Management Control: The Influence of Cybernetics and the Science of the Unknowable

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1 Introduction

Systems and cybernetic concepts are evident throughout Tony Lowe's early work (Lowe 1971a; Lowe and McInnes 1971; Lowe and Tinker 1976a, p. 258, b; Tinker and Lowe 1978). Tony made considerable effort to explore how systems and cybernetic concepts could advance our understanding of management control systems. There is no doubt he was well acquainted with key themes developing in general systems theory and cybernetics, and regularly invoked concepts from these disciplines in his work. This article considers two systems and cybernetic themes present in Tony's work, namely the design or structure of control systems and the law of requisite variety.

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A review of selected publications reveals the fundamental systems ideas underpinning Tony's work. His thinking was underpinned by the idea that control systems should be designed so that organisations can manage their relationship with the environment; should integrate strategic, management and operational control processes; and require both feedback and feedforward information in order to function. He argues that the fundamental role of control systems is to manage the organisation's relationships with its environment. This view is consistently maintained throughout his work. Early statements argue that effective control systems are those that can manage the critical enterprise-environment relationship (Lowe and McInnes 1971) while, later, Lowe and Puxty continue to assert that control "is predicated on an understanding of the necessary relationship between an organisation and its environment" (Lowe and Puxty 1989, p. 22).

Tony (Lowe and McInnes 1971; Lowe and Puxty 1989; Lowe & Tinker 1977) argued for a holistic view of control systems and challenged Anthony's view (1965) of: a three-way distinction between strategic, management and operational control; strategic control and strategic planning as the domain of senior management; strategic planning as a precedent to management control with the latter's role simply to implement those plans and; management control as efforts to influence individual behaviour to ensure strategic plans are achieved. Tony consistently advocated for the adoption of control systems that integrated both planning and control, and focused on control of the organisation rather than the individual. He argued that "being able to ensure that the managers controlled do as the plans require is a very different concept from being able to ensure that the organisation adapts…to its environment" (Lowe and Puxty 1989, p. 22).

Tony also advocated for a broader view of control than that achieved through simple feedback processes. He argued that 'control' depends on both time-lagged feedback information and feed-forward information (Lowe and Puxty 1989). He took issue with the traditional conceptualization of feedforward information as a product of periodic planning processes, operating independent of management control processes. Lowe and Puxty argue that planning must take place continuously, at all levels of the organisation. Continual planning processes operating at multiple levels help the organisation foresee its next move in relation to its environment and anticipate which actions will minimise disruptions caused by changes in the environment (Lowe and Puxty 1989, p. 20). Planning is thus considered the aspect of control that introduces feedforward information into the control system.

Tony's work on planning and control reflects his efforts to develop a framework that integrated a broader view of control than was apparent in the literature at the time. A particular feature was his insistence on the importance of feedback and feedforward information flows. His proposed framework incorporated the organisation and its environment, integrated strategic, management and operational control processes and included both feedback and feedforward information flows used for control (Lowe and Puxty 1989, p. 21).

In the remainder of the chapter we first examine selected aspects of the cybernetic ideas incorporated into Tony's work. In the next section we review the influence of cybernetics as seen through Tony Lowe's work. This is followed by a discussion of Stafford Beer and his development of the viable system model. Following this we analyse the VSM and its contribution to management control to provide a more situated understanding of Tony's insights and to consider their apparent limitations. We next offer a comparison between cybernetics and contingency theory prior to some thoughts on the demise of cybernetic enquiry as research interests in management control switched very strongly at first to contingency theory and subsequently to Simons' levers of control. Finally, we provide concluding thoughts and brief suggestions for further research.

2 Early Research on Management Control: Tony Lowe and the Contribution of Cybernetics

In this section we outline some of the significant ideas that cybernetics has contributed to management control and planning systems. Initially, we describe Tony Lowe's cybernetics-inspired framework of control that sought to integrate different dimensions of control with feedback and feedforward information flows. He argued that such a framework was the only way to achieve a holistic understanding of how control processes fit together and interact to achieve organisational control (Lowe and Puxty 1989, p. 21). This framework is briefly summarized in the following section.

