The Safety Leadership Paradox

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This paper argues that the inability to manage the tensions between prevailing paradigms of organization and leadership is a major contributory cause of organizational accidents. A paradox of organizational form occurs in balancing the need for operational discipline and hierarchy implicit in 'system safety' theory (Leveson et al., 2009) with the need for mindful sense-making and competent improvisation of the 'High Reliability Organizing' ('HRO') paradigm (Weick, 1987) that demands a shift to a more organic form. In parallel, a second paradox also exists between the current dominant leadership paradigm of leader-centric 'command and control', rooted in leader-follower and contingency theories, and the shift to a new 'enabling' paradigm of leadership as a relational phenomenon, socially-constructed within context, enabling adaptive processes and emergence of change.

The traditional paradigm of organizational reliability and safety is based on systems, procedures, operational discipline and rule-following, exemplified by the 'system safety' school of thought coupled with the current dominant leadership paradigm of 'command and control' that focuses on the characteristics and behaviours of leaders, particularly top leaders, exercising formal authority and supervision within hierarchies, and of followers complying with instructions.

This paper challenges these traditional paradigms, proposing that what goes on in organizations that successfully manage high hazard technology on a continuous basis is significantly more complex than the implicit assumptions of these paradigms suggest, in that emergent adaptive processes are at work throughout the organization, including the operational 'sharp end', continually identifying and overcoming system weaknesses and human errors before they can lead to disaster, and that this emergent adaptation and sensemaking occurs as a result of flexible organizing and 'enabling' leadership (Uhl-Bien and Marion, 2009)

This is not to say that the 'system safety' and 'command and control' paradigms are completely wrong, but instead that they are not completely correct. Equipment and systems that are well-designed and constructed, and maintained and operated by competent people using well-developed procedures, are the foundation of reliability and safety of high hazard technology. But analysis of major accidents routinely shows up system weaknesses and errors that could have been identified and corrected but were not, and it is proposed that this can be attributed at least partly to inflexible organisation and a controlling leadership that was taking inadequate account of the operational context and failing to reconcile important paradoxes of control vs adaptation.

This paper argues that a new paradigm of organizing for high reliability and safety is needed that draws on richer theories of both organizing and leadership as processes that enable adaptation appropriate to the context, superimposed on or interwoven with the essential operational discipline of traditional 'system safety' and 'command and control' theories. This is the subject of a current research project at Cranfield University School of Management.

KEYWORDS: leadership, safety, system, HRO, organization, paradox

Introduction

Commentators on industrial disasters have repeatedly criticised leaders for tolerating or even creating the organisational conditions that led to those disasters (Reason, 1997)(Flin, 2003)(Hopkins, 2006)(Hackitt, 2012)(Moure-Eraso, 2015). However, there is no common understanding of how leadership influences the level of reliability and safety of organisations that operate with high hazard technology. The lack of consensus also extends beyond leadership to the wider theories of organizing.

Certainly there are many organizations that operate with high reliability and safety: within the developed world most of the major airlines and air traffic control systems, and many maritime operations, rail transport systems and nuclear power stations, despite operating with some of the most hazardous technology, achieve the kind of safety record that qualifies them to be called 'High Reliability Organizations' (HROs). Much of the rest of industrialised activity suffers a significantly worse rate of major accidents. However, how these 'HROs' achieve such high reliability and safety is not well understood.

As industrialisation continues across the planet this knowledge gap gives cause for concern. Over the last decade interest in this area of research has grown within national government safety regulators and the major hazard industries, spurred on by a number of serious accidents, notably the Columbia Space Shuttle, 2003, BP Texas City Refinery, 2005, the Buncefield UK fuel depot explosion in 2005, the 2010 Macondo oil well blow-out and the 2011 Fukushima nuclear power station disaster.

