Conceptual Issues in the Evaluation of Formal Research Networks

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Abstract

The literature on the evaluation of the benefits of public research continues to expand rapidly. However, although governments in OECD countries are turning more and more towards creating formal networks to organise research, their is little in the way of analysis of how such networks might be evaluated in terms of their policy objectives. This paper seeks to both define the concept of formal research networks and map the conceptual issues in evaluating them.

1. Introduction

Across a range of OECD countries there has been an explosion in the development of networks as a mechanism to organize funded research in general and support research that addresses specific public policy objectives in particular. Such 'knowledge' networks cover a spectrum of activities from pre-research capability development, to structured research networks. As Rogers et al. (2001) note:

> *"....the basic assumption of network approaches for any set of social phenomena is that the whole is more than the sum of the parts. In other words ..., the nature of the links between actors takes priority over their individual characteristics."*

While there has been much discussion around the importance of networks in innovation and knowledge development, the evaluation of networks remains little explored. Most evaluation of publicly funded R&D is conducted to assess the performance of individuals and/or specific institutions and, therefore, does not provide guidance on the value of networked R&D activities. Even in the case of evaluation of larger entities — such as research centres or programs — they are treated as 'super-individuals', the sum total of their members, for evaluation purposes. This tradition does not help in the specification of relevant boundaries for network analysis of R&D systems that may lead to evaluation based on their structural properties (Rogers et al. 2001).

What research has been done within the field of science and technology, for example by Bozeman (for example 2002) others has been done on informal networks. In this paper we make an important distinction between informal[1] and formal networks. The former consist of the colleagues and research assistants involved in almost all projects and papers (including where some research time is paid). Most often projects that involve some level of collaboration could typically be thought of as, being an informal network. On the other hand, formal networks can be understood as the organisations established by governments to encourage research in nascent fields or gaining critical mass where researchers are spread across a large geographical area.

2. Research Networks as Infrastructure

Research networks are part of the system of innovation at the level of geography in which they operate. Thus a nation-wide research network is part of the national system of innovation, while a local research network is both a part of the local system of innovation and the mosaic of policies and structures which forms the national innovation system. But what ever level they operate at, they are part of the infrastructure of that system of innovation, just as research councils, research organisations and key laboratories can be understood as

[1] It might be useful at a latter date to distinguish between social networks and semi-formal networks (which Bozeman *et.al.* might describe as the knowledge value collective).

infrastructure that supports innovation. Thus research networks need to be analyzed within their respective system of innovation and tested as to the contribution they, as infrastructure make to that system of innovation

Examples of formal research networks include:

- Networks of Centres of Excellence (Canada);
- Major Collaborative Research Initiative (Canada)
- Cooperative Research Centres (Australia);
- Research Networks (Australia); and
- European Framework programmes (European Union).

In this paper we aim to both map the complexities of evaluating formal knowledge networks and to suggest a path for future research to pursue. We can define our interest in 'formal' networks as follows.

Table 1: Definition of formal networks

Definition types	Definitions
Necessary Condition 1	The network is funded by a granting council.
Necessary Condition 2	The network is required to establish a formal administrative structure.
Probable condition 1	The network is established, in part, to meet a policy objective (such as encourage linkages between researchers and user communities).
Probable condition 2	A policy objective will be to encourage communication across a geographically spread population (provincially, nationally, and more unusually internationally).
Probable condition 3	The network will be formally evaluated at some point.

Table 2: Definition of 'knowledge' in our classification of networks

Definition types	Definitions
Necessary Condition 1	The network will be established to generate or diffuse new knowledge
Probable condition 1	An element of the network's mandate will be to train, encourage or mentor new researchers.

We first explore the background to program evaluation and from there explore the evaluation of publically funded research based organisations. We specifically address how the methodologies are applicable across various organizational functions and scales. Following this we explore how 'networks' are a different form of organisation (design) typically with a different public policy function. This may suggest why conventional evaluation approach are not necessarily appropriate and do not consider the structural (i.e. the network) properties of formal knowledge networks. Lastly, we develop our suggestions for further work based on a

conceptualization of the relations between formal networks and their system of innovation, whether local or national.

3. Concepts and Methods in Evaluation

It is clear that a distinction must be made between policy reviews and program evaluations. The former represents what might best be described as policy strategy analysis; in big picture terms what has worked and what has not worked. Such analyses often encompass elements of program evaluation with future policy development suggestions. An example might be the Canadian Innovation Strategy[2]. These reviews address the strategic question for a given situation, namely; what is the right organisational structure for this issue, or even is this the right issue to address? In such analyses there is a requirement to have a considerable amount of information to identify a particular gap in a system and thus to initiate something new or given enough time to evaluate the history of the organisations.

The latter category (program evaluation) can be defined as the ongoing regular review of programs or organisations (themselves a higher order of program). Program evaluation has been the subject of considerable and growing academic interest. In the literature on evaluation there are a large number of taxonomies of types of evaluation, even if the theoretical development of evaluation frameworks has lagged behind (see Demarteau 2002). One relatively simple and intuitive approach for the current context is suggested by Hansen (2005: 448). He suggests that there are two 'traditions' in evaluation. The first is organizational effectiveness, and the second is program evaluation. Hansen suggests that three meta issues need to be addressed in designing evaluations (2005: 451). They are:

- evaluation design should logically be based on the purpose of carrying out an evaluation;
- evaluation needs to based in the characteristics of the evaluand (evaluated organisation); and
- characteristics of the problem that the programme or organization under evaluation aims to resolve need to be incorporated.