2.1 The Rrelude to Control: Information Gathering

Tony approached the problem of control system design from an information processing perspective with the aim of creating a model of business decision-making. He described management control as "a system of organisational information seeking and gathering, accountability, and feedback designed to ensure that the enterprise adapts to changes in its substantive environment" (Lowe 1971b, p. 5). He conceptualized the organisation as a bounded collection of five elements, namely information centres and decision centres, linked by information flows, guided by decision rules, synthesized within the management decision system. These components provided the base for his model of control for business enterprises. Here Tony depicted the enterprise-environment relationship as an input–output transformation taking place in an open system. Inputs and outputs were interpreted as "a large and diverse collection of human needs and values" (Lowe and McInnes 1971, p. 222). The internal structures were the arrangements required by organisations to relate and adapt to their dynamic external environments (Lowe 1972; Lowe & Tinker 1977) and consisted of three interacting sub-systems, labelled the decision and control, funds flow and operating systems, linked by feedback and feedforward information flows. The model is depicted in Fig. 1 and further explained below.

The organisation being managed is presented in the centre of Fig. 1. It operates within its substantial[1] environment. The structure of the enterprise as a system refers to the relationships of the elements within the enterprise and also with the behaviour of the enterprise, as a whole, in relation to its environment (Lowe and McInnes 1971, p. 218). An organisation's interactions with the substantial environment involve receiving informational, financial and physical inputs from it and returning trans-

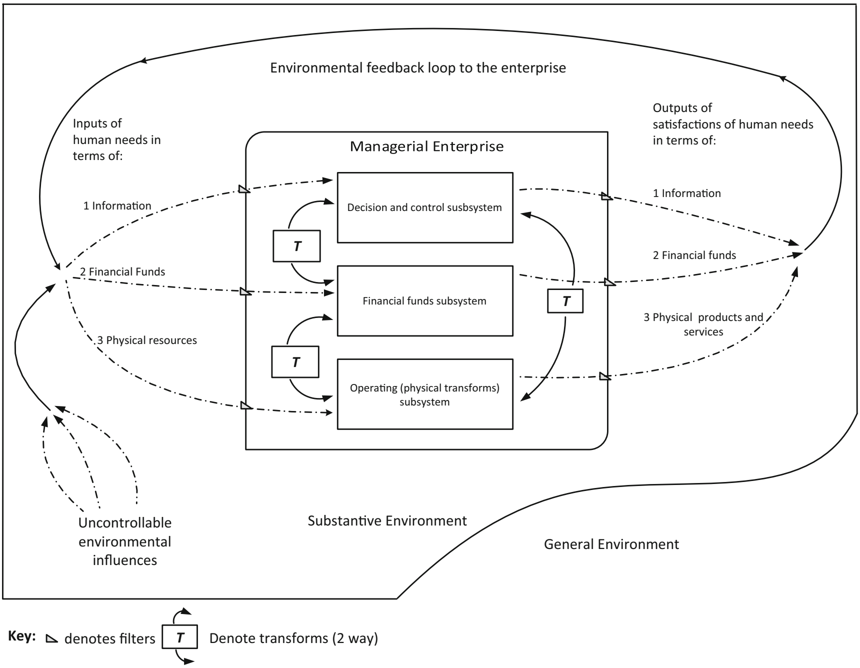

Fig. 1 The business enterprise as a financial-economic system (Lowe and Tinker 1977, p. 178)

formed informational, financial and physical outputs to it. The outflows from the organisation can be used to influence the substantial environment in ways that favour the organisation (Lowe and McInnes 1971, p. 114) and consequently reduce the organisation's need to adapt to it.

The components of the internal structure are the decision and control, financial funds and operating (physical transformation) sub-systems. The decision and control sub-system is comprised of a predictive model of future possible states and a choice model. This sub-system manages the existing transformation process and also anticipates the future by searching for new opportunities and threats, and imagining their consequences for the three sub-systems.

An organisation manages its interactions with the substantive environment to influence its performance in terms of its selected performance criteria. Successful organisations are able to match conditions in the substantive environment with their internal organisation (Lowe and Tinker 1977 p. 175) either by increasing their ability to respond to changes in the environment or by exerting influence to minimize the impact of those changes. As environmental conditions change, organisations learn and adapt, making changes to, for example, their decision models, transformation processes, performance criteria or objectives in order to achieve their expected performance.

