

# ***Motivational Information Systems: Case study of a University Research Productivity Index leading to a 6th Extension to Ashby's Law***

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## **Abstract**

Information systems are widely used to map and chart organisational activities for management to motivate staff. We have coined the term *Motivational Information Systems* for information systems that have this role. This paper illustrates the use of this new concept of motivational Information systems via a case. Causal loop modelling is used to understand the dynamics of a motivational information system in a large organisation: a university-wide motivational information system intended to motivate academics to increase research outcomes.

The case analysis pointed to two outcomes of interest. It revealed unexpected detail of hegemonic control of resources by senior academic staff and it led to identification of a sixth extension to Ashby's Law of Requisite Variety.

The systems research described in this paper is part of a larger program by the authors investigating the application and extension of Beer's Viable Systems Model, Ashby's Laws of Requisite Variety, Checkland's Soft Systems, Critical Systems Analysis, System Dynamics and Causal Loop Diagrams to situations in which these tools are not commonly applied.

## **Keywords:**

Causal loop modelling, Motivational Information Systems, extensions to Ashby's Law of Requisite Variety, case study, university systems.

## Introduction

This paper focuses on the socio-technical systemic aspects of how motivational forces are applied via information systems. The authors have coined the phrase, *motivational information systems* to refer to these and associated phenomena.

Information systems are widely used in organisations to map and chart their activities to facilitate their management and improve business outcomes (see, for example, Agre, 2000; Australian Bureau of Statistics, 1999; Borgman, 2000; Curtis, 1995; Grant & Huston, 2000; Mumford, 1999). Organisational systems account and record a variety of things for different purposes, (for example, inventory, financial dealings, assets time spent on particular tasks, and indicators of business development). These organisational systems are embedded in information systems in, for example, paperwork, computer databases and web-based/networked information management systems.

A central consideration of management is the motivation of staff (Reeves, 2007; Rowley, 1996; Smith, 1999). Many organisational information systems of recording are utilised by management for motivational purposes in which the measures of staff or organisational performance are used as a reference to encourage improved performance. This *motivational use of information systems* is the central issue of this paper.

It is fact that many information systems are primarily used to encourage humans to improve their outputs and output quality. The application of information systems in this motivational manner was discussed by Deming (1986), who was highly critical of the approach. Typically, management use the information and metrics gathered via information systems in a carrot and stick motivational manner to control, typically via other motivational information systems, individuals' access to resources (pay, promotion, power, perks etc.). For example, data about *sales leads*, *sales leads confirmed*, and *actual sales* are used as measures of sales persons' commitment and success, and often linked to their remuneration via salary information systems. The integration of these information sources provides *motivational pressure* on the sales person to encourage them to improve their performance in ways that the company desires. In general, information systems are used to provide distillations of such figures to management and employees and to relate these to access to resources or implementation of penalties to motivational pressures to increase performance and improve outputs.

To this point, having a clear understanding of the intimate socio-technical coupling between motivational processes and information systems has fallen between the disciplinary boundaries. The IS and MIS fields have primarily focused on information systems as systems for storing and managing information. In areas of Management, Human Resources, Organisational Theory, Entrepreneurship and Business Administration concerned with human motivation and improving organisations' output, motivation has typically been addressed independently of the hardware, software, informatic and hegemonic systemic structural issues relating to information systems.

To recap, for these types of socio-technical systems by which information is collected and manipulated to provide motivational pressures and encouragement, *we have coined the term, motivational information systems.*

This paper illustrates some of the potential of this approach via a case study of a university-wide motivational information system used to encourage academics to increase their research outcomes. The paper is one of a pair describing research by the authors in applying systems thinking tools to motivation of academic staff in universities in Australia. This paper focuses on the internal issues. The other paper focuses on the external issues: the power and control dynamics of how government

policy applies motivational influences on universities and their staff. (Note, this second paper was to also have been submitted to this conference but due to personal reasons outside the authors' control was not completed on time). Both are part of an exploration of motivational information systems that involve: mapping motivational information systems in systems terms; exploring processes, outcomes and counterintuitive outcomes via causal loop diagrams; and investigating the effects of discontinuities. This 3 way exploration of motivational information systems is itself part of a larger project by the authors in investigating the application and extension of traditional systems tools such as Beer's, Viable Systems Model, Ashby's Laws of Requisite Variety, Checkland's Soft Systems, Critical Systems Analysis, System Dynamics and Causal Loop Diagrams on systems to which these tools are not commonly applied, either because the systems are peculiarly complex or because these classic systems tools have not been normally considered applicable to particular situations, such as the one described in this paper.

