Analyzing management control systems:
A cybernetic approach

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Paper submitted for presentation at the Auckland Regional Accounting (ARA) conference
4 December 2014, Auckland New Zealand
Abstract

This paper draws on two strands of cybernetic thought, namely Ashby’s Law of Requisite Variety (LORV) and the Viable System Model (VSM), to analyze the control systems in one organization. The LORV specifies the conditions needed for effective control and the VSM provides the structural arrangements for operationalizing the LORV. The analysis considers a beyond budgeting system in a logistics company. The research proceeded by creating a VSM of the control system to depict its underlying structure including both components and the channels supporting their interactions. The subsequent analysis of interactions between components, guided by the VSM and informed by the LORV, revealed how the MCS managed variety, by either attenuating it or amplifying the organization’s ability to respond to it.

It was found that beyond budgeting system relied extensively on amplifiers the impact of which is to increase branch managers’ ability to respond (variety) to high levels of external variety. Amplifiers include the creation of autonomous branches, continual access to resources, and availability of real-time performance information through which branches can self-organize and coordinate their interactions. General managers site visits and internal audit processes support the sporadic monitoring of branch operations by gathering detailed operational information. The predominantly horizontal communication flows between operational units, combined with continual access to resources, allow branch managers to respond to changing conditions without the need for general management intervention.

The beyond budgeting system, designed around a range of amplifiers, is more readily able to absorb the impact of external shocks.

Key words: Management control systems, cybernetics; viable system model; law of requisite variety
Purpose: This paper demonstrates the usefulness of two strands of cybernetic thought, namely Ashby’s Law of Requisite Variety (LORV) and the Viable System Model (VSM), for understanding management control systems. The specific research question addressed is ‘How do the VSM and LORV explain the operation of management control systems?’

Design/methodology/approach: The paper analyzes a beyond budgeting (BB) system using the VSM and LORV and reports the results of a second analysis of a budget based system. A VSM was created to depict the underlying structure of the system, including both components and their interactions. An analysis of the interactions, guided by the VSM and informed by the LORV, was conducted to reveal how the MCS manages variety, whether by attenuating it or amplifying the organization’s ability to respond to it.

Findings: Results show that the beyond budgeting system incorporates a high mix of amplifiers relative to attenuators to increase branch managers’ ability to respond to high levels of external variety. The performance management systems designed around amplifiers is more readily able to absorb the impact of external shocks.

Research limitations/implications: Judgment is required to apply the VSM and LORV tools. This limitation has been addressed by providing clear descriptions of the logic underpinning the alternatives selected in creating the VSM and applying the LORV.

Originality/value: The paper offers the VSM and LORV as tools to guide meta-analyses of control systems, by focusing attention on the variety attenuating and amplifying role of control mechanisms. These new tools facilitate the description and analysis of management control systems and their fit with the external environment and strategy.
1. Introduction
The word ‘system’ is used extensively by control researchers yet there is little work that explicitly applies systems theoretic concepts in the management control literature. The descriptions of systems and cybernetics approaches to control reported in the accounting literature are partial (see for example Berry, Broadbent, & Otley, 1995; Lee & Widener, 2012; Otley, 1988; Otley & Berry, 1980) typically underemphasizing the implications of the law of requisite variety (LORV) for achieving control. The recent attempts to understand the holistic operation of control systems (Ferreira & Otley, 2009; Simons, 2000), including how the components of control systems interact (Henri, 2006) and how balance is achieved between components (Mundy, 2010), draw on existing frameworks of management control rather than on systems theory. While these frameworks can identify the components of control systems they provide few insights into the nature or adequacy of the interactions between parts of the system. This paper draws on systems concepts to consider how interactions between components of control systems contribute to organizations ability to achieve requisite variety.

Systems science focuses on the study of relationships among elements comprising a system and claims there are generalizable patterns of relationships applicable across domains. This perspective suggests patterns derived from cybernetics, which addresses communication and control in systems, could provide a theoretical foundation for understanding the operation of management control systems. This paper draws on two strands of cybernetic thought, namely Ashby’s Law of Requisite Variety (LORV) and the Viable System Model (VSM), to understand the operation of control systems. The LORV is, as the name suggests, a law like statement which sets out the conditions needed for effective control in an abstract sense. The VSM is a model which claims to specify the structural arrangements and processes required to operationalise the LORV within an organisational context in the social domain. The research question addressed in this paper is ‘How do the VSM and LORV explain the operation of management control systems?’

This paper argues for a reconsideration of the usefulness of cybernetic ideas and models in MCS research. It shows that the theoretical foundations of cybernetics provide descriptive and analytical power and can extend our understanding of control systems. By applying this approach to analyse the management control system (MCS) the paper demonstrates the power of a cybernetic analysis and its ability to provide insight into the operation of control systems at a fundamental level. This paper is timely given the renewed interest within the academic
community about the holistic operation of control systems and the problems associated with managing complexity.

The paper is structured as follows. Section 2 describes Ashby’s Law of Requisite Variety, how it informs the Viable System Model and its relevance to the challenges facing management control systems (MCS) researchers. Section 3 demonstrates the usefulness of the VSM and LORV as tools for describing and analysing complex control arrangements and their applicability to research into organisational control. The final section discusses how the VSM extends our understanding of control systems beyond the insights available from commonly used accounting control frameworks.

2. Ashby’s Law of Requisite Variety and the Viable System Model

The Law of Requisite Variety (LORV) addresses the question: ‘what qualities does a regulator need to have to achieve effective control?’ (Ashby, 1958). Central to the LORV is the concept of ‘variety’, a measure of complexity that indicates the possible number of states that the environment, a system, or a controller is capable of adopting (Rosenkranz & Holten, 2010). More specifically, the LORV reveals the relationship required between the variety (complexity) of the environment and the variety (flexibility) available in the regulator. The LORV simply stated is that the variety in the regulator must be equal to or larger than the variety of the environment in which the system is embedded (Rosenkranz & Holten, 2010), to allow the system to maintain selected output variables within specified limits. The more complex the environment, the greater the flexibility required in the regulator if the system is to remain viable. Moreover, the goals of the system (as reflected by the limits established for the selected output variables) influence this relationship. For example, in a turbulent or high variety environment, an organisation with tighter goals (i.e. lower variety goals) requires more variety in the regulator than does an organisation with less specific or looser goals (higher variety goals). In other words, systems operating in high variety environments will need greater flexibility to achieve highly specific or tight goals than they would to meet more loosely specified goals. The LORV thus describes the relationship between environmental complexity and control system flexibility while recognizing that the characteristics of the goal set influence this relationship.