The internal structures must be capable of controlling both routine, repetitive input–output processes and innovative and imaginative processes required for longer term viability and adaptability (Lowe and Tinker 1977 p. 174). Accordingly, internal structures must have the ability to manage uncontrollable factors in the substantive environment that can impact organisational performance. Controlling these factors is achieved by acquiring additional information about them and anticipating their likely impact on performance. The decision and control system thus integrates strategic control alongside management control by supporting "management's 'imaginative faculty', for speculation and anticipation, involving both search for new opportunities and the reduction of hypothetical states to the consequences for the three sub-systems" (Lowe and Tinker 1977 p. 179). Thus the interactions between the organisation and its environment reflect both operational and strategic issues.

A second system-based theme evident in Tony's work is the law of requisite variety, as discussed next.

2.2 The Law of Requisite Variety

A second system's concept drawn on in Tony's work is Ashby's (1958) law of requisite variety (LORV). Basically, the law states that effective control depends on the regulator having a range of responses (variety) that matches the range of conditions (variety) that it has to manage. Accordingly, Lowe and Tinker (1977) argue that for organisations to control performance, internal structures must be able to produce the range of responses (variety) required to match the variety being generated in the substantial environment. Furthermore, management's control capability is influenced by the quality of information supplied to it and decision rules embedded in the decision system. Existing decision rules are applied by lower level operating programmes until dynamic environments require the decision system to generate new responses (variety). Modifications to decision rules and operating programmes are made by higher order programmes referred to as monitors. Ultimately, the variety of the response repertoire available to performance programmes is predicated on the monitors governing their behaviour. The LORV determines the extent of adaptation and innovation capacity required in the organisation's problem solving mechanisms (decision models or programmes).

Tony recognized the importance of devising internal structures that promote organisational control by establishing requisite variety between the organisation and its substantial environment. The logical progression of this work would be to synthesize these concepts within a single model. A further extension of Lowe's view of organisational control would be to disentangle the information and decision centres comprising the decision and control system, and their associated information flows including the communication underpinning them. This challenge was not taken up in the management accounting literature. In the next section, we consider how Tony's model could have been extended from the work of Stafford Beer.

3 Stafford Beer and the Viable System Model

Beer's work (1981, 1985, 1995) centred on the development of the viable system model (VSM). In the VSM Beer sought to design an internal structure through which the organisation could satisfy the law of requisite variety. The internal structure in the VSM is comprised of five components, labelled systems 1–5,[2] and the communication channels and information flows connecting them. The key systems are briefly described in Table **1**.

The systems listed in Table **1** do not align precisely with the internal elements identified by Lowe, but nonetheless address the same issues. Systems 1 Implementation of the VSM are equivalent to Lowe's physical transformation system. The remaining systems can be equated with

Table 1 Systems of the viable system model

System	Commonly labelled	Description
5	Policy	Maintains organizational values, rules, norms and identity; chooses future directions; creates organizational structures
4	Intelligence	Monitors the external environment for opportunities and threats and develops proposals for adaptation and change
3*	Monitoring	Gathers information directly from Systems (1) via ad hoc inquiries to confirm information provided to System 3 and extend System 3 understanding of conditions impacting Systems (s) 1 performance
3	Cohesion	Manages System(s) 1 for efficiency, synergy and cohesion. It allocates resources, ensures accountability and implement policies set by higher systems
2	Co-ordination	Coordinates activities of System(s) 1 to ensure they function smoothly and adhere to consistent set of standards
1	Implementation	Is composed of a collection of self-managed operational sub-units which undertake value adding activities via exchanges with their local environments. Typically, multiple operational units co-exist within System 1

the decision and information centres sitting within Lowe's decision and control sub-system and indicate where specific functional decisions are made. Systems 5, 4 and 3[3] collectively form a 'meta-system' for regulating system 1. This distinction between regulator system and meta-system reflects Lowe and Tinker's distinction between operating programs and higher order monitor programs. They observe that "monitors…exist to control…lower order performance programs" (Lowe and Tinker 1976a, p. 148).

Each element of the regulatory system performs a specific function. System 3 Cohesion encompasses Lowe's financial funds subsystem (and Anthony's management control role). It functions are to promote efficiency of operations, allocate resource and maintain accountability. System 4 Intelligence has a role similar to Lowe's 'imaginative faculty' and Anthony's strategic planning. System 5 has a policy role which neither Lowe nor Anthony refer to. Finally, system 2 encompasses the organisation's formal information systems. This aligns with Tony's concept of information centres (Lowe 1971b).