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'HRO' theory, including 'organising for mindful sensemaking' has been proposed as an alternative paradigm of organizational reliability and safety (Weick, 1987) and a significant body of research has been built up, with practitioner interest growing. HRO theory has also been criticised by system safety theorists as incomplete and even wrong for example in allowing improvisation by the operational front line who may lack full system knowledge, with potential unintended consequences (Leveson et al., 2009) and this criticism underlines the paradox burden.

In parallel with and contributing to this body of HRO research, it has been proposed that leaders should be 'mindful' (Hopkins, 2011) and 'competent in process safety' (Hackitt, 2012) but the current dominant leadership paradigm for organizational reliability and safety in organizations operating with high hazard technology remains 'command and control'. However, a new leadership paradigm is emerging in the form of the 'new genre' of leadership theories including 'complexity' and 'emergence' leadership that together with 'relational', 'processual' and 'adaptive' leadership can be called 'enabling leadership' (Uhl-Bien, 2006). Additionally, it is well-accepted that leadership is embedded in context: technology, structure, culture, operating environment etc., as well as the characteristics of the people making up the organization (Osborn and Marion, 2009).

How these different paradigms can be reconciled in practice is an under-researched area; although leadership is one of the most researched subjects in organisational theory, the role it plays in organisational reliability and safety of high hazard technology remains unclear. This paper argues that a new paradigm of organizing for high reliability and safety is needed that draws on richer theories of both organizing and leadership as processes that enable adaptation appropriate to the context, superimposed on or interwoven with the essential operational discipline of traditional 'system safety' and 'command and control' theories. This new paradigm, of 'enabling leadership and contextual sensemaking' attempts to explain how organizations operate with a degree of ambidexterity that allows reconciliation of paradoxes for example of control/adaptation, efficiency/flexibility and profit/social responsibility.

This paper explores the theory leading to this proposed new paradigm by reviewing the literature of the 'system safety' and 'HRO' paradigms, the history of leadership research that underpins the 'command and control' paradigm, the new-genre of 'enabling' leadership theories, organizational ambidexterity and paradox.

Organizational Safety Theory

After the 1973 Three Mile Island nuclear power station accident, Charles Perrow, who was appointed to the investigation team as a sociologist (previous major accident investigations having been seen as a technical matter only involving scientists and engineers) published his 'Normal Accident Theory' ('NAT') which suggested that organizational disasters are an inevitable result of technological or organizational 'interactive complexity' and 'tight coupling' between system components (Perrow, 1984).

The 'system safety' school of thought claims that the complex socio-technological systems required for e.g. aeronautics and space (and by implication other high hazard technologies) can be engineered specifically to minimise interactive complexity and tight coupling, so that despite the obvious high hazards, risks are well managed and accidents are rare (Leveson et al., 2009). This supports an earlier claim made by Scott Sagan that NAT theory is pessimistic (Sagan, 1995).

The system safety view is that safety is an emergent property of the entire system in which an organization operates; risk management processes internal to an organization are strongly influenced by factors generated in the much broader system that includes regulators and other government agencies, contractors, suppliers, customers, partners and indeed all parties with which the organization has relationships. This very broad view of the system sets the conditions and restraints on safety within the context of all the often competing goals of the organization, thus the safety of a system can only be effectively managed when the whole system is analysed and understood.

Leveson et al point out if decision-makers do not have clear mental models of how their decisions will affect safety their decisions will inevitably sometimes be fallible, as was seen in both of the space shuttle disasters and also many other major accidents. They claim that safety of high hazard technology results from strategic decisions about engineering and not primarily from front line operators having freedom to do what they think makes sense, even though there may be cases where that could be important. Structurally, this proposition matters for organization design; responsibility for safety lies with project and operations managers and engineers, but as well, a powerful, independent, 'system safety' organisational function is needed to provide adequate challenge in management decision-making. Leveson has proposed a modelling technique to analyse all the conditions and restraints that determine the design and manufacture of the equipment an organization uses and how it is operated and maintained, that is, all the spheres of activity from which accidents can emerge, and hence from where safety emerges, allowing decision-makers to assess the potential effects of their decisions (Leveson et al., 2009).

