Learning How to Create Resilience in Business Systems

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In the context of the present discussion, we adopt a simple working definition of resilience as an organisation’s ability to successfully adjust to the compounded impact of internal and external events over a significant time period. Within the domain of business systems we further define success as the organisation’s ability to maintain economic viability as defined by the economic markets. We finally define time period as the average time period any firm is part of a critical economic indicator list such as the DOW Jones Industrial market index.

To learn about organisational resilience, we adopt a two-pronged approach:

- We first identify implications of adopting a systemic approach to organisations, or, business systems. Hereby we primarily build on work by Ludwig von Bertalanffy as well as more recent work by Senge (1990), Sterman (2000) and Hollnagel (2004).
- We then use a catastrophic organisational failure to illustrate the consequences of lack of resilience. The case in point is the downfall of Barings PLC in 1995. The analysis identifies actions that potentially might have helped Barings PLC to reduce the combined catastrophic impact of the actions of a single individual and market events.
The System View: Implications for Business Systems

The originator of general system theory was Ludwig von Bertalanffy, an Austrian biologist devoted to finding principles that could be applied across various scientific disciplines. The book “Perspectives on General System Theory” published in 1975, three years after von Bertalanffy’s passing, provides an overview of some of the most central concepts of the proposed system approach. The aim of the following subsections is to apply some of the most important concepts suggested by von Bertalanffy to business systems.

The Organism and System Concepts

Two critical concepts in von Bertalanffy’s thinking are the concept of organism and the closely related concept of a system. von Bertalanffy introduced the organism concept to create a contrast to a machine theoretic approach to biological entities (cf. von Bertalanffy, 1952, pp. 9). He stated that

‘… organic processes are determined by the mutual interaction of the conditions present in the total system, by a dynamic order as we may call it. This is the basis of organic regulability … Organisms are not machines, but they can to a certain extent become machines, congeal into machines. Never completely, however for a thoroughly mechanized organism would be incapable of regulation following disturbances, or of reacting to the incessantly changing conditions of the outside world.’ (von Bertalanffy, 1952, p. 17).

Hence, the organismic concept as developed by von Bertalanffy assumes that resilience is one property that organismic processes and systems have. The term organism (or organised entity) later morphed into the notion of a system as the program of systems theory emerged (e.g., von Bertalanffy, 1975, p. 152).
General system theory defines a system as “… a complex of elements standing in [dynamic] interaction” (von Bertalanffy, 1952, p. 199). The basic focus of scientific investigation is to formulate general principles that guide this dynamic interaction. The type of system that von Bertalanffy focused most attention to was an open system, i.e., a system that constantly exchanges material – matter and energy – with its environment. In contrast to that, a closed system is defined as one that does not exchange matter or energy with the surroundings, or even as a system that is cut off from its environment and does not interact with it. A closed system must, of course, in practice be able to exchange information with the environment, since without such an exchange it would be impossible to know what happened inside it!

The fundamental research questions emerging from von Bertalanffy’s perspective include understanding the underlying principles of system organisation and order, wholeness, and self-regulation. A business firm is clearly an open system that exchanges material with its environment. In fact, the open systems view of business firms lead to approaches focused on demonstrating how control mechanisms can be leveraged to reach defined objectives while viewing organisations as organisms (e.g., Morgan, 1986; Lawrence & Dyer, 1983).

The following definition of a business system will be used in the present work: A business system is defined as a set of elements that interact among themselves and with their environments. The overall system is focused on achieving shareholder value, profitability and customer equity. Particular objects, or wholes, within the system are defined by their interactions within the system as well as with the environment. The organisation of these wholes can be described in multiple ways, for instance as hierarchies, heterarchies or networks. A critical point being that the way wholes self-organise changes over time. Some system properties are not directly observable, the property of resilience being among these. To manage a business system, it is necessary to establish a view of the organisational regularities (‘laws’) at each system level. General management, policies and control principles need to be based on principles applicable to all types of organised entities. To illustrate this point, we provide two examples in the next section.
Examples of System Thinking

The two examples presented in the following illustrate how concepts developed by general system theory have been used to create principles that are potentially applicable across all levels of a particular business system. The first section describes an approach that supports the identification of generic control elements. The second section provides a generic view of types of control behaviour – the assumption being that the behaviour of organised entities, or systems is purposeful, i.e., the system if focused on achieving particular goals. In the case of business systems, we assume that these goals include shareholder value, profitability and customer equity.