The viable system model (VSM) is an articulation of the LORV within an organisational context (Beer, 1981, 1985, 1995). Appendix A provides an overview of the model including the components and communication channels necessary to achieve control. The VSM is
predicated on the fact that to remain viable organisations must be able to respond in a
coordinated fashion to enormous levels of variety in their external environment in a way that
maintains their critical output variables (e.g. profit and cash flow) within defined limits
(goals). Organisations that do not have the control arrangements capable of dealing with the
impact of external variety on their critical output variables, i.e. that lack requisite variety, are
likely to show signs of instability even if they do not fail outright. More specifically, they are
unlikely to consistently achieve all their goals which may ultimately jeopardize the survival
of the organisation. Organisations have two basic ways in which they can establish requisite
variety: they can either reduce (attenuate) the variety of the environment or increase
(amplify) their ability to respond to it. For all but the simplest organisations the level of
environmental variety is such that it is beyond the capacity of a single individual or
organisational entity to manage effectively. Consequently, organisations need strategies to
engineer variety into their organisational structure and processes so they can achieve a
balance between environmental variety and their ability to respond to it without prejudicing
the coordination and cohesion of the organisation.

A common strategy for increasing the organisation’s regulatory capacity, i.e. its ability to
respond to external variety, involves decentralising some decision making tasks to semi-
autonomous operational units. Each unit, by handling only part of the environmental variety,
is better able to manage variety and therefore be in control. But, decentralisation introduces
further control issues. There is potential for individual units to make decisions that promote
their own interests but threaten the organisation’s overall cohesion and ultimately, its
survival. The role of the regulator is to maintain organisational cohesion by constraining the
freedom and flexibility of individual units (the internal environment) without limiting their
ability to respond effectively to their own external environments. It is this challenge that the
VSM addresses by specifying a structure for balancing the natural tension between the need
for autonomous flexibility and organisational cohesion so that both short and long term goals
can be achieved.

Viability refers to an organization’s capacity to thrive and survive in an unpredictable
environment. Organisational viability implies the organisation can consistently achieve its
short and long term goals. Although the VSM is described in general terms, it can be adapted
to consider any particular type of variable relevant to organisational viability. For example,
viability can be interpreted as financial performance and translated into financially oriented
goals such as solvency, which indicates the sufficiency of cash resources, and rates of return, which indicate how well resources are applied.

In summary, the VSM is theoretically grounded in the LORV. The LORV addresses the core concern of MCS research, namely how to achieve effective control, by considering the interactions organisations use to balance the variety of the environment with the variety of the regulator. The VSM specifies how to operationalise effective control within an organisational context. The LORV on the other hand provides an analytical lens that operates at a meta-level, focusing attention on how information and communications are organised to attenuate or amplify variety.

The VSM and the LORV are used to describe and analyse the control system in one organisation. The approach employed offers a practical toolkit for management control research which may help extend our understanding of control systems. The VSM maps the structure of the control systems while the LORV considers how interactions between components influence the organisation’s ability to manage variety. The analysis considers the idiosyncratic control system operating of a fast growing commercial organisation operating in an extremely competitive and dynamic environment. The company has a broad goal set that includes, for example, profit, cash flow and accuracy and timeliness of deliveries. The VSM is used to describe the control structure and the LORV to understand how the control approach manages variety. The next section presents the cybernetic analysis of the company’s control system.

3. Analysis of MCS with VSM and LORV

The Viable System Model is a rigorous and sophisticated articulation of the features required for organizations to maintain viability in complex and dynamic (high variety) environments. The key features of the VSM are summarized here and a fuller description of the features of the model is provided in Appendix A. The VSM is comprised of:

- A set of six interdependent systems each of which identifies a different systemic role to be exercised, as follows:
  - (Multiple) Systems 1 comprising semi-autonomous operational units containing all those functions necessary to manage value adding interactions with a segment of the environment
  - System 2 which houses those functions which facilitate the coordination of activity of the semi-autonomous Systems 1
- System 3 which contains those functions necessary to maintain executive control over the operational units while minimally constraining their autonomy
- System 3* comprising all those activities which enable System 3 to monitor the activities of operational units with the minimum degree of interference
- System 4 which contains all those functions necessary to determine how the structure and operation of Systems 1 through 3* need to evolve to meet the challenges of their changing environment
- System 5 which exercises governance over the set of systems and is manifest in policies, principles and values.
- A set of 7 channels which mediate the interaction within the 6 systems.

The specification of these channels extends existing management control frameworks (Ferreira & Otley, 2009; Flamholtz, 1996; Simons, 2000) which tend to assume their existence and proper functioning.

The systems describe systemic roles that need to be performed, not jobs or functions, and so they do not map directly against conventional organizational charts. Additionally, the interactions indicated by the channels include but are not restricted to flows of information in the conventional sense. Finally, the model is multi-level; identically structured sets of systems and channels are nested within each other recursively. This provides the VSM with the ability to describe and analyse organisations of any size or level of complexity. By convention, the VSM is represented graphically using a well-specified and consistent symbolic language.

The key components of Mainfreight’s MCS are depicted using the VSM shown in Figure 1. The diagram guides the systematic assessment of the interactions between system components. The following discussion considers the system employed by Mainfreight, a New Zealand-based logistics company.