Such questions of evaluation purpose and design can be understood through various lenses on evaluation methodologies. These can be seen in Hansen's descriptions (Table 3). This perspective also helps us understand the different approaches employed in the study of science and technology oriented organizations presented later in this paper (see section 3.3).

Table 3: Classification of evaluation models and foci

Taxonomy	Evaluation Models	Questions	Criteria for Evaluation
Result models	a) Goal-attainment model b) Effects model	a) To what degree has the goal(s) been realized? b) Which effects can be uncovered?	a) Derived from goal(s) b) Open, all consequences should be uncovered
Explanatory process model		Is the level of activity satisfactory? Are there implementation problems?	Performance is analysed from idea to decision and implementation and to the reaction of the addressees
System model		How has performance functioned as a whole?	Realized input, process, structure and outcome assessed either in relation to objectives in same

[2] http://innovation.gc.ca/gol/innovation/site.nsf/en/in04135.html

			dimensions or comparatively
Economic model			
	a) Cost-efficiency	a) Is productivity satisfactory?	a) Output measured in relation to expenses
	b) Cost-effectiveness	b) Is effectiveness satisfactory?	b) Effect measured in relation to expenses
	c) Cost-benefit	c) Is utility satisfactory?	c) Utility measured in relation to expenses
Actor model			
	a) Client-oriented model	a) Are clients satisfied?	a) Formulated by clients
	b) Stakeholder model	b) Are stakeholders satisfied?	b) Formulated by stakeholders
	c) Peer review model	c) Is professional quality in order?	c) Formulated by peers
Programme theory model (theory-based evaluation)			
		What works for whom in which context? Is it possible to ascertain errors in programme theory?	Programme theory is reconstructed and assessed via empirical analysis

Source: Hansen (2005: 449)

For the purposes of the current paper and the development of a theory of evaluating formal networks, we propose the following framework as a starting point for these criteria.

- As a general rule it appears that most evaluations of public research monies have the dual goals of effectiveness and efficiency within the limited scope of a regular cycle (3-5 years) of assessment of performance;
- As already indicated we are interested in formal science and innovation system related (knowledge generation and capability) networks (typically established by governments); and
- `the policy problem` will differ case by case but our starting assumption is that many networks are established expressly to operate as a bridging organisation between various communities of interest (academia, industry etc).

As we develop this paper each of these themes will be picked up again and further developed.

4. Research System Evaluations

The first point to note is that we are discussing formal networks within the sphere of science, technology and research and development policies. It is therefore important to analyse the tradition of evaluation within this specific context.

4.1 Benefits of R&D expenditure

There is a long tradition of attempts at understanding the benefits of R&D and what could loosely be described as the economics of science[3]. Broadly within this category of work it is possible to distinguish between three blurry and overlapping areas of research foci which have emerged over the last thirty years or so. The first can summarized as studies that are interested in the economics of R&D and in particular assessing it through various metrics such as patenting, bibliometrics and return on investments in the private sector (see Pavitt 1991, Dasgupta and David 1994, Stephan 1996 and Audretsch et al. 2002). A second tradition has been built up around the practical problems of assessing particular government programs (for examples see section 3.3 below). Often performed by consultancy businesses as well as

[3] The term 'economics' is used here advisedly. Although much of the work has indeed been on the benefits to economy or specific firms arising from this public research, see for example the Department of Trade and Industry (2005) this has perhaps become too strong an emphasis (Corbyn 2008).

academics, although this literature draws upon published research in peer reviewed journals it also has also been more 'innovative' in the search for methods and data that reveal the value of particular programs and organisations.

The third stream of work appears as an attempt to bridge the formalized analysis of the literature and the needs of policy makers in assessing where to continue or discontinue funding. Papers in this latter stream have attempted to re-formulate the objectives of program evaluation by clarifying the types of benefits that can be expected from expenditure on R&D, particularly by the public sector. For example, Salter and Martin (2001) have argued that there are several types of impact of public research which can be can be summarised as:

- increasing the stock of useful knowledge;
- training skilled graduates;
- creating new scientific instrumentation and methodologies;
- forming networks and stimulating social interaction;
- increasing the capacity for scientific and technological problem-solving; and
- creating new firms.

Salter and Martin on the issue of networks state: 'Networks have been the focus of much empirical research.' (2001: 523) but there is little to help us in the quest outlined in this paper as Salter and Martin go on to say: ' This work indicates that firms and industries link with the publicly funded science base in many different ways and these links are often informal.' (p523). The focus it seems of much of the research to date, then, has been on the necessity of the private and public sectors to network / collaborate in problems solving and technological communities to foster the development of new products and services etc.

Although important in terms of science policy development, it appears that the evaluation of (formal) network performance has not been focussed upon.

4.2 Challenges in evaluation

To this point we have discussed a number of significant issues along one dimension of evaluation (type and purpose). A second dimension is the calculations embedded in the evaluation (the practical challenges).

