (Checkland, 1981: p.163)

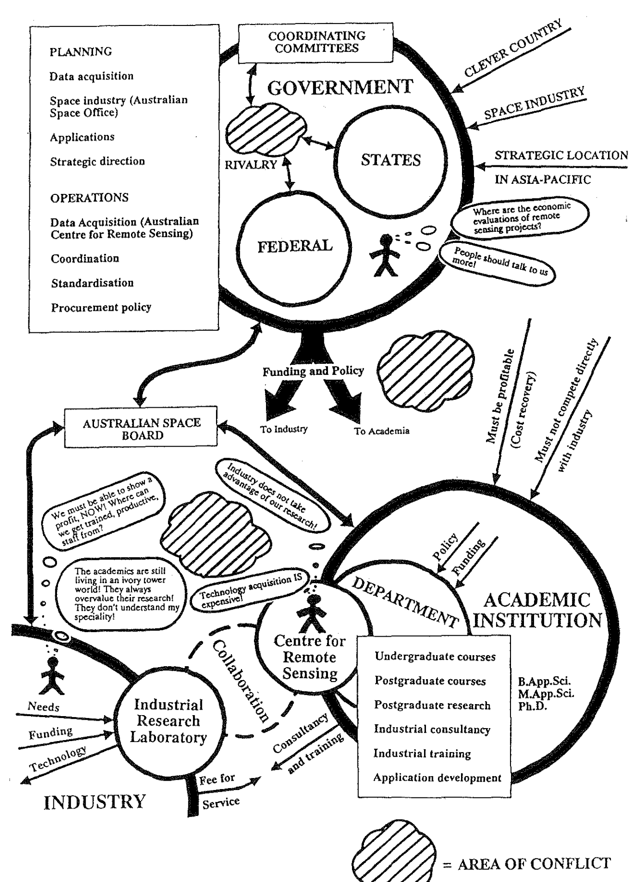

Figure 2: "Rich Picture" of the technology transfer of remote sensing in Australia.

Stages 1 and 2 : Expression of the problem

The first two stages look at what makes the situation a problem and the basic facts associated with this problem situation. Checkland (1981, p.264) suggests that a test for adequacy of work to this point is the ability to give convincing answers to the following questions: "What **resources** are deployed in what **operational processes** under what **planning procedures** with what **structures**, in what **environments and wider systems, by whom**", and "How is this resource deployment **monitored and controlled**"?

Stage 1 is the development of the discussion of the background of the problem, which leads to, in this case, the problem situation of the technology transfer of remote sensing in Australia. Stage 2 expresses the problem situation in the form of the "Rich Picture" (Figure 2) which aims to show the elements of slow-to-change **structure** and elements of constantly-changing **process** within the situation being investigated.

Stage 3 : Selection

In this stage a choice is made of relevant systems that the analyst believes will produce insight into the problem situation. The chosen systems are expressed in statements as the Root Definitions, which incorporate the points of view that make the activities and performance of the systems meaningful. The initial Root Definition for this study of technology transfer has been formulated as follows:

> An industry driven system operating within research centres with the objective of transferring untransferred technology by: knowing about untransferred technology, knowing about targeted industries, selecting technology to be transferred, selecting means of transferring technology, applying those means to an industry, stimulating the ongoing transfer, and monitoring the success of such transfers; in order to benefit all involved parties, in an environment of research, industrial competitiveness, and national and international economic development.

The formulation of "good" root definitions is decisive to the creation of the conceptual model in Stage 4. Therefore, the Root Definition should be tested against a set of elements, that if achieved, indicates that it is well formulated. However, this does not necessarily tell if it is a "good" Root Definition. This set of elements is known by the mnemonic CATWOE, that defines a check-list for Customer, Actors, Transformation process, Weltanschauung (worldview), Owner, and Environment. Invoking the CATWOE for this study results in:

C Industry which can benefit from Technology Transfer.
A Researcher who wishes to promote a technology.
T Untransferred technology becomes transferred technology.
W Transfer of technology is desirable.
O Industry (that has the power to accept or reject a transferred technology).
E Research / Industrial Competitiveness / National and International Economies.

This breakdown appears to be satisfactory for the problems associated with technology transfer. Major stakeholders are identified and the Transformation, Environment and Weltanschauung all reflect the essence of the problem.