Identifying Management Control Entities

A major contribution of control theory and systems engineering (e.g., Sheridan, 1992) has been the introduction of key concepts that can be used across many types of systems to describe system components types including components of control systems. Adopting a control theoretic and system engineering flavoured approach, a business system can be described as a state machine characterized by a set of variables and parameters. Business goals are associated with desired state values of the business system and the state machine describes how the various transitions among states can take place. For example, defining the desired state of profitable operation in terms of profitability (e.g., that profit margins need to be higher than 30%) and shareholder value, would be a first step towards articulating business goals. The management process of a business system is defined as the control system whose role it is to ensure that the business system meets or exceeds performance objectives. The behaviour of the control system is driven by the defined business goals, such as profitability, shareholder value and customer equity. The business actuators are the means used to change one or more state variables. Sensors provide information about the state variables, either by direct measurement or by some method of estimation. This control system’s view of a complex networked business is illustrated in Figure 1, adapted from Sundström & Deacon (2002).
Figure 1: A Control Theoretic Perspective on Business Systems

The ovals signify that an entity appears as a whole to other entities while the different types of lines indicate that the interaction among entities have different attributes. The basic management philosophy is uniform across the wholes, i.e., based on collecting data and from that derive metrics and/or estimates to be used by a management control function. The control function takes actions that are designed to impact the behaviour of individual and/or groups of wholes using various types of actuators.

Broadly speaking control functions, i.e., management actions at different dynamic business system levels, are geared towards furthering behaviours that lead to a healthy state of an individual whole, collection of wholes, and/or the overall business system. This healthy state is defined by objectives defined for the whole. State variables are used both to track progress towards these goals (i.e., leading indicators) and to establish whether goals have been achieved (i.e., lagging indicators). Of particular importance are leading measures related to the key resources used by business systems, i.e., financial, human and (technology) systems resources.
For business system in general, and those focused on financial services in particular, at least three distinct states can be defined as illustrated in Figure 2.

**Figure 2: Three key business system states transition behaviours**

A business system can be in a *healthy* state, i.e., a state in which business goals are met and risks are understood and accepted. Various types of behaviours can cause either an individual whole or the complete business state to transition into an unhealthy state. In such an *unhealthy* state the business goals are not met and/or the risk of incurring losses is unacceptably high. Finally, the system can move to a *catastrophic* state, where either one or more individual wholes or the overall system is lost or destroyed. The probability that the overall system transitions into an unhealthy state increases if the behaviour of the wholes create outcomes that are in conflict with the overall goal states for the business system. The more wholes adopt behaviours that do not consider the overall system goals, the more likely these behaviours will bring about an overall negative impact and as a result the overall system might transition from a healthy to a catastrophic state.
Several interesting questions and implications emerge as a result of viewing business systems as open dynamic systems: (1) Is it possible to identify events that indicate when a system is losing control, hence is in the process of changing from a healthy to an unhealthy state? (2) Is it possible to monitor business systems operational performance? (3) Is it possible to distinguish healthy system changes from unhealthy changes? All three of these questions should in fact drive control/management behaviour. In the next section, we look at various modes of control/management behaviour.

Models of Control Behaviour

While different domains have different characteristics, a common feature for all domains, including the domain of business systems, is the need to be in control. The successful accomplishment of any kind of activity – from running a nuclear power plant over financial trading to driving to work and cooking spaghetti carbonara – requires that the acting entity or agent (manager, team leader, operator, trader, driver, or chef) can maintain control of the process in question.

An essential part of control is planning and forecasting what to do within the system’s short-term time horizon. This planning is influenced by the context, by knowledge or experience of dependencies between actions, and by expectations about how the situation is going to develop - in particular about which resources are and will be available. The outcome can be a more or less orderly series of activities, where the orderliness or regularity of performance reflects the degree of control. This can be described in more formal terms by referring to four characteristic control modes, called strategic, tactical, opportunistic and scrambled (Hollnagel, 1993; Hollnagel & Woods, 2005).