Some of the key challenges of evaluation can be summarised as:

- Attribution — is it possible to ascribe a particular output, outcome or impact to a particular research project or programme? Such benefits may (probably are) derived from the accumulated experience derived from multiple projects while a given project may have an impact on, or contribute to multiple outputs;
- Appropriation — the danger of finding the benefits being looked for and acquiring (i.e. typically misappropriating) good news as indicators of program effectiveness whereas the change could be due to other projects, groups or wider economic or political change;
- Timing — research impacts often become clear long after the evaluation process is complete;
- Inequality — a small number of research projects may account for most of the measurable effects (but it is not possible to judge the value of the majority of projects in the terms of the process of knowledge accumulation);
- The "project fallacy" — it is often assumed, hoped or demanded (ie. policy makers often expect) that everything will have an identifiable benefit, which can then be attributed equitably and in a timely fashion.

Fahrenkrog et al. (2002) make the following observations on these challenges.

> Different evaluators are firmly embedded within their own paradigms. The models that they adhere to, shape what are defined as impacts. Unless experts stop misleading policy makers by claiming the superiority of their models, they will continue to cancel each other out and undermine each other.
>
> Attribution problems are manifest in RTD [research and technological development] impact evaluations. We cannot on the basis of beneficiary self-reports know whether employment, environmental, health and other socioeconomic outcomes would not have happened anyhow. There is probably no adequate theory to offer explanations except in piecemeal parts of programmes.
>
> Changes in socio-economic outcomes are complex and cannot be simply understood in terms of programme effects. Contextual, comparative and sectoral studies are also needed.
>
> Time-scales of impact are often not consistent with the expectations and needs of policy makers for evaluation. Data needs to be collected and analyses undertaken over the long term.
>
> Choices of methods follow from the identification of evaluation questions and of the kinds of impacts judged important.
>
> We do not have sufficiently developed models that explain the relationship between RTD, other socio-economic processes and mediating factors and socio-economic impacts such as competitivity, innovation, public health and quality of life.

The issues raised here can be clearly seen in the 'fixes' that have developed so far as demonstrated in the analysis of evaluations by organisational scale and function.

4.3 The significance of organisational structures and scales

While it is acknowledged within the S&T indicators field (see e.g. Geisler 2000) that the organisational size and structure matters for evaluation, little has been done to construct an overarching framework of which indicators are useful in which circumstances. As a first step in this direction, Table 2 is provided as a map of how particular research organisations have been evaluated.

Organisational structure and size matters as the smaller and more diffuse the organisation; the more traditional metrics become more problematic and loose relevance. As Glaser et al. (2004) point out there are 'least evaluable units' (LEU) where publication measures of scientific output and impact become problematic. Their analysis of the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO), a rough equivalent to Canada's National Research Council or France's CNRS, discovered that these LEUs may be interpreted as surprising large.

The following table (Table 4) lays out a range of different organisational structures and scales with examples of the evaluation indicators and approaches being used. Research networks are not included in this section but a similar representation is produced in section 5.3 (below).

The analysis reveals both a general trust in 'metrics' for evaluation as well as a number of organisations are developing their evaluation systems in a style that is not dependent on metrics. Political changes, also evidently play a part in evaluation structures (Australia) as does the occasional push back from researchers on perceived inappropriate frameworks (UK).

Table 4: Evaluation schemes used by organizations with different structures and scales

	Function				
Scale	Research Centre	Mixed teaching / research	Infrastructure	Matrix Research Organisations (labs & networks)	Granting Councils
Nano (Individual project)	Case stories	Case stories	Case stories	Case stories	Case stories
Micro[4] Institution		University department Aust Res Quality Framework Metrics & peer review[5] UK Research Assessment Exercise (RAE) - increasingly driven by metrics[6, 7]	CFI projects		
Meso I Large programs			Specific NRC lab or Department		
Meso II (Provincial or national organisations)					British Columbia Michael Smith Foundation for Health Research (MSFHR) Alberta Heritage Fund for Health Research (AHFHR) – Peer review assessment[8]
Macro (National)			Synchrotron Nuclear	NRC CSIRO[9] (Aust)	Canada – CFI [10] (infrastructure)

[4] See Bordons et al. 1995.

[5] See http://www.dest.gov.au/sectors/research_sector/policies_issues_reviews/key_issues/research_quality_framework/ Following the election of a new government in Australia in late 2007 the RQF has been abandoned.

[6] See Barker 2007.

[7] Following the 2008 round of reviews, the Higher Education Funding Council for England (HEFCE) has proposed moving from the research assessment exercise to the research excellence framework. This has been attacked by the Research Councils of the UK 'The proposals from HEFCE for a new Research Excellence Framework to replace the Research Assessment Exercise are not acceptable to RCUK in their current form' RCUK (2008).

[8] See International Board of Review (2004).

	Function				
Scale	Research Centre	Mixed teaching / research	Infrastructure	Matrix Research Organisations (labs & networks)	Granting Councils
			research facilities etc	- Options value framework CNRS (Centre National Recherche Scientifique (France)	SSHRC – indicators are being developed CIHR[11] - (Canada) Few metrics NHMRC[12] (Aust) *Metrics:* R&D exp Benchmarking Bibliometrics Cases Patents and licences RCUK – Economic Impact Framework[13] NZ HRC[14] US NIH[15] Peer review within the structure of GAO

5. Networks: Function and Form

5.1. The Policy Agenda behind Establishing Networks

Knowledge and especially new knowledge is now typically understood as an important input into societies to enhance their capacity for economic growth and social development. Because of this governments seek to promote the generation of knowledge and its application to the economy. As part of their mission to increase economic well-being, social well-being, national security and administrative efficiency, governments use a variety of policy options to implement their national vision. To achieve these goals, they have since the 1950s increasingly funded a wide range of science related organisations. Organisations with specific functions such as universities, technical colleges, national research funding councils, national