In this paper, the focus is on causal loop modelling of the structural features of a university motivational information system as they apply to academic staff. The relationship to university non-academic administration is left to another time. The research explored the influence of the motivational system structure on distribution of academic resources and value, and how institutionalized power has been used to shape motivational information systems' structures to affect this distribution and influence other university decision-making systems. From these analyses emerged a sixth extension by the authors to Ashby's Law of Requisite Variety. The earlier five extensions are described in (Love & Cooper, 2007a; Love & Cooper, 2007b, 2007c)

Prior work by the authors in applying Systems Dynamics to national innovation systems and design infrastructures, and extending Ashby's Law of Requisite Variety into complex socio-technical organisational systems has indicated it is helpful to use a case study as an exemplar to make theoretical analyses and findings more accessible (see, for example, Cooper, 2004; Love, 2001, 2003, 2005; Love, 2006, 2007; Love & Cooper, 2004, 2007b, 2007c). This paper follows that path and uses a case study of a university-wide motivational information system at Curtin University of Technology, Western Australia (CUT) aimed at improving research output of academic staff. The systems analysed in this case study comprise the Research Productivity Index (RPI) system and its associated linked information systems. The details of this socio-technical motivational information system were in part available to the authors via the role of one of the authors as an academic at CUT. The Curtin RPI system is a conventional management information system linked conventionally to other financial and management information systems of the university in ways that would be easily recognizable in any MIS textbook. The structure and purposes of Curtin's RPI system are in the public domain, see for example, <http://research.curtin.edu.au/rpi/rpi.cfm> .

This motivational information system, the Curtin Research Productivity Index (RPI) system has five roles:

1. Catalogue annual research outputs of individual academic staff, research groups, and faculty groups
2. Compare annual research outputs for motivational purposes
3. Distribute access to seed funding for research to persuade staff to increase research outputs and align the direction of their research activity with that chosen by university management
4. Provide metrics to Australian Federal government departments for use in identifying how much funding will be given to the university the following year
5. To provide reference measures of research output for other academic motivational, decision-making and resource allocation processes (e.g. promotion, distribution funding to Faculties, hiring and firing programs, etc.)

That is, the motivational pressures from the RPI system are to encourage staff to correspond with management wishes for increased outputs and to align their research with preferred research directions are applied by tying RPI data to access to research funding, and linking outcomes from the RPI motivational information system to other university decision-making systems of interest to staff such as performance management, promotion, priority in academic leave allocation, and personnel reshaping decisions (i.e. whether a staff member is likely to be made redundant).

The paper has five parts. After this introduction, the second section describes the case study features of the motivational information system at Curtin University of Technology. The third section describes one of the causal loop models of the research that maps the main functional features of the RPI motivational information system to identify causal relations, counter intuitive outcomes, locus and distribution of control, hegemonic influence, and distribution of benefits. Section four of the paper critically reviews the causal loop model identifying detail of the functioning of the system and its implications in terms of motivation and power along with control of distribution of value. Section four also makes recommendations for system improvement in line with the publicly expressed intentions of the university management for the RPI information system. This analysis is in line with extension 5 of Ashby's Law of Requisite Variety (Love & Cooper, 2007c). In addition, in Section 4 a new 6<sup>th</sup> extension to Ashby's Law of Requisite Variety is identified. Section 5 summarises the findings.

## **Case Study: research productivity index (RPI)**

The case study used in this research is drawn from the university organisational environment. In what follows, the analyses depend primarily on the authors re-visioning of the RPI system through a socio-technical lens that focuses on how it and its linked information systems are used to *encourage* and *pressurize* staff to improve their outcomes. Using a university as a case study is useful because universities contain a broad representative spectrum of organisational intentions for performance improvement and offer the basis for the findings to be applicable more generally. This case study focuses on real world information system in an Australian university: the Research Performance Index (RPI) motivational information system at Curtin University of Technology in Western Australia. The analyses have a generic aspect that suggests they are also likely to apply to any organization that use metrics and information systems in a motivational information system in which tasks and control authorities are hierarchically distributed.