Models such as this are the basis for safety management systems commonly employed in high hazard industries, and 'safety reports' or 'safety cases' demanded by regulators (European Commission, 2012) (UKHSE, 2005). However, Perrow takes the view that system safety is optimistic since 'the complexity and tight-coupling of complex, high-tech systems not only makes them opaque to the operators, but also they make it almost impossible for any one individual to understand such a system in its entirety' (Perrow, 1984).

Another view of how safety of high hazard technology is managed, proposed by a group of researchers including Hollnagel, Wreathall and Woods is referred to as 'resilience engineering' (Hollnagel et al., 2006) (Woods, 2003). By resilience they mean an organization's ability to keep stable and recover quickly from mishaps in the face of significant operational challenges, and 'engineering' resilience means creating and maintaining that ability. They propose that this is achieved through proactive internal organizational structures and processes that actively seek and anticipate potential weaknesses in hazard controls, as well as sensing and responding to them reactively (Woods, 2006). It is argued that resilience can be developed in an organization through a number of structural changes. For Woods, the important factors for engineering such resilience are firstly having a leadership team who understand human factors, how their decisions affect system safety and how to balance production pressure and safety risk to achieve effective risk management, and secondly creating an effective safety organization that is independent but involved in the decision

making, and that generates information measuring the strength (or weakness) of risk controls (Woods, 2003). This is echoes 'system safety' but brings in human factors.

The human factors field is primarily concerned with understanding and reducing error, including the important sub-set of rule-violation. Safety culture has evolved from this field, based on the idea that an organization's culture is a source and indicator of its reliability, notably through the work of the Manchester psychologists Reason and Parker, working with Hudson at Leiden university and Flin at Aberdeen. James Reason describes a strong safety culture characterised as 'just, reporting, informed, learning and flexible' (Reason, 1998). As a development of Reason's characterisations and of Westrum's 'pathological–bureaucratic–generative' cultural typology (Westrum, Adamski, 1999) Parker, Lawrie and Hudson proposed a multi-aspect five level safety culture model that describes an important process within a strong safety culture: its managers maintain 'chronic unease', staying informed about the organisation's potential weaknesses and so are able to drive organisational learning. They stay informed because workers at all levels feel empowered to report problems, even their own mistakes, since they trust the managers to exercise justice and fairness in dealing with them (Parker et al., 2006). Flin concurs and differentiates culture from climate, the latter being more appropriate for questionnaire surveys which measure transient surface features (Flin, 2007). Dekker has also emphasised the importance of justice, avoiding a blame culture (Dekker, 2011) and also introduced the idea of complexity, suggesting that errors are emergent properties of complex systems and cultures (Dekker et al., 2011).

Two further related areas of research are of interest since they have been widely adopted by commercial aviation: The first of these is 'Crew Resource Management' (CRM) which has evolved to become known now as 'Threat and Error Management' (TEM) in its latest generation (Helmreich et al., 1999). This is a suite of techniques developed by the Aviation Human Factors group at Texas University, and endorsed by the International Civil Aviation Organization (ICAO). CRM/TEM is now being adopted in many hospital surgical theatres (Helmreich, 2000). The second idea originating in aviation human factors research that has found wide practical and successful application in other high hazard operations is 'Situation Awareness' (Endsley, 1999). This is very akin to 'mindfulness' as described by Weick and Sutcliffe (Weick and Sutcliffe, 2006) and applies at individual, team and organizational levels. Hopkins also notes the need, for top leaders especially, to maintain the 'big picture' of the effectiveness of their organization's risk management systems with rapid and comprehensive information flows (Hopkins, 2009). Endsley's work includes design of equipment and systems to facilitate such information flows.