[9] ACIL Tasman 2006.
[10] See Hickling Arthurs and Low 2002.
[11] http://www.cihr-irsc.gc.ca/e/30324.html and Bernstein et al. 2006.
[12] See Garrat-Jones et al (2004a), Turpin et al. (2003) and Butler and Biglia (2001).
[13] See Office of Science and Innovation (2007) and Department of Innovation, University and Skills (2007) . It has been reported recently that the RCUKs have decided to reject the use of economic impact framework as too problematic (see Corbyn 2008).
[14] See Garrett-Jones et al. 2004b used a combination of analysis of financial data, metrics and interviews of stakeholders in a strategic assessment.
[15] U.S. Department of Health and Human Services (2007).

research organisations (Australia, Canada and France in particular) have been funded as well various organisational forms (labs, centres and networks).

The formally organized knowledge networks in contrast to the self-organising informal networks are typically established to meet a range of policy goals. Some of those goals include: encouraging the connection of researchers and users (and other stakeholders) and building multidisciplinary research agendas. Although formal networks can be funded for these purposes in any jurisdiction, they are necessary in geographically large jurisdictions particularly where there are widely distributed (relatively small) populations. In this light it is interesting to note that it would appear that research and policy networks are a Canadian invention. The National Centres of Excellence program was established in 1988. Other nations (such as Australia) may have looked at Canadian networks to see how they can be adapted to their situations (Salazar and Holbrook 2007). It seems entirely possible that the Australian Cooperative Research Centres program was influenced by the development of the Canadian NCEs (compare Networks of Centres of Excellence of Canada 2004 and Slatyer 1994).

In Australia networks meet the needs of a small population spread mostly along the east coast, while in Canada, networks address the needs of a population linearly spread across the northern US border, and meet the political needs within which most researchers operate (Salazar and Holbrook, 2007). It is interesting that networks do not seem to work as well in two-dimensional states such as the US or the EU. Lastly, as Salter and Martin (2001) have argued, network formation is a core outcome of publicly funded research.

By way of examples, knowledge network programmes that have been formally established in a number of jurisdictions include:

- Networks of Centres of Excellence (Canada);
- Major Collaborative Research Initiative (Canada – Social Sciences and Humanities Research Council)[16];
- British Columbia Health of Population Networks (Canada);
- Cooperative Research Centres (Australia);
- Research Networks (Australian Research Council);
- European Framework programmes (European Union); and
- The Economic and Social Research Council Priority Networks (UK).

The stated objectives of a few of these examples are provided at Appendix 1.

Networks that use and develop the knowledge of their members can be roughly divided into two types: knowledge networks, which carry out collaborative research and information exchange and propagation, and policy networks which consist of communities of policy researchers who carry out research for "evidence-based policy", or advocacy and issue-based activity networks (Nutley, et al., 2007). It must be noted that research is common to both.

Networks have there own advantages and disadvantages compared to traditional models of building institutional capability in organizations and centers, which in themselves have not been explored in depth.

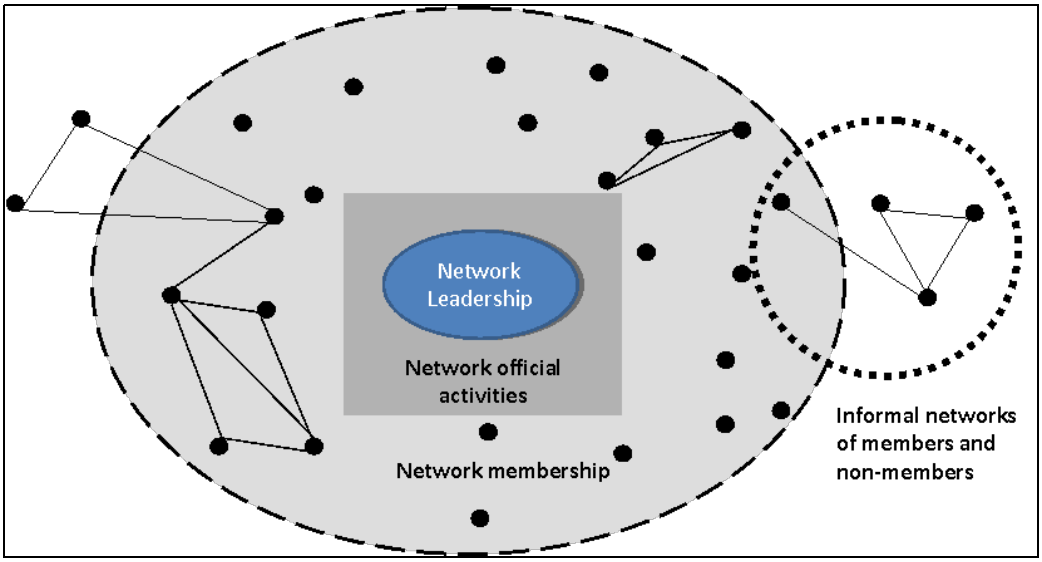
5.2 Network design and functioning

There are two particular features that separate formal from informal networks. The first is that the network is often established with the purpose of improving the embeddness of players and

[16] See for example: Holbrook, J.A.D. and Wolfe, D.A. (2005) "The Innovation Systems Research Network (ISRN): A Canadian Experiment in Knowledge Management*"*, *Science and Public Policy*, Vol. 32, #2

of increasing the numbers of players. The second is that the networks are established with an explicit management structure. Taking this second issue, we can build a model of the formal knowledge network organisation; although at the edges they have loosely defined and porous borders.