Each VSM role is supported by particular information conveyed in specific communication channels. In Tony's model, all information types are labelled as generic information flows attached to the decision and control sub-system. The VSM more clearly delineates these information flows, specifying the types of information linking specific functions via particular communication channels. These channels and the information they convey are listed and briefly described in Table 2.

Furthermore, the VSM more clearly distinguishes the operational, management and strategic dimensions of control and shows how they

Table 2 Information channels in the viable system model

Channel	Name	Linking	Description
A	Command	S1–S3	Information to communicate and manage compliance to legal and corporate requirements and cultural norms
B	Resource bargaining and accountability	S1–S3	Information to support negotiations about action programs and resourcing and convey accountability information
C	Anti-oscillation or Coordination	S1–S2–S3	Information to communicate common standards and conventions through guidelines, and maintain routine information systems
D	Audit	S1–S3*–S3	Information about specific aspects of operational performance on an ad hoc basis
E	S3-S4 homeostat	S3–S4	Information 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
F	Policy intervention	S5–S3–S4	Information to communicate vision, mission, identify and to guide the operation of the S3–S4 homeostat
G	Algedonic	S1–S5	Information to quickly report incidences of emergency or failure in the (S2–S3–S3*–S4) management system (an organizational 'override' channel)

are integrated via the information they exchange. The VSM's systems identify the functions responsible for specific types of decisions while its channels clarify the types of information required by each. The VSM thus extends the model proposed by Lowe and Tinker (1977) by unbundling the dimensions of control implicit in the decision making and control system and separately identifying the types of information flows.

The VSM is typically presented in diagrammatic form, as shown in Fig. 2. The diagram clearly indicates how components of the control sys-

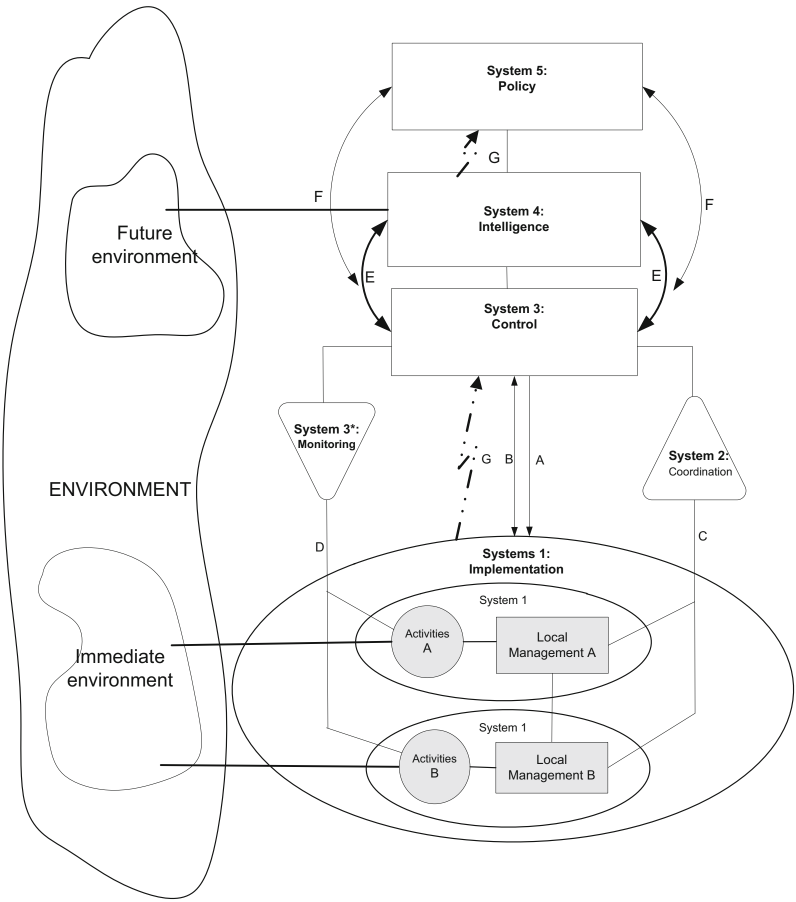

Fig. 2 The viable system model (Adapted from Beer 1981, pp. 130–31)

tem are intended to interact with one another via the specified communication channels. The systems and channels are labelled in the diagram to correspond with the functions and channels identified in Tables 1 and 2,respectively.

