

# Solving Problems in CSIRO: Recent Alternatives to Disciplinary Approaches

**Dr Geoff Syme**

*CSIRO Land and Water*

## ***Abstract***

One of the central tenets of CSIRO these days is the “one CSIRO” approach to problem solving. The organisation hopes to address significant natural resource management problems for Australia by combining the wisdom of a wide array of disciplines. A number of recent measures have been instigated to ensure that this happens and these are described in this paper. Implicitly CSIRO has recognised that cultural change is needed if the organisation is to contribute to the resolution of long term “wicked” problems. Innovations to achieve a more integrated approach are described and assessed in terms of their ability to meet recommendations derived from a review of past attempts to conduct multi or interdisciplinary research. This analysis concentrates on the pragmatics of the creation and performance of teams with differing disciplinary backgrounds in natural resources management. Nevertheless, the paper also discusses the choice of investing in strategic development of theory and methodology in interdisciplinary research versus the practical use of inductive problem solving in an organisation such as CSIRO.

## **INTRODUCTION**

One of the central tenets of CSIRO these days is the “one CSIRO” approach to problem solving. The organisation hopes to address significant research problems for Australia by combining the wisdom of a wide array of disciplines. A number of measures have been instigated to ensure that this happens. As to whether this integration can be achieved by the creation of truly interdisciplinary research approaches or simply by assembling multi-disciplinary teams is still a moot point. But it is evident that the approach that CSIRO will take is likely to vary from problem to problem and will be largely influenced by the background of the senior researcher(s) in the team.

The major purpose of this paper therefore is not to argue for or against any particular philosophy of science or problem solving. The intent is to describe how CSIRO has responded to holistic problem solving given its traditional division based management



structure and aspirations to produce “great science”. Nevertheless, the role of problem versus theory led research in developing a productive role for science in natural resource management is briefly discussed in the context of complex systems theory.

In the past and perhaps even now in CSIRO, as with universities, most individual scientist’s prospects for senior promotion have depended on publications in internationally respected journals. These are usually of a disciplinary variety. Involvement with multidisciplinary efforts therefore holds personal risks for the individual researcher. Transaction costs can be high, negotiations with other researchers uneasy and publications rates in traditionally high prestige journals slower.

Implicitly CSIRO has recognised this issue and that cultural change is needed if the organisation is to contribute to the resolution of long term and often “wicked” problems (e.g. Gilmore and Camillus, 1996, Achapelle, McCool and Patterson, 2003). A number of corporate and scientist driven initiatives have been undertaken. Some of these are described below.

Currently CSIRO has a comprehensive suite of initiatives to encourage the formation of problem focused research groupings in the natural resource and other sectoral areas. These have arisen from a history over the past ten to fifteen years of attempts to create a matrix approach to research. That is, problem areas have been identified and business unit (divisional) responses have been mapped against problems. This approach has taken time to evolve and the latest formulations are described below.

## CSIRO INITIATIVES TO ACHIEVE INTEGRATED RESEARCH

### Flagship Programs: Water for a Healthy Country

The Flagship programs have been a logical development from the initiative of the former CEO Malcolm McIntosh who in the 1990’s introduced a matrix structure. This consisted of Sectors representing major research theme areas for Australia. Business unit or Divisional activities were mapped against them. Theoretically this represented an important advance in terms of potential multidisciplinary research in that the “problem” became the focus for divisional effort rather than the interests of the business units (large or small) that often consisted of disciplinary groups or like minded individuals. Unfortunately internal funding arrangements and the dependence of many groups on winning external funds and therefore becoming leveraged by other’s priorities meant that this early initiative had limited impact. The sectoral committees established to oversee Sectoral development have, however, remained.

With the appointment of a new CEO (Geoff Garrett) the Sector approach has been evolved into a Flagship Program initiative in which key areas from the wide range of national and CSIRO interests have been identified. Unlike the earlier attempts at a matrix structure this initiative has been funded by reallocation of resources from business units. In the natural resources area an early investment has been the “Water for a Healthy Country” (WfHC) Flagship. The key challenges for CSIRO researchers in

meeting the requirements for WfHC are the formation of multi-disciplinary problem focused teams and the recognition that effective external partnerships are required. CSIRO acknowledges that it has neither all the expertise required for holistic problem solving nor the knowledge of problem definition that is inherent in industry or responsible government agencies.