Figure 1: The structure of networks



5.3 Network structures and scales

Again we examine the extant literature with a view to how such networks are assessed on their network characteristics, sub-dividing it on the basis of function and scale.

Table 5: Network Form and Function

	Action Networks	Knowledge Value Collectives	Formal 'Project' Networks	Formal networks of centres (networks)	Network Programs
Nano – Projects within networks				Case stories	
Micro					
Meso				Canada – National Centers of Excellence. Individual NCE mid term reviews Canada – MCRI – Mid term reviews	Aust Research Networks No framework yet[17] British Columbia - Health of Population networks
Macro					Canada – National Centers of Excellence. – Evaluations in 1997 & 2002, mixed quantitative &

[17] http://www.arc.gov.au/ncgp/networks/networks_default.htm

					qualitative information[18] Aust - Cooperative Research Centres[19]. – Qualitative & quantitative Analysis CIHR Institutes 'System' satisfaction Peer review
Undifferentiated by size			Particular EU Framework based networks.		EU Framework progamme
General observations					

5.4 Managing and evaluating networks

This framework reveals that there are three main areas of analysis that have been carried out (action networks, knowledge value collectives and EU framework programme networks). Each of these will be briefly summarised below.

Action networks

Creech (2001, & Ramji 2004, etc.,) has been developing a body of work analysing the networks associated with the International Institute for Sustainable Development (IISD). She calls these networks 'knowledge networks' because their goals are to create knowledge to effect particular changes in lifestyle or policy.

> *There is a fundamental gap in the current practice of networking. At present, most organizations are experimenting with models of collaboration for the sharing of information and expertise. ... Many researchers are beginning to investigate the value of these models as a means of changing public and private sector actions to be more supportive of sustainable development. But we continue to see organizations struggle with the problem of working together to increase their collective effectiveness, not just to achieve their immediate research objectives but to fulfill their vision of having real influence on decision-making for sustainable development (2001: 1).*

For the purposes of this paper and to contrast such networks with networks based in the science communities we think these networks are better thought of as action networks as they are established to achieve particular changes not to generate knowledge in a particular field. Her work has many useful insights into network management and from that position, perspectives on network evaluation. We discuss these in further detail below (section 6.2).

Knowledge Value Collectives

Bozeman conceptualises the 'value' of knowledge as being embedded within groups of users and producers of that knowledge – an entity that he calls 'knowledge value collectives'.

[18] Eg. http://www.nce.gc.ca/pubs/reports/2021/eval/eval-a_e.htm
[19] See Insight Economics 2006.

'knowledge value is not transitive among users. In our theory, the value of scientific knowledge is socially embedded in a collective of producers and users (many of whom play both roles). Scientific knowledge is developed through the transformation of extant knowledge into diverse new uses, uses that may have little or nothing in common with previous applications of knowledge' (Bozeman and Rogers 2002: 770)..

The significance of this model of scientific activity is that it puts at the centre of the endeavour, networks of individuals who generate new knowledge, use knowledge and generate again.

European Union Framework Programme Networks

The European Framework programmes have consistently required successful project teams be networks that span the geographic dimensions of the EU. There has been considerable analysis of the Programmes (see Arnold 2005 for a summary. However, although networking is apparently a key policy dimension, there has seemingly been little analysis of the effectiveness of the networking of the networks. Arnold comments:

'A factor promoting stability among a core of frequent participators is the fact that (like other network R&D programmes) the FP does not generate wholly new R&D networks, but causes network extension. Evaluations of network R&D tend to find that R&D networks evolve over time, rather than being newly constructed for each funding opportunity' 2005: 14).

Re-conceptualising the Evaluation of Formal Knowledge Networks

Given, as we have already emphasised (formal) networks are organisationally unclear there has been little attention paid to constructing appropriate evaluation frameworks. Rogers et al. make the following observation.

"Most evaluation of R&D is conducted to assess the performance of individuals and, therefore, does not provide guidance on the value of structural properties of R&D activities. Even in the case of evaluation of larger entities — such as centers or programs — they are treated as 'super-individuals' or the sum total of their members for evaluation purposes. This tradition does not help in the specification of relevant boundaries for network analysis of R&D systems that may lead to evaluation based on structural properties" (2001: 167).

In searching through eight years of the journals Research Evaluation, and Evaluation, there is little evidence for suggesting that this comment by Rogers et al. has become invalid[20]. The emphasis and focus of Mote et al. would suggest this to be a correct impression.

As we understand the literature we can identify three spheres of evaluation analysis. First, logic models of inputs and outputs (often the behind the scenes framework of many current research evaluations). Second, governance evaluations, which although not typically undertaken within research systems are common in organisational performance evaluation and should enhance network evaluation. Third we propose structural network evaluations, i.e., evaluating the networking of networks).

6.1 Logic modelling

Unfortunately, a typical first approximation of evaluation structure, logic models, the 'plausible and sensible model of how the program will work under certain conditions to solve identified problems' (McLaughlin and Jordan 1999: 66) can be quite misleading in science, technology and innovation oriented exercises.