The VSM is also notable for being recursive, meaning each set of systems 1 to 5 nests within a higher level set of systems, a little like Russian Babushka dolls. The recursive aspect of the model directly relates to the observations made by Lowe and McInnis (Lowe and McInnes 1971, p. 214) about the usefulness of different levels of resolution or hierarchy. They state that "a careful and constant use of the idea of resolution levels will greatly assist analysis in the development of MCS". The use of resolution levels implies the enterprise control problem can be consistently decomposed by adopting the relevant focus. "In each case, the system being analysed is a somewhat different one, but each can be consistently related to the others in terms of the overall analysis of the MCS problem for the whole enterprise" (pp. 215–216). While the VSM can be used to depict multiple levels of recursion in a single diagram, the detail in the resulting model is not easily assimilated. The relevance of the VSM concepts of meta-system, system and recursion are presaged in Lowe and Tinker's comment that "indeed a whole hierarchy of decision processes, each operating on the one below may be envisaged" (1976a, p. 148).

4 The VSM and Its Contribution to Management Control

The preceding summary reveals that the VSM offers a more elaborate depiction of the systems and cybernetic concepts incorporated into the work done by Tony and his collaborators. The model identifies a structure which would allow organisations to achieve requisite variety and maintain performance in the face of changing environmental conditions. Nonetheless, there is a fundamental difference in the approach of the VSM and that adopted by Tony and his co-authors.

The premise underpinning Tony's work would fit with what Pickering describes as a world perceived as a regular law-like place that can be known more or less exhaustively. While unknowns are acknowledged to exist, they are something to be conquered and drawn into the world of the known (Pickering 2004, p. 30). This fundamental belief is evident in, for example, Lowe and Tinker's discussion of operating programmes into which decision rules and processes are embedded, and where the role of monitor programmes is seen to be establishing decision rules and determining when they need to be modified or changed. In contrast, the VSM reflects Beer's belief that exceedingly complex systems, which occur in social contexts, are unknowable and we have to learn how to cope with, rather than control, them. Complexity requires mechanisms that are capable of self-regulation,[4] meaning they can respond to situational perturbations, even those that have not been anticipated, in a way that maintains dynamic homeostasis. Furthermore, these mechanisms, referred to by Beer as homeostats, allow for continual learning and updating of decision routines and goals. A key differentiating feature here is that the self-regulation envisaged by the VSM is achievable within the system at each level of recursion, without the necessity for intervention from outside the system. The system or sub-system must have the ability to self-regulate thus limiting the issues to be managed outside the system, by a higher level regulator, to those that cannot be resolved at this current level of recursion.

The potential of the VSM to inform management control research has been explored in only a handful of studies to date. The VSM specifies the necessary and sufficient components of control systems, as indicated by cybernetic principles. One such application of the VSM for this purpose is provided by Bititci et al. (1999). As part of a wider study of best practice in performance measurement, the authors sought to identify a universally applicable business structure within which to position practices that promoted agility. They suggest that a synthesis of the VSM (Beer 1979, 1981, 1985) and business process thinking (Childe et al. 1994; Hammer 1990) could produce structures that organizations could use to maximize their ability to respond to rapidly changing operating environments. The researchers applied the VSM to assess the structure of their case organisations and concluded that a "viable business structure is cybernetic and is true for all businesses" (Bititci, et al. 1999, p. 197). The authors do note, however, that "our research…is not [able]…to provide objective data on the actual agility, responsiveness and performance of organizations using the viable business structure" (Bititci, et al. 1999, p. 198). More recent research provides some evidence of this link, as discussed next.

Morlidge (2010) drew on cybernetic principles to model financial performance management systems (FPMS). The VSM provided the framework for situating the principles within an organisational context (Morlidge 2010, p. 85). He proposes twelve structural principles that aligned with the systems and communication channels identified in the VSM. His eleven informational principles reflected the nature of the information required for regulation and the eleven regulatory principles addressed the processes used to support and update the decision rules and predictive models employed by the regulatory system. Having created a questionnaire based on the 34 principles, to measure the 'cybernetic health' of organisations, Morlidge applied it to two organisations. In a second stage analysis, he considered the relationship between the cybernetic scores and indicators of financial performance. In one assessment, he measured the cybernetic health of Unilever Poland before and after a major reorganisation involving changes to its organizational structure and practices. Morlidge (2010) found Unilever Poland's cybernetic score increased after the change and its revenues subsequent to the reorganisation were less volatile and grew more steadily in contrast to the volatility and steady decline prior to the changes. He concluded that cybernetic structure and organisational performance are linked.