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1 Country managers were recently introduced and the role does not yet exist in all countries in which the company operates.
Example 1: Cybernetic assessment of a non-budget based MCS

Mainfreight has operated successfully in the highly turbulent international logistics industry since 1978. The company has more than 5,000 team members employed in over 200 branches operating across 44 countries. It has three main operating divisions, Domestic, International (Air and Ocean) and Logistics. In Mainfreight’s highly decentralized structure there are just three levels of management below the Group Managing Director, namely the country, general/divisional, and branch managers. Mainfreight does not use budgets to manage its operations.

Background – Structure:

At Mainfreight ‘branches are king’ meaning they are recognized as the drivers of company performance and the locus of all day to day decision making. Branch managers are given extensive autonomy and expected to run their branches as their own profitable business. This is underpinned by the financial reporting system which generates a separate profit and loss and balance sheet for each branch, all following the same account structure.

Funding and performance targets

Mainfreight does not prepare annual budgets. Branches can request funding for specific projects at any time throughout the year. Branch managers are expected to deliver annual profit growth of 15% without jeopardising the quality of the services they provide. Increased levels of expenditure must be at least matched by increases in revenues.

Each year, branches announce their ‘profit pledge’ at the branch managers meeting. The pledges identify challenging profit targets for branches. Branch teams strive for best possible profit performance to increase their team-based bonus which rewards them with 10% of branch net profit. This amount can increase or decrease depending on the branches’ relative performance across a range of financial and non-financial indicators including, for example, profit, debtors and customer claims.

Environment

To achieve profit and KPI goals, branch managers must cope with their highly competitive and uncertain external environments and the myriad of interactions required between branches to provide logistic services to customers. In other words, branch managers face high variety environments. As will be demonstrated, the company’s management control
Figure 1: Mainfreight’s operational control system

system is designed to enhance branch managers’ ability to respond to this variety while preserving the company’s ability to maintain the coherence and alignment of the branches.

*Structural mapping against the VSM*

Systems 1 to 5 depicted in Figure 1 indicate the various roles involved in managing the external and internal variety. Branches are the revenue generating units of the business and
therefore modelled as Systems 1. The multiple lines between the branches and their immediate environments are used to indicate the high variety being handled by the branches. The remaining VSM systems regulate the operational activities of the branches which, given the degree of autonomy that they enjoy, is the critical feature of the Mainfreight model. System 3 (Control) is enacted by the general managers who oversee the collective operation of branches and search for opportunities to improve performance of the overall network. As part of this role, general managers decide, for example, where and when to open or close branches and whether individual branch funding requests are appropriate in light of wider network considerations.

Crucially System 3 general management make very few prescriptive interventions in branch operations. Instead there are well developed System 2 (Coordination) and System 3* (Monitoring) systems which promote organisational alignment and continuous improvement, with minimal intervention for System 3 other than to build and maintain the processes. Coordination processes are intended to minimize inter-branch disruptions by ensuring, for example, that people are appropriately trained on operational and IT systems, and that branches are paired with a ‘buddy branch’ of similar size and service range to facilitate knowledge sharing and comparisons of performance by branch managers. System 3* processes allow information which would not be picked up through routine reporting processes to be collected from branches. Furthermore, they allow System 3 management to gain insights into System 1 operations to help promote improvement and detect incipient problems. This monitoring might be undertaken directly, through site visits, internal audits or indirectly through feedback from branch customers.

**Analysis of VSM Channels**

To uncover the nature of the control processes in Mainfreight our analysis focuses on the interactions between those elements of the system involved in regulating operational activity at a single level of recursion. More specifically, the analysis considers how the activities of Systems 1 are regulated through their interrelations with Systems 2, 3, and 3* and how these interactions are used to manage variety. A broader assessment of performance management would include Systems 4 (Intelligence) and 5 (Policy) and additional levels of recursion. The more focused analysis presented here is appropriate for the aim of the paper which is to reveal the power and versatility of the VSM and LORV.
Thus, based on the VSM of Mainfreight’s system, the LORV is used to consider the communications arising between interacting components and explain how the control information contributes to the company’s efforts to manage its variety. The first communications considered are those between general managers (system 3) and branch managers (systems 1) via command channel A.

**System 3 Command channel** information (Channel A): The command channel is intended to convey prescriptive information about corporate requirements and cultural norms. Mainfreight’s culture is built on letting the individual decide and there are few directives issued within the company. However, there is a non-negotiable requirement for all branches to produce ‘weeklies’, which report the weekly financial results in a condensed profit and loss format. Additionally, it is expected that branches will post weekly profit and KPI performance within the branch for the entire team to see. This ensures all branches focus on the same key drivers of performance and thereby promotes organisational cohesion and coordination (a System 2 function). The communication types and their role as attenuators or amplifiers is summarized in Table 1 as an attenuator.

While general managers rarely intervene in branch situations, they are responsible for managing internal variety to maintain cohesion and performance of the overall network. They provide a broader perspective on local decisions to ensure the integrity of the wider system. For example, the European general manager intervened to influence one branch’s initial decision about non-profitable freight routes:

*Last week I was sitting with Belgium and France.... France wanted to stop all depot-to-depot lines. I said how can you stop depot-to-depot line traffic where we all agree this is our core market? Why is it making a loss? Because it’s not full enough. So, you have to concentrate on making sales to make the container full. In the end we’re still doing the same thing but we are harmonising our efforts. If we harmonise, and we all go and hunt for Belgium, France and Netherlands traffic, we will make these depot-to-depot lines full in two months...after half a day everybody went out with a totally different, unified mindset [as opposed to their starting position which was] you against me [country against country].*

**System 3 Resource bargaining and accountability information** (Channel B): The resource bargaining and accountability channel communicates information about opportunities for action and improvement and utilization of resources. Mainfreight believes the unpredictability of its operating environment requires quick and flexible responses from

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2 The channels are described in Table 4 included in Appendix A.
managers and that fixed annual budgets constrain this responsiveness and are meaningless as soon as they are completed. Mainfreight’s resource allocation process operates continuously throughout the year providing branches with resources as and when they are required, subject to the general proviso that branches maintain their margins. In LORV terms, the company has replaced the low variety budget mechanism with a high variety resource allocation mechanism better suited to its high variety environment. Continuous resource allocations maximise branch managers’ ability to manage variety and attain their performance goals.