In the scrambled control mode, the choice of the next action is basically irrational or random. This is typically the case when the situation assessment is deficient or paralysed and there accordingly is little or no alignment between the situation and the actions. In the opportunistic control mode, the salient features of the current context determine the next action but planning or anticipation are limited, for instance because there is limited time available. The resulting choice of actions is often inefficient, leading to many useless attempts being made. The tactical control mode corresponds to situations where performance more or less follows a known and articulated procedure or rule. The time horizon goes beyond the dominant needs of the present, but planning is of limited scope or range and the needs taken into account may sometimes be ad hoc. Finally, in the strategic control mode, the time horizon is wider and looks ahead at higher-level goals. At this level, dependencies between tasks and the interaction between multiple goals is also taken into account.
Adoption of a strategic control mode is facilitated by adopting system thinking – a critical ability for learning organisations according to Senge (1990, p. 14). A learning organisation (or system) is an entity that “continually expands its capacity to create its future.” (Senge, 1990, p.14). Senge discusses five disciplines that will lead to organisational learning: personal mastery, team learning, mental models, building shared vision and system thinking. Senge views the fifth discipline, i.e., system thinking, as the discipline that integrates all others. Senge defines the key elements of system thinking as follows: “....seeing interrelationships rather than linear cause-effect chains, and seeing processes of change rather than snapshots” (Senge, 1990, p.73). (For other examples of the importance of the importance to adopt a dynamic system view or system thinking, see Sterman, 2000.) To start a process of system thinking, Senge argues that the first step is to gain an understanding of feedback loops. This will eventually establish an ability to identify recurring event patterns that reflect specific system structures, or system archetypes. To use von Bertalanffy's language, the ability to identify recurring wholes (i.e., patterns of interaction among organised entities) will develop and as a consequence this will facilitate adoption of a feedforward based strategic control mode.

In summary, the general system view has the following implications for business systems:

- A business system is a dynamic open system with wholes organised on multiple levels, e.g., wholes could be described has being organised in a classical hierarchical structure. Each organised whole is defined by its interactions with other entities as well as its environment.

- Business systems will define desired behaviours by defining goals, policies, standards, processes and procedures. The expectation is that defined policies, processes and procedures should help the wholes of the system to stay in a healthy state. The nature of some of these policies, standards, processes and procedures will depend on what the business system is producing to create market value. For example, if a business system produces financial services, its policies will reflect the fact that financial services is a regulated global industry.

- Each organised whole develops a pattern of interactions driven by its defined and/or perceived goals. Obviously, goals associated with organised wholes can be in conflict with each other and/or in conflict with the business systems overall goals, i.e., profitability and shareholder value. As we will see in the Barings PLC example, such a goal conflict eventually drove the organisation into a catastrophic failure.

- Organised wholes can adopt different types of control modes or management behaviour. These can be described as strategic, tactical, opportunistic, scrambled or a mixture of the four, depending on the conditions. Using the Barings example, it will become clear that the most appropriate strategy to maintain control of an open dynamic business system is a feedforward based strategy.

- The property of resilience emerges as a result of a system’s ability to transition from one state to the next. In fact the property of resilience implies that a system has the ability to maintain a healthy state over time despite the fact
that it (or its wholes) may be subjected to negative and/or destructive events. A key pre-requisite for a system’s ability to maintain a healthy state, or to transition from an unhealthy to an healthy state, is to re-organise/re-adjust system boundaries and /or re-align/change both the scope and the types of business controls used as part of the business control system.
Figure 3 provides an overview of the concepts used to describe business systems. Three separable business systems are portrayed in Figure 3, namely business systems A, B and C. Each system has its own control system, leveraging the control system elements illustrated in Figure 1. Thus, each system has defined goals, market drivers and desired output, i.e., measurable shareholder value, profitability and customer equity. The policies, standards, processes and procedures defined by each firm are designed to cover the scope as determined by the system boundaries relative to each system’s business control system.
Each business system’s whole will develop patterns of interactions to reach its objectives. A business whole that reaches its objectives using behaviours in accordance with policies, processes, standards and procedures is in a healthy state. A key enabler for any business whole to reach its objectives is to be able to predict the impact of its behaviour. As discussed above, the ability to predict impact of behaviour is maximized using a strategic feedforward control approach.

As an example, firm B’s business control system views a part of firm A as part of its business control scope. As a result firm B’s control approach can proactively adopt a strategic view of the impact of the business whole belonging to firm A. If the reverse is not true, then a likely result is that firm A has a limited ability to change the business wholes’ unhealthy state to a healthy state if the state is caused by the interaction with B’s business whole. Over time, this situation can have a negative impact on both A and B, or, it can lead to a re-design of the control system scope of firm A to better match firm B’s approach. As a result both firms might end up being more resilient to potential negative impact resulting from the two firms’ interactions.
As we will see in the Barings example, the lack of explicit design of the business control system coupled with the lack of viewing Barings as a dynamic system eventually led to the catastrophic events that destroyed the firm.

The Barings PLC Case

Barings PLC was a 233 year old British financial institution of high reputation, which proudly counted the Queen as a client. Financial markets were therefore stunned when this institution had to declare a state of bankruptcy in February 1995. The reason was a staggering US $ 1.3 billion loss caused by the trading practices of a single person, Nick Leeson (e.g., Kurpianov, 1995; Reason, 1997). This loss was, however, not due to the actions of an individual trader alone but also owed much to the failure of Barings’ global management team. Figure 4, adapted from Sundström & Hollnagel, (2004), provides an overview of the key components of the dynamic system that Nick Leeson was part of.