Researchers in various disciplines are considering the potential of cybernetics and the law of requisite variety. Examples of recent studies include Ojha et al. (2013) who use the law of requisite variety to investigate the relationship between manufacturing flexibility and operational performance. They develop a requisite variety construct that matches manufacturing flexibility (internal variety) with demand variability (external variety). They find that manufacturing flexibility, interpreted as the ability to vary timing (using equipment flexibility), quantity (using volume flexibility), and output variety (using product-mix flexibility), enables the organisation to regulate work flow to match changing levels of demand variability. Godsiff and Maull (2011) explore sources of variability and the strategies adopted to manage it through the analysis of a case study based on a commercial laundry. They identified that the main source of variety was the volume component of demand and that the management system was designed to provide the capability to respond to it. Vogus and Sutcliffe (n.d.) investigate whether requisite variety allows organizations to notice more, develop a broader repertoire of responses, and be more adaptive over time. They develop a model to test the effects of requisite variety on risk detection (noticing), innovation (responding), and firm performance (adapting). They have yet to report the results of an application of their model to a sample of 174 IPO software firms. These and other studies indicate that cybernetics researchers are seeking ways to operationalize the LORV.

5 Cybernetics and Contingency Theory

A part of the argument we offer in this chapter concerns the relative neglect of cybernetic theory and the associated law of requisite variety in contingency based perspectives of control. The LORV offers interesting ways of extending and augmenting insights derived from contingency research in a management control system context. Contingency theory argues that the appropriate form of organisation varies according to contingent factors arising in the environment.

The LORV offers a more nuanced perspective of the relationship between environmental complexity and organisational structure. The law of requisite variety defines the qualities a regulator must possess, expressed in terms of variety, to achieve a desired outcome or goal set (Ashby 1958; Morlidge 2010). This means the goal set impacts the variety required of the regulator. For example, the options available to regulators trying to achieve multiple, precisely specified (tight) goals are more constrained than those available to regulators pursuing fewer, less specific (loose) goals. While contingency research considers the relationship between the environment and the organisational structure, it has not fully considered the influence of the goal set on the structure of this relationship. This more precise articulation of Ashby's law recognizes a three way relationship between the varieties of the environment, the regulator and the goal[s]. For effective control, the net variety of the regulator and its goal set must at least match that of the situation being controlled. This distinction between regulator and goal set allows for the development of hypotheses that offer significantly greater correspondence to the context than those presented by the more conventional and limited concepts that define contingency theory. Despite the limitations acknowledged in the contingency approach (Chenhall 2007; Otley 1980, 2015) the findings from this stream of research do not contradict the relationships suggested by cybernetic theory or the LORV as discussed next.

Morlidge (2010) reviews the findings of contingency research, as summarized by Chenhall (2003), from the perspective of cybernetics and req-

Table 3 Comparing contingency and cybernetic understandings of organisational control

Findings of contingency theory	Insights from cybernetics/LORV
Environment	
The more uncertain the external environment, the more open and externally focussed the MCS	Situations of high environmental uncertainty increase variety (open and external control systems) required of regulator
When tight financial controls are used in uncertain environments, they are associated with the simultaneous use of flexible, interpersonal interactions	The use of tight (low variety) goals in high variety (uncertain) settings increases use of mechanisms that increase regulators ability to respond (flexible interpersonal interactions) to changing conditions
The more hostile and turbulent the environment, the greater the reliance on formal controls, including traditional budgets	Unclear how to interpret this finding. For an organisation with a low variety control system, any form of environmental turbulence is 'hostile'
Technology	
Technologies characterised by standardised and automated processes rely more on traditional MCS (including budgets) and there is less incidence of slack	Low situational variety (standardised, automated processes) reduces the variety required of the regulator; no need to enhance variety via budget slack
With higher task uncertainty, there is less reliance on standard operating procedures and accounting performance measures, but higher incidence of participation, broad scope MCS and greater use of personal controls such as clans control	High situational variety (task uncertainty) increases use of mechanisms that enable regulator to respond to wide range (high variety) of conditions
Higher levels of process interdependence are characterised by the use of more informal controls, more frequent interaction and greater use of aggregated and integrated MCS	High situational variety (process interdependence) increases use of mechanisms that enable regulator to respond to wide range (high variety) of conditions