Resource negotiations involve direct discussions between branch and general managers. These exchanges are less about seeking formal authorization for the expenditure than about ensuring the reasoning underpinning the request is sound and the allocation can be accommodated alongside existing funding commitments. Mainfreight’s approach is summarized by one manager in this way:

Mainfreight is big on autonomy. Typically we let people make their own decisions. If an operational manager wants a new piece of equipment, say because he knows there’s a busy week coming up, he’ll let me know he has rung the forklift company to organize additional equipment. But he’s not looking for my approval. I trust him to know his work, and to use his own experience to decide what is needed and to get on with it. This approach let’s everyone focus on the business and the customer. When you get that right, then the financial returns will flow from that.

The advantage of conducting negotiations through face to face discussions is the ability to discuss a broader range of details about the proposed expenditure in less time than would be possible if budget request forms were used.

Together, autonomy and the continuous funding process facilitate branch managers’ ability to respond flexibly to changing market threats and opportunities in a timely manner. Consequently, changing conditions are viewed as sources of opportunity to be seized (Davies, 2013) rather than as threats to the achievement of pre-determined plans.

Enabling branch managers to handle the variety of the external operating environment reduces the need for higher-level involvement. Autonomy of the branches means that situations developing at the branch level are handled at this level; only residual variety

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3 Residual variety is similar to but subtly different from the concept of management by exception, variance analysis or diagnostic control. Variances and exceptions can often be resolved by managers operating at the level being considered. Residual variety refers to situations which cannot be handled by managers at a particular level due to, for example, lack of knowledge or resources. Issues which are not resolvable at one level
requires general managers’ attention. However, autonomy also increases the potential for inconsistent responses within the organisation thereby increasing internal variety. This risk is mitigated through coordination and monitoring processes (discussed below) that maintain the integrated operation of the overall network and consistent achievement of performance standards.

Accountability: Branches are held accountable for both financial and non-financial aspects of performance. Managers are expected to use their resources to deliver quality customer service while maintaining their margins, and to analyze their ‘weeklies’ to understand the impact of their decisions on financial performance. Weekly results are compared to own branch performance last year and across branches. The weeklies are reported to general managers as a means for ensuring that allocated resources are used appropriately and for tracking performance. KPI performance is reported on a monthly basis, and KPI league tables allow performance to be compared across branches. Comparisons of relative performance motivate best possible performance without the need for general management intervention. This point is discussed further in the section on coordination.

The format and timing of weeklies is standardized. This reduces the internal information (variety) that general managers need to consider and facilitates comparisons between branches. Limiting the content of weekly reports to key performance indicators, and brief comments about unanticipated conditions, reduces the detail general managers become involved with. In other words, branch managers deal with the full variety of their operations, limit what they report to general managers, and involve general managers only when there is an issue that cannot be handled at the branch level. Thus collective performance is maintained without slow and constraining reporting systems. General managers place minimal constraints on branch operations and involve themselves with branch level decisions on an exception-only basis. The influence of these controls on requisite variety is summarized in Figure 2.

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are escalated to the next higher level. This is not the same as upper management meddling when there is a variance and pre-empting responses by lower level managers.
**Attenuators:**
- GMs may intervene when BM decisions negatively impact wider network
- Weekly reports focus attention on limited number of key performance drivers

**Amplifiers:**
- Continuous resource allocation increases BMs ability to respond to prevailing opportunities;
- Face to face resourcing discussions ensure BMs are fully informed about proposed expenditures

**Figure 2: Variety engineering in the resource bargaining and accountability channel**

**System 2 Coordination information (Channel C):** Information communicated via coordination channel C contributes to the maintenance of common standards, promotes self-organisation amongst branches, and ensures the routine activities amongst them operate smoothly. Providing an integrated logistics service to customers requires high levels of coordination between branches, and the constellation of branches required to complete a particular delivery is continually changing. A multitude of factors contribute to the extremely high variety facing logistic services including, for example, choice of transport mode, type of product being delivered, urgency of delivery, and delivery routing. Mainfreight believes that branches are best placed to manage this variety but also ensure that each branch is fairly compensated for inter-branch transactions. Mainfreight has an inter-branch allocation schedule that specifies the standard rates branches will receive for handling deliveries originating in other branches. This standardizes inter-branch charges and ensures smaller branches are not disadvantaged by larger branches who might expect to keep a larger share of the customer revenue.

The company’s proprietary IT systems enable multiple branches to coordinate their activities and to interact in highly flexible ways. Real-time information from operational IT systems is used to coordinate activities across the network. For example, when Branch A receives an order to ship goods from a logistics warehouse in country X to a customer specified location in country Y it enters this information in the operational system. The sending and receiving branches, as well as the intermediary logistics, international and domestic services,
coordinate their actions by accessing the shared information. The key point to note is that although the procedures for operational IT use are determined by general managers, it is branch managers’ actual usage which produces the coordination. In other words, while System 3 provides the system, it is the use of it by Systems 1 that delivers System 2 coordination. At Mainfreight, the coordination of activities between inter-dependent branches is achieved through real-time information and networks, rather than *a priori* plans and budgets.

General managers develop processes to foster the self-organizing ability of branches. They do this by inducting branch managers into formal networks and helping them to develop informal networks. Centralized training and leadership development courses, such as induction or Outward Bound⁴ courses, create cohorts within the company which provide the basis for internal networks. Organized face-to-face meetings, of branch managers or finance professionals, for example, also foster the development of working relationships. Managers of similar or ‘buddy’ branches visit one another’s facilities each year to compare performance and share knowledge about how to improve it. Pairing similar branches in this way facilitates knowledge sharing, promotes best practice throughout the network and develops synergies without the involvement of general managers.

The weekly performance information contributes to branch self-management. Information about current performance is available to branch managers and they can consider how to improve it without the need for general management intervention or monitoring. The dissemination of weekly profitability and KPI information on branch Quality Boards invites the entire team to become involved in improving branch performance. Furthermore, the branch-based Positive Action Teams (PATs) meet regularly to discuss how to maintain smooth operations and improve performance.