HRO theory is now examined in some depth. Interest in this has grown over the past decade as a result of the continuing series of high-profile major industrial disasters. Several literature reviews have been carried out recently, which serve well as logical entry points to this field. Chief among these are the extensive UK Health and Safety Executive review (Lekka, 2011) that by the psychologist Karlene Roberts who was a leading member of the original Berkeley HRO researchers (Roberts, 2009) and the 20 year retrospective by the Geneva sociologist Mathilde Bourrier (Bourrier, 2011).

The Berkeley research (Roberts, 1990) represents the first view of how HROs work: that despite the hazards, the likelihood of bad consequences is kept very low by having active organisational and interpersonal processes that reduce and contain human errors and system failures. Roberts points out the previous dearth of organizational theory concerned with organizational reliability other than accident analyses and the difficulty of deducing any useful theory of organizational reliability based on such a trial and error approach. Additionally she noted that at that time the only social science based accident analyses, by Perrow, Sagan and Shrivastava, are based entirely on reviews of historical documentary evidence. This led the Berkeley group to adopt the quite different ethnographic method of the in depth 'embedded researcher' case study: they wanted to watch and talk to the people inside HROs to find out what they did that was so effective in avoiding accidents.

Their research method is interesting: for intermittent periods of five to ten days over an extended period (three years) team members of different social science disciplines joined a US Navy nuclear powered aircraft carrier full time. They rotated round all the relevant activities so that in the end all members observed all these activities with the intent of reducing individual bias. They looked specifically for ways that the organization minimised the negative potential effects of Perrow's 'interactive complexity' and 'tight coupling'. A key coping strategy they noted was that these HROs were adept at coping with paradoxes: for example standardisation vs flexibility. The ships' exercises were developed with much standardisation and specialisation of individual roles, but also with deliberate flexibility to encourage creativity in problem-solving, and considerable redundancy both of systems (e.g. many different means of instant communication: radios, public address systems, hand signals etc) and people (crew members were given skills in many different tasks and teams were given the flexibility to decide themselves who would do what on a rapid dynamic basis).

Another well managed paradox noted was the maintenance of a high workload for key individuals (pilots, landing officers, nuclear plant operators etc) to achieve the high attention levels necessary to reduce error and also to develop high competence while avoiding the obvious potential negative effect of fatigues and stress on error-rate with the deliberate strategy of high redundancy: having many pairs of eyes watching for errors or anomalies. This vigilant cross-checking and teamwork focussed on catching errors was a key component of a strong safety culture. This culture was frequently reinforced by the officers and petty officers by rewarding the reporting of errors and defects and avoiding individual blame

Berkeley researcher Todd La Porte observed that although authority was predominantly hierarchical, as one would expect in the military, 'collegial patterns of authority based on skill and functional relationships emerge as the tempo of operations increases…As these clearly recognised patterns shift, communication patterns and role-relationships are altered to integrate the skills and experience called for by the situation.' (La Porte and Rochlin, 1994). Roberts similarly emphasised the importance of flexible organizational form to the operation of an HRO. 'In a sense the pyramid is inverted. The organization focusses on training and on letting people use that training. Low level decision making is part of that focus' (Roberts, 1990). This flexibility of authority structure offers an insight into how the control vs adaptation paradox can be managed.

These ideas have been further developed into what has become possibly the best-known HRO model – the 'five characteristics model' established by a team of social psychologists led by Karl Weick (Weick et al., 1999) and further developed by them under the key ideas of 'sense making' (Weick et al., 2005) and mindfulness (Weick and Sutcliffe, 2006). Weick, Sutcliffe and Obstfeld have put this forward as a consolidated theory of HRO (Weick et al., 1999). They agree with Roberts' suggested HRO characteristics of redundancy, high competence from continuous training and vigilance from strategic prioritization of safety as necessary but not