Adapted from Morlidge (2010)

uisite variety. He considers whether contingency findings are congruent with what one would expect given Ashby's law. Table 3 summarizes some of his analysis which compares the contingency findings with respect to environment and technology factors to expectations based cybernetics principles.

The conclusion Morlidge (2010) draws based on his comparisons, is that the findings of contingency research broadly reflect the expectations about organisational control derived from cybernetics and Ashby's Law.

Cybernetics and the LORV offer the potential to develop a theoretical framework that is currently lacking in contingency theory. Cybernetic theory can accommodate the wide range of attributes currently addressed by contingency theory, such as tight/loose goals noted above, and synthesise them within one overarching framework. Many of the dichotomies found in extant research, such as formal/informal control and bureaucratic/cultural control, would simply be viewed as different ways of achieving requisite variety in the regulatory system. Furthermore, the concept of variety allows the thinking behind contingency theory to be formulated in a much more rigorous way.

6 Discussion: The Displacement of Cybernetics by Contingency Theory and LOC

Our evaluation of the contribution of Tony Lowe to management control has sought to show how the systems principles he, and allied authors, worked with were theoretically well founded. Their research was an important step forward that offered a valuable counterbalance to earlier ideas on planning and control (Anthony 1965). Unfortunately the line of research which Tony and his co-authors developed was then rather neglected in the management control domain. The application of cybernetics ideas, in the management control literature, was overtaken by an increasing focus on contingency theory research. Contingency offered an apparently fruitful avenue to researchers who preferred the apparent advantages of remote collection of quantitative data over fieldwork. At the same time, although the highly simplistic models (Carenys 2010) underpinning contingency research suited data analysis and publication, they often related poorly to real world systems and contexts (Otley 2015). More recently, Simons' levers of control framework—another simple model of organisational control—has gained currency in management control research. Consequently, conventional management accounting control theory is dominated by research informed by contingency theory and the levers of control (LOC) framework [and in some cases a combination of the two].

We have suggested above that a return to a more realistic image of the complexity of organisations as systems could contribute important insights. The only approach that clearly offers such a framework is that of cybernetics and the VSM. The VSM is sufficiently flexible to accommodate both the levers of control framework (O'Grady et al. 2010) and, as argued above, a contingency approach. We offer below a very limited comparison of the key concepts of cybernetics in comparison to contingency theory and LOC in Table 4. While a more sophisticated comparison might separate some differences between contingency theory and levers of control our focus is on what cybernetics offers. Consequently we will not go further here save to suggest that the comparison might best be characterised in the following manner: (i) The cybernetic/LOC comparison is primarily about the inner structure of the control system whereas (ii) The cybernetic/contingency comparison hinges primarily on the degree of concern attached to achieving an appropriate match between the control system and its environment. Cybernetics is about self-regulation whereas conventional management control (and certainly conventional management control research tends to be about the control of others assuming a relatively hierarchical environments.

Tony Lowe and others in accounting have often noted the backward looking nature of much accounting information. The contrast between the cybernetic approach and the historic orientation typical of traditional accounting information systems is also noted by Beer who suggested that we should 'look straight ahead down the motorway while you are driving flat out [rather than as] most enterprises are directed with the driver's eyes fixed on the rear-view mirror' (Ibid., 1972, p. 199, as cited in Pickering 2004). This observation recognizes that there are severe limits to the

Table 4 Alternate control approaches

Cybernetic	Levers of control/contingency
Control is a property that emerges from the operation of the system; the system enables the organisation to be in control	Control is exerted over the organisation
Control depends on managers establishing structures that enable self-regulation supported by the provision of appropriate information	Control relies on managers being in charge and exerting control over and influencing the behaviour of others
Control is dispersed and there are multiple loci of control—although there is still some upward reporting, it is designed to be minimal	Control resides at apex of hierarchy
Strategic control is effected via strategic planning arises at multiple levels	Strategic control is enacted through plans almost exclusively assumed to be developed at the top of hierarchy
Proactive control through the continuous integration and balancing of strategic and operational concerns	Less active control through periodic interactions when senior management invokes interactive control
Control is about achieving requisite variety	Control is about achieving the plan

ability of conventional information systems to provide novel and real time information to deal with unexpected circumstances. A further limitation associated with traditional approaches to control is related to the information processing limitations or bounded rationality of individual or groups of managers commonly associated with information overload.