The performance of branches is compared so that relative performance can be assessed. Branches consider their financial performance in relation to last year and to similar sized branches. All branches are included in league tables of KPIs performance. These comparisons make performance visible to peers and reinforce the intent of general managers that branches achieve the best possible results. Publicizing this information reduces variations in branch performance because ‘deviant’ behaviour, meaning poor performance, is discouraged without the need for general management involvement. Peer visibility motivates

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⁴ An outdoor-based experiential growth and development course
branch teams to achieve best possible performance and reduces the involvement required of group managers.

Managers’ ability to respond to emerging conditions is influenced by the timeliness of feedback information. The weekly reports provide real-time information which enables branch managers to adjust their activities to maintain performance. The speed of the feedback enables branch managers to initiate responses *at the same rate* at which changes emerge in the environment.

Mainfreight’s culture, core beliefs and values, embedded in ‘the three pillars of Mainfreight’, facilitate inter-branch coordination without the need for formally stated plans. The pillars promote specific behaviour that reflects a family approach, team effort, open discussion, group problem solving, mutual support and open information. Open access to information is promoted through open offices, formal and informal networks and IT systems. The corporate culture, which supports the rapid exchange of information throughout the company, facilitates the quick recognition of and response to changing conditions. The three pillars illustrate the operation of System 5, which enacts policies to promote a cohesive sense of identity. The three pillars serve to strengthen the operation of System 2 enhancing both overall coordination and organisational cohesion. The ready availability of information in the formal and informal systems enables interacting branches to mutually adjust their activities to meet customer logistic requirements. The influence of these controls on the company’s ability to manage variety is summarized in Figure 3.

**Figure 3: Variety engineering in coordination channel**
**System 3* Monitoring information (channel D):** Detailed information about selected aspects of Systems 1 activity is communicated via monitoring channel D. This channel provides information over and above that possible through the accountability and routine reporting channels which have been designed by System 3 to necessarily filter out information, some of which may be significant. In other words the monitoring channel is a high variety channel which compensates for the low variety channels dealing with structured information. An important feature of this high variety channel is that general managers initiate the monitoring on an *ad hoc* basis to access detailed information about specific issues from branches. The information sought could, for example, indicate how well branches are complying with company standards or norms of behaviors. Alternately, monitoring could be undertaken in a purely exploratory, intuitive way, as evidenced in approaches such as ‘management by walking about’ or Toyota’s ‘Genshi Genbutsu’ – ‘go and see’. Direct observations made during branch visits and details revealed in conversations with key customers are a valuable way to collect information that might otherwise remain unnoticed.

One member of the executive describes the importance of the monitoring channel, and its value for identifying how branches actually operate:

> We also learn a lot about how branches operate by walking around. One of our underperforming divisions is [division X in country Y]. I found out last time I was there that the branch managers couldn’t get at their general ledgers. The accountant thought they shouldn’t have all that information. We were just ... lucky to find out about it. And so the branches have their access back.

Branches are also subject to semi-annual internal audits. Team members from the training department with operational and sales experience visit branches and review their systems to make sure they are being used to the fullest extent. The internal audit team accesses detailed information about various aspects of branch operations. Branches are audited twice a year with one audit being unannounced. The audits consider how branches conduct their activities and their adherence to company standards. The requirement for internal audits influences branches to conform to expected standards of behaviour and performance.

The audit report is fed back to branch and general managers. The information is used by branch managers to respond to departures from expected standards, and by general managers to determine when to modify performance standards across the network. Figure 4 summarizes how monitoring information enables Mainfreight to manage variety.
Amplifiers:
- GMs discussions with clients and site visits reveals insights into performance
- Internal audit reveals whether expected standards are being met

Attenuators:
- Existence of oversight processes reduces variability in branch performance without need for GM intervention

Figure 4: Variety engineering in monitoring channel

Summary

To summarize, Mainfreight’s branch managers face high variety in the external environment and the operational control system supports their autonomy subject to minimal constraints. Managers have the flexibility required to respond to the situations they face. The continuous operation of the resource bargaining process (Channel B) allows branches to acquire resources in response to new opportunities as they arise. Weekly accountability reports (Channel B) inform branch managers when activities need to be adjusted and general managers whether performance is on track. Real-time operational information provided via coordination channel (Channel C) allows branches to mutually adjust activities in response to customer service requirements. The detailed information about ad hoc issues, communicated via monitoring channel (Channel D), allows general managers to understand the factors influencing performance and stimulates their search for improvements. Mainfreight’s system empowers those closest to day-to-day activities, namely branch managers, to handle variety. A key feature of the systems is the formalised use of informal processes, such as System 2 coordination processes and System 3* monitoring processes that promote self-organisation. The informal processes reduce the involvement required of general managers in operational decisions, thereby freeing them to focus on maintaining cohesion and developing synergy throughout the network. Table 1 summarizes how Mainfreight’s control system manages variety.

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<th>Variety engineering impact</th>
<th>Attenuate</th>
<th>Amplify</th>
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<tr>
<td>Structures Branch structure</td>
<td>Ability to handle variety is amplified</td>
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<tr>
<td>Directives Channel A (3→1)</td>
<td>Branches are required to prepare and disseminate weekly results in prescribed format.</td>
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<td>---------------------------</td>
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| Resource negotiations Channel B (3↔1): Accountability Channel B (1→3) | Heuristics establish minimum performance targets for profit and KPIs  
Occasional GM intervention to provide broader perspective on branch decisions, and modify decisions that reduce synergy of overall network | Continuous resourcing process enables BMs to respond to respond opportunities as they arise  
Face to face discussions provide BMs with information about proposed expenditures |
| Coordination Channel C (2↔1) | League tables make results visible to peers and reduce variations in branch performance without GM intervention  
Allocation schedule standardizes inter-branch charges across network | Availability of real time operational information enables dynamic coordination of branch activities  
Weekly performance feedback and peer comparisons inform BMs when improvements are needed  
PAT discussions drive continuous improvement  
Access to information - via networks, posted results and open plan offices - improves BMs ability to respond to prevailing conditions  
Corporate culture fosters open discussion, team problem solving and open information |
| Monitoring Channel D (3*-1) | Existence of internal audit process promotes adherence to standards and reduces variations in branch performance without need for GM intervention | Detailed information accessed via branch visits, customer conversations and internal audits reveals conformance to expected standards and opportunities to improve processes and adjust standards |