This university-based case is predicated on the assumption that individual and group performance improvement is crucial to organisational management. Performance improvement requires collection of metrics to identify individual and group performance and whether proposed strategies designed to improve performance are effective. The external aspect of the Curtin RPI motivational information system is its collation of metrics about the research performance of Curtin University for delivery to the Australian Federal government that influences the level of funding the university receives from the Federal Government. It is these metrics and the information systems through which they are collected, managed and delivered also provide the basis for developing motivational strategies and processes for improvement in performance outcomes by employees and management of the university.

The structure of metric-based information systems strongly shape their operational functioning and how they motivate. The structure can define, or be defined by, the organisation's motivation and improvement strategies. In the case of a university such as Curtin University of Technology, opportunities for motivation for increased research outcomes are strongly shaped by the details of

how research outcomes result in the carrots and sticks to encourage academics to put in extra work to compete for access to future resources.

The details of motivational performance improvement strategies include:

- What is counted
- How counted elements are relatively weighted
- How, and how much, access to resources and penalties are linked to what is counted and weighted (i.e. the scale and type of carrot and stick)

Let us look at the system in the concrete. In information systems terms, the system comprises multiple components that include:

- An internal information system in which academics outputs are recorded
- A financial information system that records how much each academic currently has in their research fund
- An information system that makes the connection between the funding available within the university for research motivation, and the rules for distribution to academics as a whole. Typically, a lump sum is set aside by the university. The total number of research elements is counted across the university, with different weightings per type of element, and the amount of research funding per element is fixed by distributing the total budget available evenly across the weighted research elements. Thus if the previous year is high output then for the year following it, the distribution of funding for those elements of the previous year is lower per element if the funding is fixed. In effect, each researcher being asked to compete for their place in a pecking order for a fixed resource. Where there is an increase in researchers, then the overall payment per research falls.
- An information system for calculating the amount to be transferred from central financial reserves into each individual researcher's account on the basis of the researchers previous year's research output.
- The internal information system that identifies which purchases of a researcher can be charged against the funds in their research account. This is required by government constraints on the spending of government distributed research funds as well as attempts by university management to direct academics research spending
- A system of deriving centrally administered computer-based research funding accounts into local sub-accounts. This information system exists and is managed outside the computerized accounting system.
- An information system that refunds the cost of purchases that researchers have made from their own money or pays direct from university accounts.
- A system of access to RPI data for use when RPI is a part of other university motivational systems

The practical motivational mechanisms include:

- Transfer of a proportion of government block grant funding associated with research to individual academics accounts or the accounts of research groups and Faculties.
- Linking to management decisions about study leave (for which research outcomes are expected).
- Linking to management decisions about long service sabbatical leave (for which research outcomes are expected).
- Linking to access to funding for research fellows (with the sole aim of them increasing research metrics).

- Linking to partial buying out of research active academic staff members' teaching commitments.
- Links to decisions about funding for academic staff to attend national and international conferences.
- Links to decisions about ad-hoc funding support for research activities and research active academic staff subject to the personal judgment of academic managers.

The motivational effects of the system stem from the carrot of offering increases in future benefits from increased activities undertaken in the present.

In all cases, there are *feedback loops*. The three most obvious feedback loops are:

- The feedback loop that decides on the amount of research funds to be distributed to an individual this year on the basis of their research outputs in previous years.
- The feedback loop that comprises the longer term effects on future research outputs of the individual using the research funds distributed by the system this year.
- The motivation feedback loop for Professors and senior staff to modify the details of the motivational information system to benefit themselves as a group and as individuals.

Each of these loops is controlled by professors and senior academics for motivational purposes.