sufficient, seeing high reliability as more of an active process of seeking and fixing problems, than a condition. They describe an active nature of HROs, sensitive to and dynamically responsive to the environment, compared with 'normal' or 'low reliability' organizations whose operating models lean more towards exploitation than exploration, so these organizations are less adept at recognising and responding appropriately to changes to the operating situation and more easily lose the 'big picture'. This 'organizational cognitive ability' Weick Sutcliffe and Obstfeld call 'mindfulness', and propose that this is the core of what differentiates an HRO. They go on to analyse the component activities, proposed as more tactical than strategic, that they claim allow HROs to develop and maintain mindfulness, presenting the 'five characteristics' as follows:

Preoccupation with failure: which implies maintaining a culture and infrastructure that support the reporting and expert analysis of near-miss incidents and other learning opportunities, and which suppresses the complacency that often accompanies a focus on success.

Reluctance to simplify explanations: this is based on the assumption that it takes a complex system to sense a complex environment, so 'requisite variety' is cultivated, including 'diverse checks and balances embedded in a proliferation of committees and meetings, frequent adversarial reviews, selection of new employees with non-typical prior experience, frequent job rotation, and re-training' as well as sceptical but mutually respectful questioning of actual reported conditions, assumed competence and the like, all of which call for excellent interpersonal skills to deal with the implicit lack of trust. Such cross-checking represents another form of redundancy, and the value of this for reliability is acknowledged, as part of accepting human fallibility. This characteristic also expresses a willingness to accept 'false alarms' as the cost of habitually making a 'strong response to a weak signal'.

Sensitivity to operations: this idea makes reference to Endsley's description of 'situation awareness' (Endsley, 1995): Sensing the situation, i.e. gathering information from the operating environment, making sense of that information as it relates to the individual's or organization's goals and then projecting the developing situation forward to anticipate appropriate survival responses. It also contains the idea of top leaders being well-connected to the operational 'sharp end' of their organisation: understanding the needs and problems of operations and maintaining personal involvement.

Commitment to resilience: more than coping well with anticipated abnormal situations arising from predictable human and system failures, resilience is seen as responding effectively to the unexpected: anomalous errors or failures that have not been observed before. Resilient organizations maintain a capacity for improvisation and ad hoc problem-solving to contain the situation, avoid escalation towards a major incident and swiftly restore normal operations. They also attach great importance to early warning systems to detect and act quickly on such anomalies.

Underspecification of structures: This is changed to 'deference to expertise' in Weick & Sutcliffe's later book (Weick and Sutcliffe, 2001). One meaning is that decision-making about safety-critical matters is not kept as the prerogative of the formal hierarchy of line management; instead, the expertise of operational and technical specialists is given due weight and will normally take precedence. Another meaning is the overt acceptance that formal procedures cannot prescribe all situations, so people are expected to challenge and sense-check to avoid mindless operation of fixed processes.

To summarise, a broad review of the literature reveals a wide spread of ideas relevant to understanding the key features of HROs. What seems like a confusion of ideas and theories can be rendered simpler on analysis. The common threads and apparent differences can be grouped into two main paradigms: 'System Safety', based on a mechanistic, analytical 'management system' approach, combined with 'operational discipline' of execution following established procedures and 'HRO', based on flexible, mindful sense-making and competent improvisation.

Sagan suggests that 'HRO Theory' is optimistic (Sagan, 1995). Leveson agrees and further argues that both the NAT and the HRO views of safety are incomplete and flawed (Leveson et al., 2009). She sees reliability and safety as different properties, and argues that although redundancy can reduce accidents caused by component failure (lack of component reliability) most accidents in complex systems have roots in cultural and human factors where redundancy does not help, and can increase complexity which then tends to reduce rather than increase overall system reliability. She also cautions against operators of high hazard technology improvising without a complete understanding of the design and potential unintended consequences of their well-intentioned actions.