Table 1: How Mainfreight’s control system manages variety

The LORV analysis reveals Mainfreight’s approach to control relies on increasing branches’ ability to respond to external variety and reducing the need for general management intervention at the operational level. The company’s overall variety is handled via its 220 branches, each of which handles a sub-set of external variety. General managers typically intervene in branch operations only when branch decisions negatively impact the performance of the wider network or when there are issues that branches cannot resolve themselves, i.e. residual variety.
The analysis shows that the communication flows supporting Mainfreight’s approach to control are predominantly horizontal rather than vertical. This pattern of communication indicates that information flows directly between operational units without relying on the intervention of general managers. This pattern of information flows typifies systems designed to support self-regulation of operational units (Systems1). Mainfreight’s system provides branch managers (Systems 1) with extensive real-time information through IT systems and formal and informal networks (System 2) and detailed ad hoc information through internal audits and branch visits (System 3*). The vertical communication flows involve general managers (System 3) in branch decisions only when there are outstanding issues (residual variety) or decisions impacting performance of the wider network. Finally, Mainfreight’s culture, values and principles influence how things are done in the company and empower team members to act. The implications of the analysis are discussed next.

4. Discussion
The preceding section considered the management control system of a logistics business through a cybernetic lens. The VSM and LORV were used to describe and analyze the systems, respectively. The highly flexible, beyond-budgeting system was easily mapped onto the VSM, to reveal its underlying structural features. The completed model reveals the constellation of roles and processes through which the organization enacts the VSM functions of cohesion, coordination and monitoring. This part of the analysis demonstrates the usefulness of the VSM as a tool for succinctly presenting the key components of organizational control systems.

The analytical power of the VSM stems from its grounding in the law of requisite variety (LORV). Using the VSM as a guide, a systematic analysis of the communications between interacting components of the system was conducted to reveal how the company manages variety to achieve control. Mainfreight’s system operates by increasing (amplifying) branch managers’ ability to respond to unanticipated developments impacting financial performance.

Mainfreight’s control system is well suited to a highly turbulent operating environment i.e. a high variety situation. The company’s control system has a preponderance of amplifiers. Their role can be likened to shock absorbers which maintain smooth performance despite bumps in the road. Amplifiers provide branch managers with high levels of flexibility to respond to ever changing external conditions in ways that maintain goal performance. Branch managers use their autonomy to respond to situations as they develop and draw on the
MCS to provide the resources, information and feedback they need to regulate their own performance. This approach to control minimizes the interventions required of higher level managers in operational decisions. The risk inherent in granting branches high levels of autonomy is that individual branch decisions may negatively impact the wider network. Mainfreight’s upper management counters this risk by using regular site visits to promote the company’s culture, philosophy and values and to flush out opportunities and issues that would otherwise be undetected.

The insights provided by the VSM analysis of the control system are consistent with observations reported in the literature. In particular, the large body of empirical contingency theory research, reviewed by Chenhall (2003), clearly recognizes the relationship between control arrangements and the operating environments of organizations. Nonetheless, there is little explicit recognition in the research of the influence of the target dimension on this relationship. Arguably, the LORV provides a rigorous theoretical foundation for management control research, thus overcoming the acknowledged absence of a theoretical base in contingency theory (Otley, 1980), to encompass all relevant dimensions. Furthermore, claims have been made that the insights provided by the LORV are consistent with and help explain the findings from research into reliance on accounting performance measures (RAPM) and budgetary slack (Morlidge, 2010).

The control systems in some organizations are designed to embrace environmental variety and enhance management’s ability to respond to it. According to Scala et al. (2006), organizations operating in turbulent environments are likely to rely on ad hoc decision making, coordinate ill-defined and overlapping tasks through mutual adjustment, and require systems that allow for a wide range of responses i.e. support high variety (Scala et al., 2006, p. 28). Similarly, de Leeuw and Volberda (1996, p. 132) report that in organizations operating in turbulent environments, managers need a wide range of procedures to control the organization and the environment. These statements reflect the approach to control observed in Mainfreight. The MCS supports the high level of autonomy granted to branch managers, allowing them to respond flexibly (in contrast to ad hoc responses in a pejorative sense) to changing conditions.

The VSM perspective on control is based on the concept of requisite variety. While requisite variety is not directly observable its existence can be inferred when organizations are able to consistently achieve their performance goals in the face of unanticipated disturbances.
Evidence suggests that Mainfreight’s MCS can generate requisite variety. Branches were able to maintain profitability despite a range of unanticipated events such as, for example, the 2011 Christchurch earthquake, the 2012 New York floods, and the global financial crisis. While requisite variety cannot be directly observed, the literature suggests the its lack will be revealed by commonly observed pathologies (Hoverstadt, 2010; Morlidge, 2010; Pérez Ríos, 2012).

The VSM and LORV reveal how interactions between system components create a balance between external variety and organizations’ ability to respond to it. The concepts of amplifiers and attenuators provide the foundation for meta-analysis of control systems to understand how this balance is achieved. When MCS are considered from a variety engineering perspective, the focus of attention is on the way different packages of controls combine to balance variety, rather than on the operation of isolated mechanisms or distinctions such as existence or use of control mechanism. The VSM and LORV provide additional tools that management control researchers can use to investigate the integrated operation of control systems.

In summary, a cybernetic analysis approach utilizing the VSM and LORV provides an alternate understanding of how control systems operate to achieve balance and control. Analyses guided by the VSM and LORV consider whether the set of possible actions when matched to the set of potential disturbances can produce viable outcomes (Burton & Forsyth, 1986). The interactions between components of the system influence whether the organization can balance external variety with organizational responses. The concept of interaction and balance promoted by the VSM and LORV can inform current management accounting research considering these issues (see for example Henri, 2006; Mundy, 2010).