## Causal Loop diagram

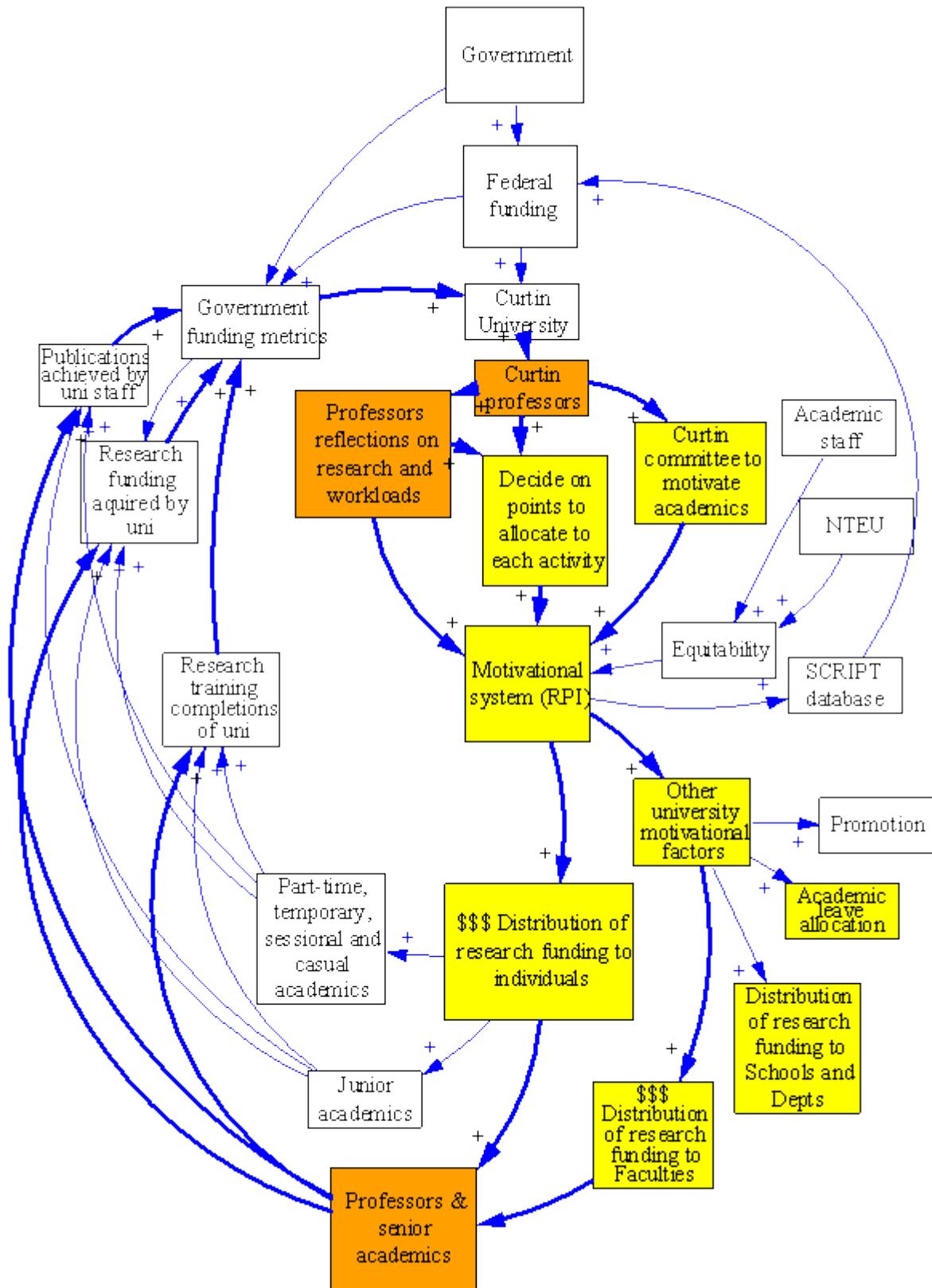


Figure 1: Causal loop model of RPI motivational information system

## Discussion

The application of causal loop modelling to the case study of the RPI motivational information system illustrates several features not readily apparent otherwise.

Six issues emerge as being driven by the structure and functioning of the RPI system.

The structure and weightings allocated to metrics of the RPI system preferentially distribute its resource value, such as internal funding for research and benefits for promotion, preferentially to individuals and groups higher up the university academic hierarchy (see example below in Table 1).

Second, the management structures of power and control of the RPI system and its distribution are vested overwhelmingly with professorial and management staff at the top of the university's academic management hierarchy. The structure of management and functioning of the RPI motivational information system is such that the professorial group can define the structure and weightings of the RPI system to preferentially benefit them and place pressure on academics lower in the hierarchy, Table 1 below and the associated analysis indicates that this bias has been implemented by this professorial group.

It is apparent that the motivational *pressures* from the RPI motivational information system fall heaviest on least experienced staff groups or staff lower in the hierarchy in ways that adversely impact on other aspects of their employment. This happens in ways that cannot be controlled by them, and reduce their effective power in relation to staff higher up the academic and management hierarchies.

By linkages between the RPI and other university systems, the RPI motivation information system functions as an oppressive tool of control placing a barrier that makes movement up the academic hierarchy more difficult for those lower in the hierarchy.