Figure 4: Dynamic System View of the Nick Leeson Scenario at Barings
The situation can be described as two linked control loops – although neither of them was in full control of the situation. In one, the right hand part of Figure 4, was the trader (Nick Leeson), who saw his trading strategy fail. The outcome of the trades were far from expected (also because of market unpredictability), and he therefore had to resort to a more risky but less well thought out strategy in the hope of covering the losses. In order to hide the losses, Leeson removed his error account from the daily trading, position and price reports to London. As a result any type of proactive impact analysis by the second control loop became impossible. In addition to problems with the market, Nick Leeson also faced requests from the Barings’ home office, altogether leading to a situation of fire-fighting and opportunistic – or even scrambled – behaviour rather that tactical thinking.

In the second control loop, the left hand part of Figure 4, was the company, Barings PLC, which continuously received reports of stellar profits; in fact profits that were quite unreasonable given the officially communicated securities trading strategy. However, the management’s lack of experience and concomitant lack of feedforward strategy, and their inability to truly understand the behaviour of Barings Securities business coupled with the perception of Leeson as a star performer, led to a situation in which the team did not take proper action. During this time period, Barings PLC (UK) was itself under pressure to provide information about the (excessive) margin calls to the Bank of England as well as the Bank of International Settlements. Over time, management’s lack of true understanding of the securities business (and of derivatives trading in particular) led to opportunistic management control, which could not effectively monitor how Barings Futures performed. The result is well known: in both cases control was lost and Barings PLC had to declare a state of bankruptcy.

Figure 5 describes this situation using a state diagram. Clearly some of the system wholes in Barings PLC were not in a healthy state in the first place. From the beginning, \( t_1 \), the management team lacked a fundamental understanding of securities trading and therefore failed to establish appropriate management strategies and controls. The lack of understanding also meant that excessive revenue was not seen as a problem. Even as the situation deteriorated, \( t_2 \), management at Barings PLC ignored early warnings in their balance sheet indicating that they provided excessive funds to run Barings Futures. Instead they approved excessive margin calls, failed to separate sales and reconciliation, and failed to ask for critical data. In the last stage, \( t_3 \), the management team failed to notice that the losses incurred exceeded the available capital, but continued to provide excessive funding to run Barings Futures. Despite multiple requests from key regulatory bodies, cf. above, their reporting was not transparent.
Conditions were not much better at Barings Futures in Singapore. The trader, Nick Leeson, was new in his position and lacked experience. He was furthermore in control of both sales and reconciliation, contrary to policies. As the situation grew worse, \( t_2 \) and \( t_3 \), he continued with excessive margin calls, tried to hide the reconciliation and removed key data from reports. Thus even of the Barings PLC management team had known what to look for, they would have had difficulties in finding it.

**Figure 5: A State Transition View of the Barings PLC scenario**

A key learning from this scenario is that a business system can only be resilient if the management team is able to use a feedforward based management strategy resulting in the appropriate design of business controls. Example of such critical business controls are an appropriate flow of reporting information and clarity around roles and responsibilities. Both of these obviously impact how the various business system wholes interact with each other.
An organisation is resilient if it is able successfully to adjust to the compounded impact of internal and external events over a significant time period. Barings PLC was clearly unable to do so, and given the above analysis its collapse was not just due to the specific circumstances of Nick Leeson’s trading but rather to a general degradation of the barriers and behaviours that together made up its control systems. In this case each of the two business control systems, Barings Futures in Singapore and Barings PLC in London, failed in adjusting effectively to exogenous variability. For Barings Futures the exogenous variability came from the markets; for Barings PLC the variability came from Nick Leeson’s trading practices. Both resorted to feedback-driven control and therefore worked in a basically reactive mode. This is bound to fail if the feedback is incomplete or delayed, as in the case of Barings PLC, or if the response strategy is short-sighted and shallow, as in the case of Barings Futures.

In terms of the four control modes mentioned above (strategic, tactical, opportunistic and scrambled), both Barings PLC and Barings Futures operated in an opportunistic or even scrambled mode. There is in general a strong correspondence between system conditions and control modes, such that the control mode goes down when there is insufficient time and/or when the situation becomes unpredictable. Referring to the three states described in Figure 5, a healthy state is characterised by strategic and tactical control, and unhealthy state by tactical and opportunistic control, and a catastrophic state by scrambled control. While recovery from a state with opportunistic control is possible with a bit of luck, i.e., if conditions are favourable, recovery from a state of scrambled control is unlikely to take place.