Stage 4 : Model Building - Conceptual Model

This stage is where a logical expansion of the Root Definition is made into the minimum necessary set of activities to define what the system actually does at a particular resolution level. The Conceptual Model that results should have only a limited number of entities, Wilson (1984) recommends that:

> The first resolution level model from a root definition should not contain more than about 12 activities, otherwise it becomes difficult to defend them as constituting a minimum necessary set. It is frequently stated that the mind is only capable of retaining between five and nine entities at any one time, and hence a single stage model expansion should only be of this order (p.72).

The qualitative modelling process uses pictures and diagrams to define and communicate structure, logic, ideas and relationships. The Conceptual Model should be expressed by verbs.

The logical expansion of the Root Definition for technology transfer results in a Primary Conceptual Model of four activities within a technology transfer system boundary. The linkages illustrate logical dependency and relationships between activities, the external environment, and wider systems. This Primary Conceptual Model is illustrated in Figure 3.

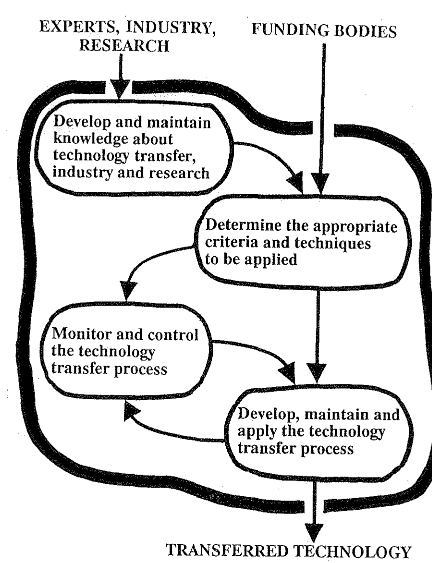

Figure 3: Primary Conceptual Model - Technology Transfer Second Resolution Conceptual Models

The second resolution model takes each activity from the Primary Conceptual Model and expands that activity into a more detailed model of activities within a new sub-system.

Three systems, "knowledge", "criteria" and "application" have been modelled, with the activity "monitor and control" remaining at the first level of resolution (Figure 4).

This detailed model represents a human activity system that can now be used to create a well structured evaluation of the state of the real world. This is achieved by comparing the model with perceptions of "what is the present mechanism".

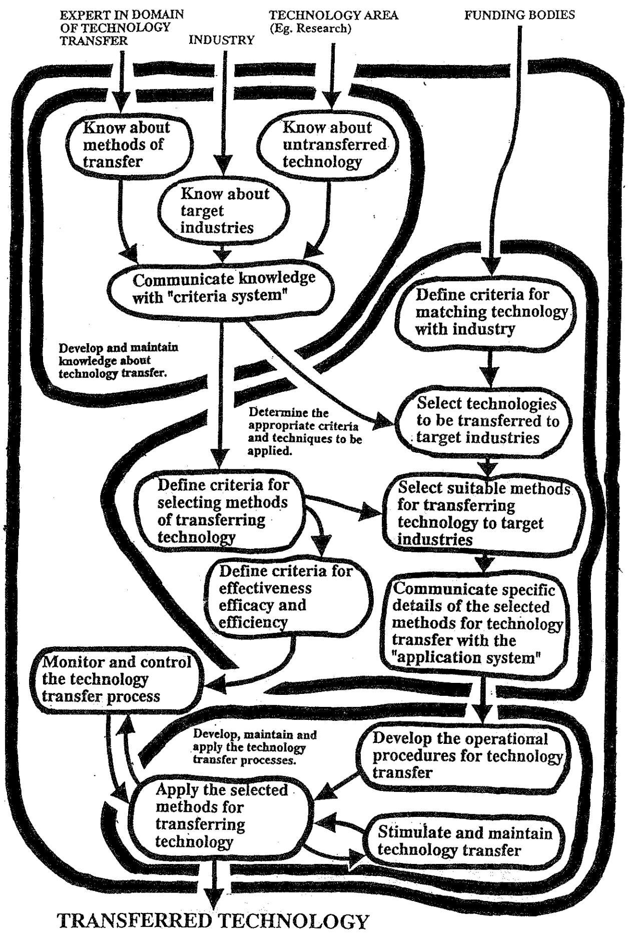

Figure 4: Second Resolution Conceptual Model

Stage 5 : Comparison

Comparison of the Conceptual Model with the real world is undertaken by comparing each of the second resolution activities within the model with the real world problem situation. This was achieved in this study by the rigorous interviewing of project managers in agencies and companies that use remotely sensed data. In the interview the following questions were asked for each activity:

1. Do you undertake the described activity?
2. If so, please briefly describe how this is accomplished.
3. If so, please define the measure of performance for undertaking this activity.
4. If so, please describe any improvements that could be made to the way you currently undertake this activity. If not, are you likely to undertake this activity in the future? How would you do it?
5. Do you think that this is an important activity?

The research programme is now at this stage of the analysis. Preliminary comparison studies with selected agencies indicate that the majority of the activities in the Conceptual Model, while being relevant to the real world, are either not done at all, or are undertaken in an ad hoc manner. Other activities are undertaken within well specified environments, or by stakeholders with well defined interests. Activities that attract particular interest by virtue of their absence in the real world include:

- Monitor and control the technology transfer process.
- Know about untransferred technology.
- Define criteria for selecting methods of transferring technology.
- Define criteria for effectiveness, efficacy and efficiency.
- Develop the operational procedures for technology transfer.

The Conceptual Model will now be developed to the third level of resolution based upon this first comparison with the real world. This will result in 10 to 12 detailed models with an aggregate of about 80 activities. The comparison stage will then be repeated with organisations that are representative of the various sectors in the real world that have an interest in the technology transfer of remote sensing.

Stage 6 and 7 : Recommendations for Change, and Taking Action

The final comparison studies in Stage 5 will generate proposals for change that will present a solution for the problem. These proposals will then be assembled into feasible desirable changes that can be implemented. This may require the assessment of the desirability and feasibility of alternative "Hows" to achieve the proposed change.

EVALUATION OF PROGRAMME

The participants from the organisations studied have generally responded well to the analysis process. An important measure of success is their willingness to continue with further interviews, and their assistance in identifying other potential groups for study. In a majority of cases, individuals have claimed that their participation in the analysis has directly lead to useful insights into the problems they are having with technology transfer.

A number of tools have been developed within the analysis, including a remote sensing newsletter, a project, personnel and technology database, and a poster display. These have improved communication between groups, and provided a focus on remote sensing and technology transfer issues.

This application of Soft Systems Methodology (SSM) to the problem of technology transfer of remote sensing has produced useful results as the analysis progresses.

The participative nature of the analysis has in its own right improved communication between agencies involved in the study. This has resulted from the proactive process of maintaining and developing a dialogue with industry and government agencies as part of the programme. The most tangible form of this benefit is the development of the remote sensing database.

The iterative nature of the analysis allows opportunities to identify weaknesses in the existing system early in the study and therefore respond both through more detailed modelling and action in the real world. An example is the activity **"monitor and control the technology transfer process"**. The real world comparison identifies that it is very desirable, but rarely undertaken. Moreover, examination of this activity has identified that **economic evaluation** of successful remote sensing projects is an element that to date has consistently been lacking. This clearly identifies an action that can be taken immediately to improve the problem situation. A model for the economic evaluation and management of remote sensing operations has therefore been developed (Finegan, Ellis and Rollings, 1992) and is now being tested.

The cyclic and adaptive nature of the SSM facilitates learning and input from other relevant systems models (Stage 4b in Figure 1). Therefore comparative analysis with existing general models for technology transfer allows the SSM model to be both validated and further enhanced. This will ensure that the resultant model for technology transfer is both robust and functional.

The final model will be presented in a format that is accessible to potential users. Options for presentation include:

- **Technology template**, where the user matches the attributes of a particular technology with the relevant part of the template, which then recommends actions to improve the situation.

- **Decision tree**, where, based on the operation of rules, the user traverses the tree to a set of recommended actions. This mode lends itself to implementation on a rules based expert system for remote sensing technology management (Finegan 1992).

CONCLUSION

The Soft Systems Methodology described in this study is successfully providing action to improve the situation for the users of remote sensing, while developing a model for technology transfer that will be both useful and accessible to the wider Australian community.

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