It does this by linking RPI metrics (with choice of metric and weightings biased to have these effects) to other academic management decision-making systems involved in distribution of benefits to academics. For example, the annual RPI report for individuals is widely used as a key element of assessment for performance management. In addition, the RPI information system has been linked to promotion via formal and informal *expectations* and this provides a barrier between junior and senior staff due to differences in working practices that can usually only be surmounted by dint of additional unmeasured activities by staff lower in the hierarchy that substantially must be undertaken in academics own time, or by dint of long employment (climbing the hierarchy via dead men's shoes).

This in effect adversely leverages the inequities in the motivational information system to benefit the professoriate, senior academics and university management preferentially and increase pressure on junior academic staff, part-time and sessional academic staff and all academic staff whose focus is primarily teaching.

Oversight of the RPI system management, particularly the means of defining its metrics, structure and distribution of value is compromised, because any such oversight is undertaken by the professorial group controlling the structure of the RPI process. This group has a strong interest in continuing the redirection of that value to themselves and reducing competition by increasing the numbers at that level (an interest shared with university management who manage salaries).

For transient staff or in changing situations, the RPI motivational information system acts to minimise distribution of value to academic staff undergoing change and retain its value for distribution to more established senior staff. This issue is addressed in more detail by the authors

elsewhere in another paper under review as a part of a systems-based review of biases in the distribution of value in motivational information systems in which real world discontinuous systems are presumed continuous by those designing the motivational and metric recording systems. Temporally, the *lags* in the motivational information system place an additional *stress* on staff with temporary contracts, are on probation, or have newly taken up post.

Compare, in Table 1 below, a Professor with ongoing supervision of in any one year of 6 PhD students (typical) with a lecturer B delivering 2 international conference papers per year (typical).

Table 1: Relative bias in RPI outcomes, workload and cost to academics at different points in the hierarchy

<b>Position</b>	<b>Research contribution pa</b>	<b>Income from RPI</b>	<b>Additional workload</b>	<b>Cost to academic's research funds</b>
<b>Professor</b>	6 PhD students (typical)	\$18,000 6 x 600 points at \$5/point	Nil Fully included in allocated workload	Nil
<b>Lecturer B</b>	2 international conference papers	\$500 2 x 50 points at \$5/point	140 hours of own time Research time in workload used for research on which conference papers are based.	\$11,000 2 x international conferences typically \$5,500 ea.

For tasks similarly appropriate to their career trajectory, the professor is distributed 3600% more research income, has nil additional workload and nil costs. In contrast, the junior lecturer has minimal research income, must work an additional 20 days over and above their workload, and raise \$11,000 of research funds.

In other words, *the* motivational information system implemented by Curtin University of Technology for encouraging research is biased. This is primarily because the control and operation of the RPI system is dominated by a feedback loop controlled by professorial representatives who have arranged the RPI system in a way that preferentially (and hegemonically) distributes its value to themselves and acts to reduce the potential of others lower in the hierarchy to change the basis of this structure. This is done by controlling the structure of data gathering, the type of data gathered and the weightings associated with data items to heavily weight those items primarily available to professorial members and senior academics or for which they often have gatekeeper control access.

This can be seen for example in the control of doctoral supervision opportunities vested in the professoriate who typically retain larger numbers of doctoral students than distributed to those lower in the academic hierarchy. This acts as an additional flow through bias in terms of RPI-related effects. High weightings are given to doctoral supervision and research income, which form a much higher proportion of professors and senior academics workload than for junior academics. In contrast, the returns for the activities of junior academics necessary to build their research profile and research networks (e.g. presenting conference papers) counts for less than doctoral supervision and yet costs the junior academic more in time and research funds.

## Insights into improving the equitability of the RPI motivational System

The causal loop modelling above also indicated it is straightforward to make the RPI system more equitable via minor changes each targeting a specific part of the RPI motivational information system.

Postgraduate supervision is an issue that offers opportunities for improvement of equity and functional alignment. Postgraduate supervision is in essence a teaching activity rather than research activity. One potential change that resolves several issues is to manage it under teaching and learning and remove it from the RPI motivational system. Thus supervision of postdoctoral students would count only for teaching workload and be rewarded via the Teaching Performance Index (TPI) of Curtin University of Technology (rather than RPI) and the quality of a supervisor's teaching would be assessed by students in a similar way to that for undergraduate teaching.