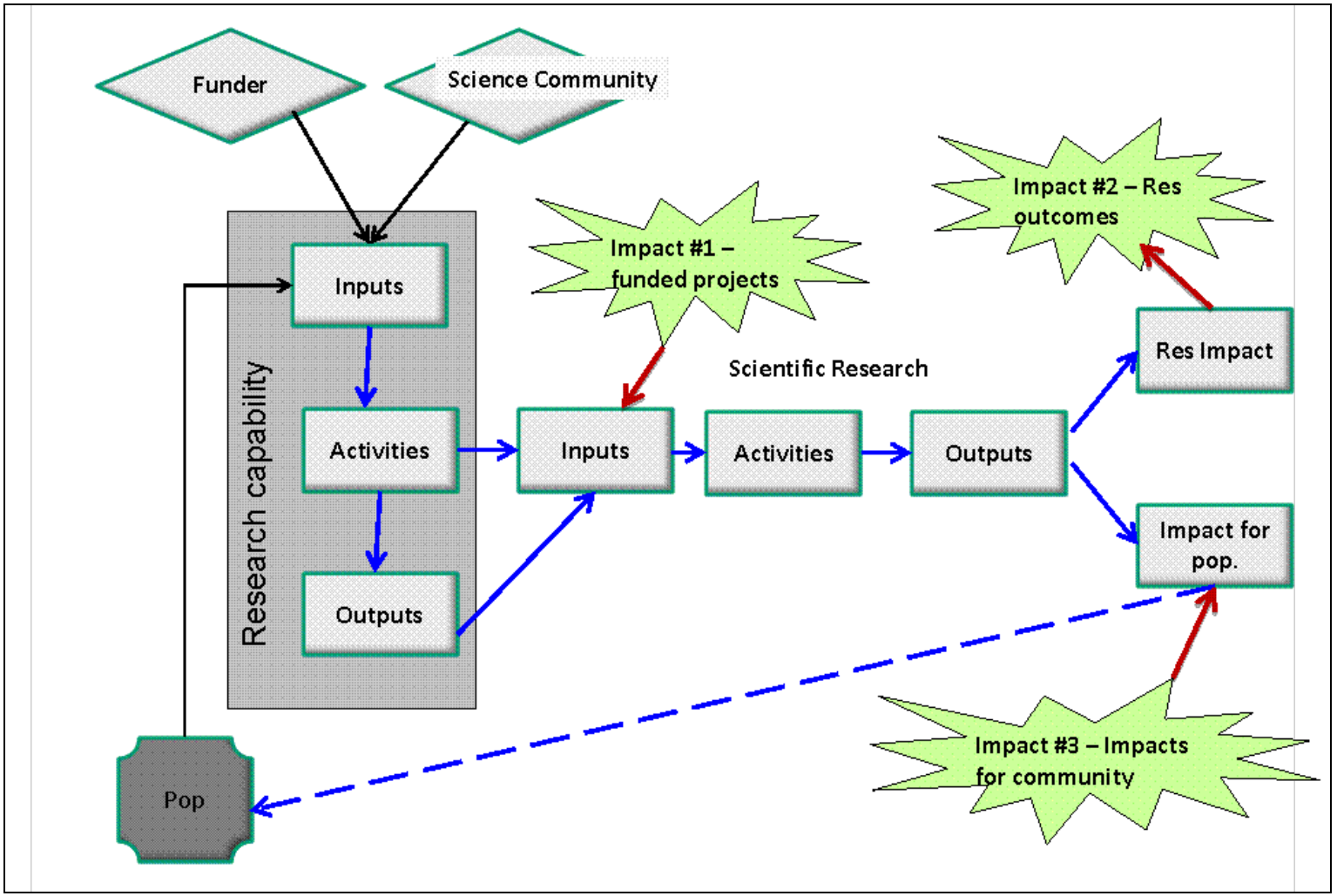
[20] This is not to suggest that there are not bibliometric studies of the network of scholars working in the same fields, so called invisible colleges Crane (1972) and many since then.

The logic model has been around since at least the early 1970s and the benefits of using the logic model tool (according to McLaughlin and Jordan 1999: 66) include:

- building a common understanding of the program and expectations for resources, activities and outputs;
- helping for program design or improvement,
- communicating the place of a program in the organization or problem hierarchy, particularly if there are shared logic charts at various management levels; and
- pointing to a balanced set of key performance measurement points and evaluation issues thus improves data collection and usefulness.

Thus the logic model for a network that is expected to increase research capacity in a particular scientific field in a particular jurisdiction – a not uncommon occurrence, the logic model might look something like this.

Figure 2: Logic modelling of a research capacity building network



For networks which target research capability development there are three points at which networks can be assessed. The first is if they influence the development of teams that are eventually successful in getting research funded. Other impacts such as research outcomes are common to networks for research capability (HoPNs) and research networks. However, there are number of criticisms of logic modelling in the context of research systems. First, the mentally of input-output generates a linear perspective which is not able to encompass all the possible outcomes and impacts and places an undue expectation on the evaluator for producing metrics (publications, patents and licences etc).that research outcomes

Second, it encourages a view that projects or research programmes produce a discrete stream of work that is separate from other projects and is neither cumulative (building on the last project) nor cross fertilising (projects in parallel streams can be co-evolutionary).