WfHC therefore creates new teams and new partners as well as novel funding mechanisms. It also requires new models for delivering research. CSIRO researchers are in a stage of learning how to deliver in this new world!

### **Emerging science areas: socio-economic integration and complex systems science**

In addition to focusing CSIRO's efforts on major Australian problems there has been recognition that there is a need to invest specifically in new science if the organisation is to evolve. For this reason an emerging science program has been developed. While this is still in its early and evolving stages two areas of particular significance to the discussion integration have been created. These are Complex Systems Science (CSS) and Socio-Economic Integration (SEI). The research that has begun to transpire from both have a significant natural resource management focus and require input from a variety of disciplines, both in the biophysical and socio-economic areas. Projects from both initiatives require integration between social sciences (including economics) and the wider science and policy delivery contexts. Research is currently in its early stages and the organisation of both CSS and SEI is still volatile.

Additional initiatives have included a retrospective review of the lessons to be learned from earlier multidisciplinary research within CSIRO (Kington, 2003) and an ongoing action research based "learning by doing" project sponsored by the SEI program. The SEI and CSS programs each also sponsor a Science Forum program that among other things encourage ongoing debate on both integration and emerging theoretical and methodological issues of relevance to CSIRO. Finally, an ethics forum has been initiated to examine the ethics involved with research in the context of public policy areas and within socio-economic integration itself.

### **Informal team building in response to demand**

With the culture of attempting to achieve a one CSIRO approach to specific problems there is an emerging flexibility between groups to assemble one-off teams to tackle major research programs or consultancies. These are particularly evident in natural resource management areas. Thus, for example, a major research proposal has been negotiated between the community, air monitoring specialists from CSIRO Atmospheric Research, social researchers from CSIRO Land and Water and a variety of government stakeholders. This proposal deals with a chronic controversy relating to outputs from a smelter.

In this case there was considerable investment in designing the question to be addressed from different disciplinary perspectives from inside CSIRO, but also in scientific and engineering inputs from outside. Most importantly there has been an attempt to design the study incorporating local knowledge from the community. The research process

itself has been negotiated with the community to ensure procedural justice. While the fate of this proposal is under consideration it is an example of a number of significant attempts to develop an integrated approach to research within the organisation (CSIRO, 2003). As it has transpired the proposal in its final version has the potential to require input from a number of other units in CSIRO who were not involved with the proposal formulation.

### **Incorporating integration within the research management structure**

Perhaps the most obvious means of integrating social and economic research with biophysical research is to incorporate the expertise of differing disciplines within the same research or business unit. This has tended to be the approach of CSIRO Sustainable Ecosystems, for example in their Rangelands and Savannas and Resource Futures Programs. On the other hand CSIRO Land and Water have tended to assemble their socio-economic scientists within two larger groups the Australian Research Centre for Water in Society (ARCWIS) and the Policy and Economics Research Unit (PERU). Even between these “specialist” groups there are two approaches. ARCWIS prefers to nest itself within a wider Directorate incorporating a variety of disciplines and PERU prefers to stand as an independent unit. Both groups aim to serve wider CSIRO and outside clients.

It is interesting that within two divisions CSIRO has tried three models for integration. There has been no formal evaluation of the strengths and weaknesses of the three models in terms of providing integrated solutions to priority problems for their Divisions or CSIRO. Nor has there been an assessment of the issues involved for the professional development of staff both inside and outside the socio-economic sciences.

## **WHAT DOES CSIRO KNOW ABOUT ITS PAST PERFORMANCE IN THE INTEGRATION AREAS AND CAN IT ASSIST IN THE ABOVE INITIATIVES?**

All these developments reflect an extensive and recent change in the way CSIRO “does business” and are intended to be the foundation for ongoing change. They are though not novel. There have, as indicated above, been attempts to create inter or trans or multidisciplinary work in CSIRO in the past. There were more than seventy substantial initiatives identified by Kington (2003).