This would remove the multiple equity problems relating to professorial gatekeeping of postgraduate supervision and resolve an important hierarchical equity problems pointed to in the previous section. It would also remove the biasing effect on access to promotion from including doctoral supervision in RPI. By bringing postgraduate supervision under the rubric of Teaching and Learning, it would be more exposed to a quality-building and evaluation environment that would help address the many criticisms of generic poor quality in doctoral supervision (see, for example, Sinclair, 2004).

Second, aligning the functioning of the RPI motivational information system with the different career priorities of junior and senior academic staff provides another opportunity to reduce the inequities and problems of the RPI system. For junior academic staff members, presenting refereed papers at conferences is important to build their profile and develop research contacts and networks. This however is relatively unimportant for senior academic staff and vice versa for achieving research grants. Having the RPI point system reflect these differences would help improve equity.

The RPI is more significant for junior academics (who have less access to research funds). For a professor with a well-established research record and supported by effective research administration, it is expected they will obtain multiple grants of the order of hundreds of thousands of dollars. In contrast, an early career academic without a research track record will be struggling to gain competitive grants in the order of thousands of dollars.

*It would seem obvious to modify the RPI point distribution to reflect the several orders of magnitude difference in difficulty and expectation between the two situations by allocating a higher rate of points for junior academic staff compared to senior academic staff.*

If implemented well, these and related changes to RPI to address issues that can be identified from the causal loop modelling potentially have five benefits: they would provide a single target of points for all staff regardless of their place in the academic hierarchy; they would act to reduce the ethical inequities of the current system; they would help improve postgraduate supervision and doctoral completion outcomes by helping emphasise the teaching and learning in doctoral education; they would help distinguish between motivational information for research and assessment for promotion and access to university resources such as academic study leave; and they would reduce the negative effects on academic staff motivation that result from the current system.

## A Sixth Extension to Ashby's Law

Part of the larger systems research program of which this is a part involves exploring the use of classic systems tools in unusual circumstances. Of particular interest is extending the application of Ashby's Law of Requisite Variety into socio-technical situations. The authors have published five extensions to Ashby's Law of Requisite Variety that extend its use into the social realm (Love & Cooper, 2007a, 2007b, 2007c).

From the analyses of this case study of the RPI system, the authors propose a sixth extension to Ashby's Law of Requisite Variety.

*In complex socio-technical systems in which the distribution of variety of individuals' tasks and authority are hierarchically layered*

*AND individual and subgroup variety is assessed via information systems used for motivation*

*THEN the motivational information system will tend to distribute value preferentially to individuals and groups higher in the hierarchy; act as a barrier to movement of individuals up the hierarchy; and increase the amount of control variety higher in the hierarchy.*

Also implicit in this sixth extension to Ashby's Law is the indication that the implementation of motivational information systems in this context results in increased trend towards, and support of, autocratic control.

## Conclusions

This research, by using causal loop modelling to make the functioning of the RPI system more transparent, showed there exists a hegemonic pathway of control by which, consciously or not, senior academics arranged the weightings and distribution of value to preferentially benefit themselves, reduce potential competition from individuals lower in the hierarchy and increase motivational pressure (with less rewards) on academics lower in employment hierarchy. The inequity of the system has been disguised by the fallacious claim that it is equitable because it applies to all academics. That is, the RPI has been developed as a structurally inequitable system hidden by a fallacious sleight of words.

This research has resulted in four outcomes.

- It demonstrates the benefits of causal loop modelling for gaining insights into complex socio technical situations.
- It has provided a more comprehensive understanding of the case study motivational information system. It has revealed more generic understandings of the behaviour of motivational information systems in hierarchical organisational contexts.
- It has led to identification of potential solutions to resolving issues exposed in the case study.
- It has revealed a sixth extension to Ashby's Law of Requisite Variety

The most surprising finding for the authors in using causal loop analysis in this case study was the amount of detail that it revealed relating to hidden effects of power that had been effectively hidden by fallacious logic, i.e. 'the RPI system applies to all staff therefore it must be equitable'.

From earlier research we had expected causal loop modelling to reveal new and counter intuitive findings. We had not expected it to reveal, however, the depth of the hegemonic issues, ways of resolving them, and a sixth extension to Ashby's Law. These indicate the level of intrinsic advantages offered by the causal loop diagramming method.

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