There are many avenues for future research. This paper analyzed the operational control processes operating at a single level of recursion. The research could be extended to incorporate additional levels of recursion, and consider the interactions between the various levels. Mapping multiple levels of control study would provide insights about the alignment of control systems between organizational levels. A second extension would be to include the strategic intelligence and policy functions to support analysis of the complete control system. Including the remaining two systems would allow an analysis of the interactions between operational and strategic control functions to understand how organizations balance their competing needs for operational efficiency and strategic adaption. Thirdly, our analysis
revealed that regulatory systems which make greater use of amplifiers than attenuators have greater flexibility and can more readily absorb the impact of external shocks. Hypotheses could be developed around this insight and tested in future research. Finally, the systems analyzed in this paper arguably represent extreme positions on a continuum of control approaches. Future research could use the VSM and LORV to analyze more typical control packages in use by other organizations to identify the specific attenuators and amplifiers through which the organizations manage variety.

5. Conclusion

This paper argues that the viable system model (VSM), and the law of requisite variety (LORV) which it embodies, extend our understanding of control systems. These concepts provide insights about the operation of control systems in complex, real world settings beyond those available from other management control frameworks.

One contribution of the paper is to re-conceptualize control in terms of LORV. Management control systems can be understood as systems for managing variety to achieve organizational goals. According to the LORV achieving control depends on the regulator having a range (variety) of responses equal to or greater than the range (variety) of disturbances impacting the system being controlled. In other words, control depends on the regulator having requisite variety. This conceptualization offers new avenues for research and new understandings of existing control research.

This paper offers a way to close an acknowledged gap in existing frameworks of control. The accounting control literature provides little discussion about the communication channels linking components of control systems. The VSM specifies and describes the nature of seven communication channels that are integral to the operation of control systems. According to Rosenkranz and Holten (2010, p. 24) “the VSM is an appropriate language for modeling the information flows and communication channels between an organization’s parts”. The VSM provides a detailed description of the communication channels required in control systems and how they operate while the LORV analyses these in terms of attenuators and amplifiers. This knowledge can be used to extend existing frameworks of control such as the levers of control (Simons, 1996) and the performance management framework (Ferreira & Otley, 2009).
Finally, the paper demonstrates the usefulness of the VSM and LORV for researching control of dynamic systems. They comprise a practical tool kit for understanding management control systems. The VSM depicts the underlying structure of the system and the interactions through which variety is managed. The interactions between the interdependent components become the focus of any analysis, which as Scala et al (2006, p. 36) note is the appropriate unit of analysis for dynamic systems. The LORV is useful for assessing whether communications between interacting components help attenuate variety or amplify the organization’s ability to respond to it. The cybernetic analysis focuses on the impact of the communications on variety management, rather than on the content or type of information. It moves beyond the specificity of the information flows to their role as attenuators and amplifiers of variety. The cybernetic view provides incisive insights about control systems, such as their ability to absorb shocks and respond to unanticipated conditions. Furthermore, the VSM and LORV can be applied to any type of organization, thus enabling comparisons of seemingly disparate control systems to be conducted.

We believe the VSM and the LORV are useful tools for guiding management control research and encourage other researchers to consider them in their studies.
Appendix A

This appendix briefly describes the sophisticated and subtle internal structure of the VSM.

The VSM identifies five necessary and sufficient components of viable systems and the interactions between them (Beer, 1995). The components are generally called ‘systems’ and each performs a specific regulatory role. The components are usually referred to simply as Systems 1 to 5\(^5\) but, to facilitate understanding, this paper adopts the convention of labeling the systems with their number and a label e.g. System 3 (Control). Figure 5 shows the diagrammatic form of the VSM.

Figure 5 uses the example of a university focusing on the financial control system. The VSM identifies the organisational roles and tasks contributing to each function of the control system and the internal communication channels that link these functions.

From Table 2 it can be seen that the Senior Management Team and various committees contribute to System 3 (Control) by participating in resourcing discussions with Faculties (Systems 1) via the resource bargaining channel B. The lines in the diagram indicate communication channels and are labeled with the letters A - G. The channels indicate how control information circulates in the system to support different control functions. The channels mediate interactions between the five systems and undertake distinct roles such that the systems interact in certain well defined ways. The two way communications underpinning the interrelationships between components may be formal (e.g. the exchange of information in the form of prescribed reports) or informal (e.g. direct observations or face-to-face conversations).

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\(^5\) These are systems 1 to 5 plus System 3* [read ‘three star’] which is not usually counted as a separate system
Figure 5: Components of financial control system at University level

In addition to the channels mediating relationships within the VSM, there are channels connecting the VSM to the external environment. The channel between System(s) 1 and the immediate environment manages the value creating exchanges which sustain the whole system in the short term. The value added at the university level is determined by the institution’s brand image. The strength of the university’s brand influences its ability to attract top notch staff and students and to generate fees and research revenues. The channel
between System 4 and the (potential) future environment helps the system to anticipate external changes to which it must adapt. Table 2 and Table 3 further elaborate on the components of the VSM depicted in Figure 5.

Table 2 provides a brief description of each VSM system. System1s (Implementation) undertake the value adding activities of the organization. The regulation of operational activity is handled by Systems 3 (Control) supported by its Systems 2 (Coordination) and 3* (Monitoring) functions. System 4 (Intelligence) responds to the strategic risks and opportunities facing the organization and develops plans for adaptation and change. System 5 (Policy) maintains organizational identity and vision. Figure 1 and the final column of Table 2 indicate how these systems could be constituted in a University.

Table 3 briefly describes the seven communication channels that support the operation of the five systems. The four key channels available to regulate Systems 1 (Implementation), labeled A through D, are distinguished by the different types of communication they support. For example channel A conveys non-negotiable directives in one direction while channel B supports two way negotiations about resourcing and accountability requirements. The final column of Table 2 provides examples of the communication channels that might be evident in a University setting.