According to Pickering (2004) there is a bigger problem than the ability to process data. This is the error of assuming analysis of the past can be used to fully anticipate the future. He considers that this leaves the information system detached from the action and therefore unable to offer useful decision support (see also Beer 1985):

> …conventional informatics…is all about the accumulation of data and knowledge. One might eventually want to draw on that knowledge for action. ***The information system is, as it were, detachable from the action*** (Pickering, p. 30, emphasis added)

We believe Tony remained committed to the need for information systems which could be comprehensively designed to enable the organisation to deal with any problems facing it. On the other hand, Beer's central idea is that organisations need adaptive systems to deal with complex and unknowable changes in the environment in real time. Pickering (2004) again notes that:

> …all Beer's projects can be understood as specific instantiations and workings out of a cybernetic ontology of unknowability and becoming: ***a stance that recognizes that the world can always surprise us and that we can never dominate it through knowledge. The thrust of Beer's work was thus to construct information systems that can adapt performatively to environments they cannot fully control***. (Ibid., p. 29, emphasis added)

We think that Tony sought to assimilate ideas from cybernetics into management accounting control while maintaining a relatively conventional perspective. Despite their grounding in different paradigms, similarities to the VSM are apparent, especially in the priority given to the external environment: the economy, competitors, the market and customers. Here Tony and his colleagues were relatively open to looking outward in contrast to the much more closed system view of contingency theory at the time.

7 Conclusion

We have briefly outlined in this chapter the cybernetic developments of both Ashby and Beer which went beyond the work that Tony and others developed in management accounting. The LORV and VSM which we briefly describe earlier are instantiations of these ideas about coming to terms with levels of complexity in the environment that neither Tony nor other later writers in the conventional literature on management control have addressed in a systematic manner. This is a surprising oversight that indicates the possibility of considerable scope to advance our understanding of what we can and cannot control. The working through of these cybernetic ideas on complex control systems ought to be enticing for management control researchers. Such cybernetic approaches to control might also be better supported in an environment where computing power is much cheaper and more readily available.

The further investigation of these ideas could also offer a synergy with qualitative and interpretive field work that was largely absent when Tony began his investigations into complex control systems. Such a move could pick up more directly on Pickering's conception of the unknowable, or the unknowability of complex systems, much more strongly. Interpretive research would tend to accept the notion that there are severe limits to what we can ever know of human social interactions. Researchers using a broadly Interpretive lens are much more likely to appreciate that the contributions of their research to the understanding of control systems may only ever be transitory. Such research offers us the opportunity to seek explanations of context based events that ought to serve as important clues on the limits of existing control systems. Such understandings help us to appreciate what controls cannot achieve rather than continually promoting the idea that a more sophisticated system and better implementation is always just a step away. Here there are important linkages in research and management accounting practice that offer performative frameworks for understanding control practices at the micro level (Nama and Lowe 2014; see also Jorgensen and Messner 2008; Lowe and Koh 2008). Interpretive practice-based approaches would accept fully the ideas on unknowability that Beer and his cybernetic-based ideas highlight. The attempts to build ever greater responsiveness into complex control frameworks to deal with environmental perturbations was something that Tony Lowe clearly also struggled to represent. This latter research would offer a somewhat different but potentially complementary perspective to a thoroughly cybernetic approach.

Notes

1. The substantial or substantive environment is defined to be that subset of the general environment which affects the organisation's performance.
2. There is also a system 3*, read "3 star".
3. Including its supporting systems 2 and 3*

4. The ability of a system to monitor and correct its own behaviour using information communicated from the environment. Self-regulation mechanism can be simple of complex. Complex self-regulatory devices include those geared to respond to conditions which anticipate a loss of control and make an adjustment before this happens, and those that have sufficient flexibility to respond to unanticipated conditions (Leonard 1990/revised 2004, p. 52).