6.2 Governance evaluation

Earlier we noted that Creech and Ramji, (2004) has suggested that evaluation of network governance is one approach to the topic at hand. She suggests that evaluation around the following themes.

- Effectiveness: changes in knowledge base, communication practices, relationships; strategic plan
- Structure and governance: network formation, relationships, governance
- Efficiency: interaction among members, institutional support, systems and procedures
- Resources and sustainability: human and financial resources, timelines, sustainability
- Lifecycle: life-cycle analysis

We believe that although this a good starting point these are not the best categories for program evaluation of formal research networks as we have defined them here. For example ‘efficiency’ isn’t necessarily an appropriate way of thinking about network operations and her description of network life cycles is more of a discussion of management issues than evaluation themes. Nonetheless, evaluation of governance should be incorporated into network analysis. We suggest the following themes provide a framework for moving forwards.

- Resources: As the logic model reveals and Creech and Ramji (20004) shows, network resources are important.
- Structure & governance: Structure and governance differ between networks ands these need to be incorporated into individual assessments.
- Progress markers: The Creech and Ramji (2004) category of ‘efficiency’ is a problematic category to measure when your outputs are not precise. We would prefer the language of progress markers to highlight the measurement of outputs across time and systems components.
- Impacts: Effectiveness roughly translates in to the language of ‘impacts’ within the evaluation and specifically the research evaluation literature.
- Sustainability: Life cycle analysis needs to be combined with sustainability – should an organization continue, does it need to be transformed into a different entity or funding discontinued

This is only a first step as it only analyses networks on the basis of existing mindsets, it still doesn’t approach the topic of assessing the value added of funding ‘networks’.

6.3 Networks as Networks: A Conceptual Model of Evaluation

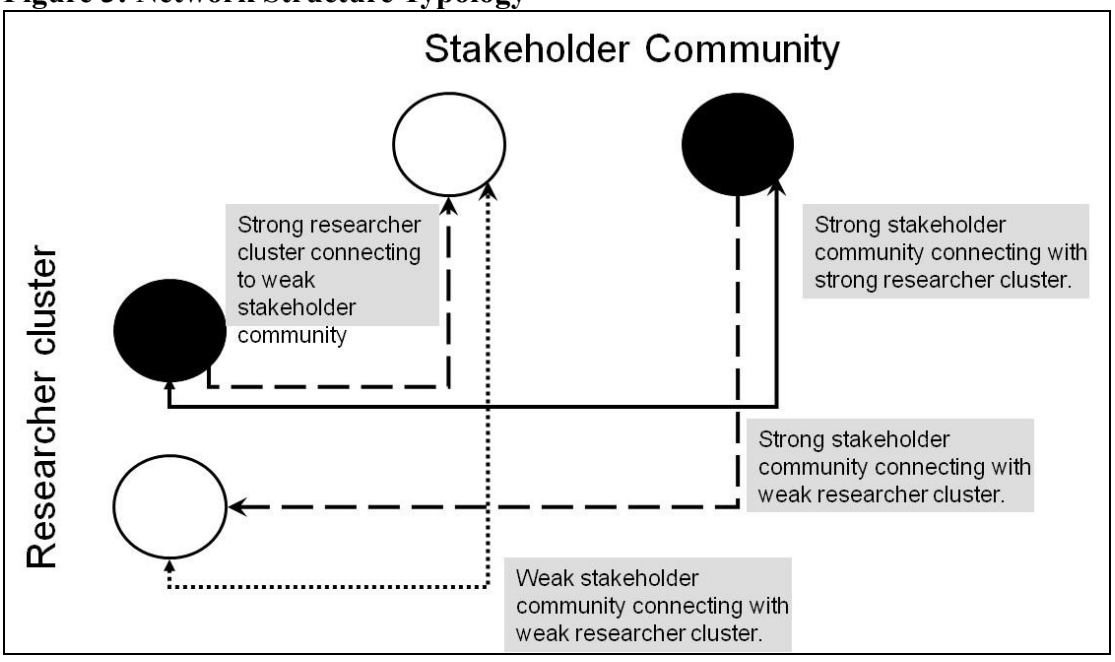
Although evaluations of the EU Framework Programme Networks (as observed earlier) highlighted that the networks were largely unsuccessful in their attempts at increasing the size of the core research pool, this objective lies at the heart of much of the policy behind networks. Thus, if formal networks are reliant on informal networks as Arnold implies[21] (2005: 34), then it is crucial to have an evaluation tool which takes account of the extension of networks.

As a starting point we make the observation that it is interesting to note that studies of industrial innovation have for a long time recognised that the formation of relationships between users of innovations and those with the capability to produce them is a necessary condition for progress (see e.g. Von Hippel 1988). It seems that there are important knowledge flows between those who benefit from change and those who can design the changes. The authors are unaware of related studies conducted innovations occurring in social or health system innovation but the extension appears logical.

Further, as noted already, the policy objectives of formal networks are that they build linkages within and between communities. We can therefore build a first approximation of a taxonomy (see Figure 3) of network connectedness. In this taxonomy we are interested in whether the starting formal network has a specialisation either as a research or as an industry / community set of relationships. We are then interested in how well such initiating networks taken as a whole (nodes) reach out to connect to other communities.

We propose various combinations of weak and strong research and community nodes and weak and strong degrees of connectedness.