The VSM has a recursive structure meaning its systems and channels are duplicated at multiple levels. Each set of systems 1 to 5 (one recursion) sits within system 1 of the level above. Figure 5 for example, presents a University-level view in which Faculties are Systems 1. The next lower level would present the Faculty level with departments as System 1s; the next lower level would present Departments with courses as their Systems 1.
<table>
<thead>
<tr>
<th>System</th>
<th>Commonly labelled</th>
<th>Description</th>
<th>University illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Policy</td>
<td>Maintains organizational values, rules and norms; maintains organizational identity; chooses future directions; creates organizational structures</td>
<td>Senate and Vice Chancellor are responsible for maintaining the university’s identity as a research led, campus based institution of higher education</td>
</tr>
<tr>
<td>4</td>
<td>Intelligence</td>
<td>Monitors the external environment for opportunities and threats and develops proposals for adaptation and change</td>
<td>Vice Chancellor and Senior Management Team monitor government education funding policies and student enrolment trends to anticipate resource implications of developing changes</td>
</tr>
<tr>
<td>3*</td>
<td>Monitoring</td>
<td>Conducts ad hoc inquiries into the activities of System(s) 1 activities to provide detailed data to System 3</td>
<td>Ad hoc project teams or committees may investigate extent of particular practices, such as e-learning, and their resourcing implications for the university</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>Manages System(s) 1 for efficiency, synergy and cohesion. Its role is to allocate resources, ensure accountability and implement policies set by higher systems</td>
<td>Senior Management Team and Budget and Planning Committees are responsible for how financial resources are allocated across the university</td>
</tr>
<tr>
<td>2</td>
<td>Co-ordination</td>
<td>Coordinates activities of System(s) 1 to ensure smooth operations and consistent standards</td>
<td>Planning and Budget Committees establish guidelines for budget process to standardize budget submissions</td>
</tr>
<tr>
<td>1</td>
<td>Implementation</td>
<td>Is composed of a collection of self-managed operational sub-units which perform the value adding activities of the system by exchange with the environment. Typically multiple operational units co-exist within one viable system</td>
<td>University implements its strategy via Faculties, which are treated as black boxes by higher level systems 2-5.</td>
</tr>
</tbody>
</table>

Table 2: Components of Viable System Model
<table>
<thead>
<tr>
<th>Channel</th>
<th>Name</th>
<th>Linking</th>
<th>Description</th>
<th>University illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Command</td>
<td>S1 – S3</td>
<td>To communicate and manage compliance to legal and corporate requirements and cultural norms</td>
<td>Formal notifications sent to relevant parties about statistics required to be reported to Tertiary Education Commission</td>
</tr>
<tr>
<td>B</td>
<td>Resource bargaining &amp; accountability</td>
<td>S1-S3</td>
<td>To support negotiations about action programs and resourcing and convey accountability information</td>
<td>Draft budgets are submitted, reviewed and negotiated in an iterative process involving representatives from Faculties and Budget Committee; Faculties report against their Annual Plan (and budget) twice a year.</td>
</tr>
<tr>
<td>C</td>
<td>Anti-oscillation or Coordination</td>
<td>S1-S2-S3</td>
<td>To communicate common standards and conventions through guidelines, and maintain routine information systems</td>
<td>Planning and Accountability Guidelines are available on the intranet and more detailed queries answered via email or direct meetings. The guidelines specify formats and timelines for Annual Plans and budgets. Routine reports of overall performance</td>
</tr>
<tr>
<td>D</td>
<td>Audit</td>
<td>S1- S3*-S3</td>
<td>To convey detailed information about specific aspects of operational performance on an ad hoc basis</td>
<td>Special investigation teams may conduct interviews and discussions to learn about issues of importance such as extent of resources committed to e-learning</td>
</tr>
<tr>
<td>E</td>
<td>S3-S4 homeostat</td>
<td>S3-S4</td>
<td>To establish a balance between the requirements of existing operations (as represented by S3) and the anticipated demands of the future environment (as represented by S4) through intense interaction and debate</td>
<td>Annual strategic planning retreats bring different levels of management together for intense discussions of strategic uncertainties including issues affecting university resourcing</td>
</tr>
<tr>
<td>F</td>
<td>Policy intervention</td>
<td>S5:S3-S4</td>
<td>To communicate vision, mission, identify To guide the operation of the S3-S4 homeostat</td>
<td>Intranet used to disseminate University’s Strategic Plan</td>
</tr>
<tr>
<td>G</td>
<td>Algedonic</td>
<td>S1-S5</td>
<td>To quickly convey information in the event of emergency or failure in the (S2-S3- S3*-S4) management system (an organizational ‘override’ channel)</td>
<td>A special channel is required to notify senior management of issues such as budget improprieties</td>
</tr>
</tbody>
</table>

**Table 3: Channels of viable system model**
Each set of five systems reflects a different level of resolution and interacts with a different subset of the environment. Each recursion must manage the specific environmental variety it faces and attempt to establish requisite variety. Each recursion manages variety using exactly the same pattern of control components, i.e. systems 1 to 5 and the associated communication channels. For example, at the level of the university resources are allocated between faculties by means of faculty budgets, but within faculties the same function is discharged through departmental budgets.

Three preliminary insights relevant to management control research can be drawn from these figures and tables. First, the VSM makes the distinctions between different dimensions of control explicit by recognizing coordination, monitoring, control, intelligence and policy as separate functions. Second, organizational members can contribute to multiple control roles. For example, the senior management team (SMT) as shown in Figure 5 operates as part of Systems 3 (Control) and 4 (Intelligence) functions. In the first role, the SMT focus is on the efficient use of resource across the University while in the second it shifts to the identification of external trends which might impact the university’s future operations. Third, accounting control information flows is communicated via multiple channels to support different components of control. Table 3 for example, indicates that budget information is conveyed to/from System 3 (Control) via channel B to support resourcing and accountability negotiations with Systems 1 (Implementation), and to/from System 2 (Coordination) via channel C to provide guidance to Systems 1 (Implementation) about budgeting procedures and to capture routine information to track performance.
References


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