A subset of six of these initiatives from across differing Divisions were evaluated in detail as an initial activity of SEI. Five of these could be said to have fitted loosely within the NRM ambit. From this analysis eight major recommendations emerged. The first recommendation related particularly to the development of the SEI program itself. The remaining seven are shown below in Table 1 and are probably equally applicable when integration is being considered in the biophysical sciences.

**Table 1.** Recommendations from the review of Contemporary SEI Best Practice in CSIRO. Kington, 2003

---

**Recommendation 2: Cultural change**

Communication and staff training is likely to be required following the clarification of CSIRO's strategic direction in SEI. The training should include familiarisation with methods of knowledge generation beyond the traditional hypothetical-deductive approach, new approaches to interfacing between technology and people and knowledge of policy evaluation and the role of research in policy formulation.

**Recommendation 3: Project management skills**

Project management skills were vital within most of the integrative SEI research reviewed and a significant investment in training would be required to support an expansion of effort in this field.

**Recommendation 4: Gaining the best from existing SEI groups**

It has been noted that there have been some interdisciplinary groups formed within CSIRO, particularly in CSE and CLW. These are recent initiatives but the experience gained by the groups would be of great assistance in developing this emerging science area. It is recommended that a formal evaluation of the issues relating to promotion of high level SEI performance be conducted in the next three to five years.

**Recommendation 5: Rewarding integration**

Clear reward systems for participation in multi-disciplinary teams and other SEI endeavours need to be developed to encourage participation in SEI research. This may encompass inclusion of specific integration categories in the APA (*Annual Performance Appraisal*) pro forma and promotion cases. Team rewards should also be systematically developed.

**Recommendation 6: Minimising transaction costs**

The transaction costs for socio-economic integration are currently high in all research organisations. It is recommended that a systematic investigation as to how to minimise these costs needs to be conducted. This investigation should include improved coordination of Divisional financial and administrative systems and maintenance, evaluation and succession planning for more established SEI groups. The widespread uptake and commitment to the philosophy underlying "One CSIRO" is of crucial importance in this area.

**Recommendation 7: Addressing the "right" problems**

Recognition of the importance of precise problem definition in SEI projects needs to be supported through planning and budgeting of well organized scoping phases of research projects for at least twelve months. Techniques such as action learning and scenario scoping techniques may assist in this regard.

**Recommendation 8: Succession planning for projects**

In cases in which SEI projects have a change role, (e.g. those involved with community partnerships or organisational change), provision should be made for the hand over of processes or knowledge. This would maximise the project's on-going influence.

---

It can be seen that apart from Recommendation 2 relating to Cultural Change (which is a basic reason why the SEI innovation was instituted in the first place) most recommendations address organisational and implementation problems and issues. It is

understandable that organisational and cultural change will take time but until some progress is made in responding to these recommendations integration theory development may be hampered by implementation deficiencies.

These recommendations are also suggestive that new roles may be required at strategic levels in CSIRO in terms of group management and fostering career development. But this change may also need to flow to project level where project coordination and operations management should become key and rewarded roles within research teams.

But perhaps the major challenge to researchers within CSIRO will be the determination of whether or not the project is addressing the “right” problems and their critical questions (Recommendation 7). This recommendation suggests that action learning may be involved as well as incorporation of local knowledge. This may require a partnership approach in which the researcher provides special skills towards solving the “problem” and is just one of many participants. While this may enhance adoption of outputs this can be confronting to professional scientists who often see the role of “expert” as equivalent to the role of “leader”.

## LETTING “THE RIGHT QUESTION” LEAD THE RESEARCH

There is significant intuitive appeal to developing “the right question” to lead the research. Care should be taken to assure precision in objectives. In the past, particularly in disciplinary research, the “right question” has emerged from existing theory or from peer review from other scientists. But in CSIRO’s new age of problem solving for Australia’s benefit the question will only be seen as “right” if the community or stakeholders are involved in its definition. This is a basic element of procedural justice (Lind and Tyler, 1988).

If one defines the right question purely from the researchers’ viewpoint, even if multi-disciplinary or interdisciplinary approaches are involved, the influence of the resultant research is likely to be limited. This can be attested by the poor uptake of computer based decision making aids despite increasingly wide disciplinary input into them. There are, of course, successful models, but usually these have usually been accompanied by a systematically thought out interaction with stakeholders (e.g. McCown, 2001).