Figure 3: Network Structure Typology



Evaluations built on this model would look at the degree of connectedness between the start-up network and potential partners and would extend to include the strength of relations within nodes. Evaluations using this approach would have the strength that they would attempt to answer one of the central

[21] 'we need to understand the 'Knowledge Value Collectives' on which the FP projects operate and we need to know much more about human capital and mobility, since people are crucial as 'knowledge bearers'.

evaluation questions of formal networks – i.e. did they network? Our theoretical contribution lies with the third dimension of this framework. We argue that there are probably four types of formal networks which have, more or less, the following characteristics (Table 6):

Table 6:Identification of Researcher/Community combinations

	Weak stakeholders	**Strong stakeholders**
Strong Researcher Community	Quad 1. 'researchers' are relatively easy to define, but the population communities are more diffuse on a comprehensive basis (e.g. gerontology, rural etc)	Quad 3. formal networks where there are two strong poles.(e.g. AIDs researchers and AIDs support organizations)
Weak Research Community	Quad 2. there is both a disparate researcher community and a diffuse stakeholder community (e.g. women's health)	Quad 4. the research community is more disparate: there is a strong emphasis on community engagement and support. (e.g. First Nations medicine)

On this basis, assessment of the network could be differentiated according to the different starting conditions. For the different quadrants of our 2X2 we could suggest the following.

Quad 1. How well did the research community do in locating and embedding within the network appropriate community members.

Quad 2. How well did the initial team do in building a coalition of researchers and community stakeholders focussed on an appropriate issue of concern or practical research problem.

Quad 3. Given, the starting conditions for success, what were the outcomes, was their sufficient partnering and if so was there discernable progress in research and knowledge translation.

Quad 4. Were the community stakeholders able to identify and attract researchers to the network and was there any change in research agendas.

The challenge with such evaluation strategy is that it leaves to the evaluator three crucial phenomena to assess:

- what were the objectives of the funders;
- Did the network have a strategy for developing a specific core theme;
- What was the success of the actual connections and what were the potential connections?

The first of these is obvious, as evaluations (as pointed to earlier) need to be based in the objectives of the program.

The second one is a research hypothesis that networks need to target a specific area(s) of concern in order to be able to focus on constructing appropriate network connections.

If this is the case then our last point, is the most challenging for the evaluator. Our assessment model is built on the premise that it is possible to narrow down a target group of potential research, industry and

community partners and to evaluate the network on its success in reaching and including and /or generating a wider milieu of informed but unconnected partners.

Therefore in our formal network evaluation methodology it is essential to develop assessment samples from within and external to the network.

6. Conclusions

We have shown in this paper that although there is an extensive literature on the evaluation of research, science and technology for publically funded projects, there has not been a focus on the properties of formal knowledge networks. This appears to have resulted in evaluations that for the most part overlook the network attributes of networks. Further, we have shown that such networks are special and need consideration on their own merits.

We would tentatively make the following suggestions as to an indicator system for formal knowledge networks. There should be three layers to their analysis:

1. logic framework analysis of inputs and outputs (conducted with due caution this is conducted in various ways in the many evaluations);
2. governance analysis (suggested by Creech and Ramji 2004 – although this framework is not typically found in S&T evaluations, many would benefit from this style of organisational management analysis); and
3. 'network' analysis (based on the community of participants) as outlined in section 5.3.

From the start we set the goal for this paper of outlining a new conceptual framework for network evaluation, we need to leave to a future date research to test our thinking.

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Appendix 1: Examples of Network objectives

Canadian National Centres of Excellence

Excellence defines the individual researchers who have distinguished themselves through a record of peer-reviewed research. The Centres are created from this pool of excellent researchers who work together on common research projects. The Networks are institutes without walls, formed by Centres coming together to assemble a critical mass of intellectual capacity and to address strategic research questions deemed vital to Canada's social and economic development. Together, the Centres are capable of achieving more than the sum of their individual efforts. http://www.nce.gc.ca/about_e.htm

British Columbia's Health of Population (research) Networks

The Health of Population Networks' Performance Indicators Working Group (MSFHR HoPN PIWG 2008) recently clarified the six key objectives of the program. They are:

- Network has clear purpose and goals;
- Networks enhance knowledge transfer and policy impact;
- Networks build or increase research capacity;
- Networks promote collaboration and partnerships; and
- Networks leverage financial opportunities to
- Have appropriate governance systems in place.

Australian Cooperatives Research Centres

The CRC Program commenced in 1991. The objective of the Program is:

"to enhance Australia's industrial, commercial and economic growth through the development of sustained, user-driven, cooperative public-private research centres that achieve high levels of outcomes in adoption and commercialisation."

The CRC Program links researchers with industry to focus R&D efforts on progress towards utilisation and commercialisation. The close interaction between researchers and the users of research is a key feature of the Program. Another feature is industry contribution to CRC education programs to produce industry-ready graduates.

https://www.crc.gov.au/Information/ShowInformation.aspx?Doc=about_programme&key=bulletin-board-programme&Heading=The%20Program accessed 19 March 2008.

ARC Research Networks Objectives:

The ARC Research Networks scheme builds on investments in excellent research undertaken by individual investigators and small teams to: Enhance the scale and focus of their research; Encourage more inter-disciplinary approaches to research; and facilitate collaborative and innovative approaches to planning and undertaking research.

http://www.arc.gov.au/ncgp/networks/networks_default.htm