What would have made Barings more resilient?

The first step Barings’ management team should have taken is to view their trading business from a dynamic open system perspective. Figure 6 provides a simple view of the trading system as a dynamic system.
If Barings had used a proactive impact analysis and risk management approach, and if it proactively had monitored its trading operations to check for unusual performance variability, then Leeson’s trade outcomes should have been anticipated – by Barings PLC, if not by Leeson himself. The proactive analyses should have enabled Barings to anticipate patterns and therefore to be able to proactively take actions (feedforward-driven) rather than just reacting to events (feedback-driven). In such a feedforward-driven mode, system control behaviour is triggered by a model of derivatives trading and likely events. In a feedback-driven mode, system control behaviour is a reaction to undesirable events (e.g., Leeson’s frequent margin calls). If trade outcomes had been predicted, including expected profits, discrepancies would have been noted in time and Barings would have remained in control. However, the Barings management team was in a reactive mode; the team furthermore had no access to the appropriate data nor did they take any action to ensure that Leeson was appropriately supervised. As a consequence, the Baring business system was highly unstable and as such vulnerable to disturbances from the market. This combination of reactive decision-making in response to Leeson’s behaviour and providing regulatory entities (i.e., Bank of England) with poor information, over time ended in a complete failure when unexpected events affected the market in a negative direction.

Figure 6: Dynamic System View of Trading Operations
If Barings management team had adopted a feedforward management strategy, they would quickly have known that the revenue reported by Nick Leeson would have been impossible given the trading strategy that Leeson purportedly was using. However, adopting a feedforward strategy assumes that the management team has sufficient knowledge about the nature of the securities business. In Barings PLC this was however not the case, most of the management team had a traditional banking background and lacked experience with the securities industry.

Assuming that Barings’ management team had adopted a dynamic system view of their business, the team could have proactive established a feedforward strategy with the following elements:

- Clearly defined system goals, including the level of risk acceptable to both the local Asia based and London based management teams. These system goals should have been designed seamlessly to intertwine business and risk goals. For example, a part of the risk management strategy could have been tightly to control the size of the margin calls approved before providing Leeson with funds for his trading activities.

- A continuous monitoring of state variables, i.e., those variables that could change the state of Barings from healthy to unhealthy. In the Barings case the management team did not seem aware of the fact that they lacked accurate data to identify the potential impact of Leeson’s activities on the whole system. i.e., Barings PLC. This situation was possibly due to management’s lack of knowledge of what they needed to look for. In fact, a very simple report could have been used to match up the losses made and the capital made available to Baring to cover these losses.

- Continuous monitoring of state variables related to the three key components of operational risk, i.e., people, systems and process. This should have included close supervision of Nick Leeson, the reporting systems that were used and of course the associated trading and reconciliation processes. As it turned out, Nick Leeson was not supervised and the required data to monitor his activities was not available to the London based management team. Finally, trading and reconciliation processes were not properly separated, i.e., Nick Leeson was in control of both.
Figure 7 provides a high-level view of the simple management framework that Barings could have leveraged proactively to manage risk and impact of the Barings Securities business on the overall Barings business system. The Barings example also clearly demonstrates the importance of identifying unexpected (i.e., unlikely) events that have the ability to drastically impact the overall state of the business system.

Figure 7: A simple Control Engineering Style Approach to support a FeedForward Driven Proactive Risk Management Strategy.
Concluding Remarks

An organisation’s ability to survive depends on the extent to which it is able to adjust to the compounded impact of internal and external events over a significant time period. A critical success factor for any organisation is therefore finding ways to learn how to facilitate emergence of resilience. In the present chapter, we suggested that viewing organisations as dynamic open systems, adopting an explicit view of business control systems and being aware of the impact of various types of system control behaviours could enable an organisation to avoid transitioning into a catastrophic state. Our analysis of the Barings PLC case illustrated that articulating system goals, acceptable risk levels and a focus on monitoring key state variables could potentially have helped Barings’ management team to detect that the firm was in the process of entering into an irreversible catastrophic state.

References


1 Of the original companies forming the DOW Jones only one (i.e., General Electric) made it to the 100th anniversary of the index.

2 Planning for the longer term is, of course, also important, but the uncertainty of outcomes is usually so high that only a limited effort in that direction can be justified.

3 This therefore constitutes a third control loop that had an effect on the two already mentioned. The present analysis will, however, disregard that.

4 The two parameters, available time and predictability, are clearly not independent but affect each other. A more detailed presentation of this relationship can be found in Hollnagel & Woods (2005).

5 See http://www.bis.org for information about the Basel II accord and operation risk.