The achievement of the right question therefore must involve “local values”, and ongoing participation of stakeholders and/or the wider community in the research process itself. This will involve some ethical practice issues as recognized by the SEI program. But there are wider and more personally challenging issues.

Viewing the researcher as simply having a specialist, but largely equal, role in problem solving can create acute challenges and threats to self perceptions. These occur even to social researchers who have derived data from a community participative process. Even those involved with community based justice research!

For example, the following two quotes from Nancarrow and Syme (2001) show that despite the authors considering that their justice and fairness research must naturally fill a central role in water allocation decisions this did not occur. Both in terms of influence on decision makers and even choice of method by the community they were cast in supporting rather than starring roles. It transpired that the most sophisticated methods, often forming the bases of internationally published works in the area of social justice research (and recommended by Nancarrow and Syme (2001)), were considered by the community to be inappropriately fancy. At the time this was much to their chagrin.

### **Decision making role**

“we began our research confident that justice and fairness issues were all important for decision makers. We were particularly pleased with our development of existing fairness theory as we felt that the ethic of a “fair go” for all had been a central tenet for Australia’s development almost since federation even though it had been overlooked in recent years.

It came as a shock therefore, that when serving on an expert panel and having created a fairness “solution” it was largely ignored. But more ignominiously a procedure we were asked to design to sequentially adopt the fairness solution was noted but never discussed.”

### **Sophisticated methodology**

“Social and community psychology measurement has increasingly moved on the one hand towards sophisticated techniques such as quantitative latent variable modelling and on the other towards qualitative post-modernist approaches to data analysis. Both have their good points. We found, however, that results of such analyses fed back to farmers—with the researchers’ interpretation can often be inadequate. It is the community’s interpretation of the data that will lead to accepted solutions. Regression weights and in-depth qualitative discourse analyses may often seem to be excessive by the community. All may not understand the jargon, or the analysis—and to present recommendations from these analyses is likely to cause resentment. Certainly, not providing information that is understandable, and more importantly useful for all, is in defiance of the need for procedural or interactive justice (Folger, 1996).”

The major dilemma is that without an agreed question being answered in an acceptable way integrated research will have problems in influencing outcomes. The fact that the research team provides a supporting act for the process though can be uncomfortable. And the question may be asked: “How do we minimise transaction costs and provide the incentives for researchers to persist with the vagaries of wider decision making processes as well as ensuring CSIRO adheres to the other recommendations suggested from the Kington (2003) review?”

There is also the “politically incorrect” view advanced by many a frustrated scientist that in fact too much involvement in environmental or risk issues by stakeholders and the community will lead to game playing among the community for selfish reasons. Science is therefore not improved by involvement. The literature is replete with indignant descriptions of “feral” communities who are generally suspected to be



insincerely outraged or cunningly selfish in a NIMBY (Not in my backyard) sort of a way. I could lead a very comfortable lifestyle if I had accepted every consultancy offered to prove that the above was the case.

So should researchers therefore cut the transaction costs by providing a new form of leadership through starting at the theory end first and influence through brilliance rather than negotiation or persuasion?

## SO WHERE SHOULD THEORY FIT IN?

The above discussion has emphasised “useful” research with an external focus and the reminder that in essence the science may be just one interest in determining the right question. Of course this is an over simplification there are differences among scientists themselves. In fact if faced with an applied problem scientists from differing backgrounds may not agree either on the question or its solution. This reflects both the training and the personal values of the researcher. In this way diverse researchers resemble diverse values and interests in the community. It all depends on the problem and its interpretation through an individual’s training, values and experience.

This may not be of concern if we wish to view disciplinary scientists as similar to lawyers who present their side of the argument when defining the question and on behalf of the people who have funded them. The resolution of the issue can be left to skilled facilitators who lead the discussion towards “compromise”. In Australia for example we have science based advocates of trees as the “preferred” solution for dryland salinity. We also have a coterie of supporters for drains. But to those who pay taxes and therefore expect some leadership (not dictatorship) from scientists this may not be satisfactory. Should an argument be settled with the aid of good science (social or biophysical) or through sophisticated negotiation procedures? Inevitably often we will have to use both.

One way to ensure the procedural quality of natural resource management arguments is through the creation of “procedurally just” processes (Lind and Tyler, 1988) that give all parties “voice” and influence. Nevertheless, even the procedural justice literature demands that participants in negotiation need appropriate levels of information to help them make a decision. Are scientists and social scientists therefore acting ethically in the debate if they do not attempt to look at the emergent outcomes of their own debate before making life more difficult for the average citizen?

Obviously the first place to turn to is to encourage interdisciplinary or transdisciplinary perspectives on the problem so that a more unified “front” can be obtained. Indeed for those problems that are not easily solved by a traditional discipline (e.g. hydrological or social psychological models) the formation of an interdisciplinary viewpoint to contribute to the debate may lead to a more lasting outcome than a temporary truce developed from a well run and fair debate.



The advantages of taking an interdisciplinary approach have been discussed by many authors (e.g. Nissani, 1997). Individual disciplines can get “tired”, become predictable and then an ideas “crisis” can ensue after which progress is difficult. The introduction of an outsider can create fresh perspectives, new energy and lateral thinking. All of these should be available to decision makers and the community. “Outsiders” are less prone to ignore anomalies and to resist new conceptual frameworks” (Nissani, 1997).

This is not to say when developing new truths that outside perceptions and interdisciplinary thought are always superior. Sometimes, for example, generalising by analogy from the perspectives of one discipline may result in tenuous conclusions. For instance the value of borrowing biological theories to explain human organisational behaviour has both its critics and supporters. Nevertheless, it is hard to argue against integrated thinking being unwise, particularly when it comes to understanding the effects of new science and technology on the environment and its populace.

The issue is whether the scientist is using her or his role in the development, defining and answering of questions in a way that can aid the integrated environmental management process. Are there theories relating to integration that can assist scientists in their contribution? If so can we use this theory to go beyond bringing disciplinary perspectives to the table? What does integration theory provide beyond “common sense” or the idiosyncratic creativity of research team members into the wider debate?

One relatively new area of theoretical development that may hold promise is the application of complex systems theory, incorporating organisational theory (Stacey, Griffin and Shaw, 2000), to assist in examining emergent properties that may occur from different styles of management. By systematically examining, discussing and understanding the interactions between biophysical and human factors through such tools as agent based modelling “surprises” from planning (e.g. see Wandersman, 2003) are more likely to be avoided. But perhaps just as importantly processes such as companion modelling can be implemented on a participative basis (e.g. Barreteau, Garin, Dumontier Abrami and Cernesson, 2003) as can other complex system approaches such as social simulation or network theory (e.g. Moss, Pohl-Wostl and Downing, 2001).

The discussion fed by the interdisciplinary agent based modelling team and incorporating local knowledge about the nature of emergent properties and the assumptions and theory behind the modelling itself will provide the opportunity for science based community to lead some aspects of the debate not ordinarily amenable to traditional participative methods. If this is the case the theory and practice of new modes of complex systems analysis that concentrate on the interaction between parts, agents or nodes of the biophysical system and within human processes such as the functioning of institutions can significantly enhance the role of scientists in natural resource management.

Perhaps complex systems approaches are not the only or even the best way of assisting integrative solutions. But the potential shown by these techniques provides a demonstration of how scientists can assist in novel ways in integrated planning systems. The fact that there is a quickly developing literature relating to participative agent based

modelling complete with emerging theories of stakeholder engagement (with the potential for integration with similar theory from a variety of social science disciplines) gives some promise that this may be something that can assist in real life planning.

The important thing is not the assumption that integrated science is “better” than disciplinary approaches. The key issue is can we develop integration orientated theories that enhance the contribution of scientists to holistic and effective answering of the right question. In simple language our question should be: “How can integration theories place scientists in rewarding roles that will avoid “stuff ups” in planning for the environment?”

## CAN WE MEET THE CHALLENGE?

This brief paper has two parts: a discussion of the organisational challenges involved in integration and a short discussion of the role of scientists in natural resource management problem solving and whether that can be enhanced by the development of “integration” theory.

The first part of the paper shows I believe a genuine and concerted attempt by CSIRO to develop integrated research or a “one CSIRO” approach to problem solving. Our Chief Executive continually exhorts us to “partner or perish”. However, the Kington (2003) review of SEI and the early development of other programs within the organisation shows that there are many organisational, administrative and incentive issues that will need to be addressed. These will need to be canvassed systematically if we are to achieve an organisation with 7000 staff members all able to mix and match with differing disciplines and for differing problems.

Perhaps the biggest issue facing us is a cultural change in engaging others, including the general community in assisting us with designing and answering the “right” questions. This challenge will take some time and effort if it is to succeed. There is no point in having pockets of outwardly focused, participative groups in the organisation and others that shun non scientists and just want to get on with their research regardless of the effects on the wider community. Inconsistencies of this kind are readily spotted by the community and stakeholders and will lead to tension if not addressed. Really, how many integrators do we need in CSIRO and how many with a disciplinary focus (not all problems will have ‘integrated’ solutions)? Most importantly, how will integrators and non integrators get along within a “one CSIRO” system?

It is clear to me that the organisational issues are the vital ones to be solved if we are to achieve and develop theory in this area, particularly theory that will actually help someone eventually. This will take organisational cohesiveness and ongoing evaluation to assist in improving performance. Such an observation is not new or surprising. Bruce, Lyall, Joyce and Williams (2004) have identified the importance of getting the organisational issues right if interdisciplinary research is to succeed in Europe. Finding the determination to succeed across CSIRO will be a novel outcome in itself. The evolution of initiatives such as the Emerging Science program and the Flagship Programs will be followed with interest by those outside the organisation.

Having placed an emphasis on organisational issue though there is much to be gained by the development of theory such as that in the complex systems area. If done in a participative fashion this may result in scientists finding new partnerships with the wider community but also a more satisfying leadership role in problem solving.

## REFERENCES

- Achapelle, L; McCool, S.F. and Patterson, M.E. (2003). Barriers to effective natural resources planning in a “messy” world. *Society and Natural Resources*, 16, 473–490.
- Barreteau, O., Garin, P., Dumontier, A., Abrami, G. and Cernesson, F. (2003). Agent based facilitation of water allocation: Case study in the Drome River valley. *Group Decision and Negotiation*, 12, 441–461.
- Bruce, A., Lyall, C., Tait, J. and Williams R. (2004). Interdisciplinary integration in Europe: the case of the Fifth Framework programme. *Futures*, 36, 457–470.
- CSIRO (2003). The Wagerup Air Quality Study: A Research Proposal.
- Folger, R. (1996). Distributive and procedural justice: Multifaceted meanings and interrelations. *Social Justice Research*, 9, 395–416.
- Gilmore, W.S. and Camillus, J.C. (1996). Do your planning processes meet the reality test? *Long Range Planning*, 29, 869–879.
- Kington, E.A. (2003). Social and Economic Integration: A review of contemporary SEI Practice in CSIRO. CSIRO, SEI.
- Lind, E.A. and Tyler, T.R. (1988). *The Social Psychology of Procedural Justice*. New York, Plenum.
- McCown, R.L. (2001). Learning to bridge the gap between scientific decision support and the practice of farming: Evolution in the paradigms of model based research and intervention from design to dialogue. *Australian Journal of Agricultural Research*, 52, 27–34.
- Moss, S., Pahl-Wostl, C. and Downing, T. (2001). Agent based integrated modelling: the example of climate change. *Integrated Assessment*, 2, 17–20.
- Nancarrow, B.E. and Syme, G.J. (2001). Challenges in implementing justice research in the allocation of natural resources. *Social Justice Research*, 14, 441–452.
- Nissani, M. (1997). Ten cheers for interdisciplinarity: The case for interdisciplinary knowledge and research. *The Social Science Journal*, 34, 201–216.
- Stacey, R.D., Griffin, D. and Shaw, P. (2000). *Complexity and Management: Fad or Radical Challenge to Systems Theory?* London, Routledge.
- Wandersman, A. (2003). Community science: Bridging the gap between science and practice with community centred models. *American Journal of Community Psychology*, 31, 227–242.