This view is countered by the 'deference to expertise' attribute of HRO theory and the opposing claim that safety is an outcome of organizational reliability, so having a variety of ways of ensuring a safe activity (cross checking, many pairs of eyes etc) is a useful tactic, and that component reliability is also a good reason for having redundant sub-systems. Redundancy is also defended as necessary for organizational mindfulness: analysis of data for relevant information, in order to enact 'reluctance to simplify', needs people with time for that task (Hopkins, 2009).

HRO theory claims that the system safety analytical 'management system' and 'operational discipline' fails to recognise that although standard procedures and competence and discipline in using those procedures is important, it is mindful use of them that stops things going awry: people at the operational sharp end need to be empowered and encouraged to make sense of situations and use judgement, beyond merely following standard procedures: 'when problems occur, let decision making migrate to the people who have the most expertise to deal with the problem' (Weick and Sutcliffe, 2006).

In summary, both of these major paradigms overcome NAT, but in paradoxically different ways: system safety by engineering; deliberately reducing interactive complexity and coupling in the overall system design and maintaining accurate models of the system to guide decision-making, HRO by flexible organizing and processes that compensate complexity and coupling by encouraging sense-making and competent adaptation, and for example maintaining organisational 'slack' by separating critical activities from each other, providing multiple channels of communication and developing highly effective teamwork based on highly-developed interpersonal skills and mutual respect.

The need to reconcile the operational discipline of rule-following so essential to system safety theory with the mindful sensemaking and competent improvisation so essential to HRO theory is a major paradox. Such improvisation can appear as rule violation, and so of serious concern to those espousing the traditional system safety and hierarchical command and control paradigm. This tension has interested researchers for some time. It is of course recognised that rules and procedures vary in their quality and usefulness. 'It is

probably true to say that procedures, together with the training and checking that goes with them, are the main reason commercial aviation is safe as it is' (Green et al, 1996). However, as James Reason observed: 'In the nuclear industry nearly 70% of all human performance problems can be traced to unclear or otherwise bad procedures' (Reason, 1997) and Sidney Dekker noted the impossibility of a procedure to cover all situations, so violating a procedure is sometimes the safest action (Dekker, 2003).

A recent study of anaesthetists' use of rules suggests rules could be seen alongside other principles to guide naturalistic decision-making and so could and should be violated when doing so met one of three principles: 'doing the right thing'; 'doing what works in the circumstances'; and 'using one's skills and expertise' (Phipps and Parker, 2014). This concurs with the view that problems arise from slavish adherence to rules that do not work in a changed context or if rules are not used to guide adaptation (Woods and Shattuck, 2000) (Dekker, 2003).

In parallel, a second paradox also exists between the current dominant leadership paradigm of leader-centric 'command and control', rooted in leader-follower and contingency theories, and the shift to a new 'enabling' paradigm of leadership as a relational process, socially-constructed within context, that enables adaptive processes and emergence of change, invoking complexity theory. This paradox is explored in the next section. Managing the tension between these two leadership paradigms and between the hierarchical system safety and flexible HRO paradigms requires a degree of organizational ambidexterity. Theories of how this can be achieved are explored later.

Leadership

The current dominant paradigm: 'command and control embodied in leaders'

Traditionally, leadership research has been preoccupied with the characteristics and behaviours of leaders, as opposed to leadership in its wider sense. The main theories that emerged in the first half of the 20th century were attempts to define the attributes, styles and behaviours of the effective leader. Taylor's scientific management (Taylor, 1911) and Fayol's management principles of 'plan, organise, command, coordinate and control' (Fayol, 1916) were founded on the military and authoritarian assumption of the leader's right to demand compliance of workers and that effective leaders were endowed with certain characteristic traits. (Antonakis et al., 2012). This view was stated unequivocally early in the 20th century by W. H. Cowley: 'any study of leadership to be of value should produce a list of traits which go together to make the leader.' (Cowley, 1928).

Although many traits such as stamina, intelligence, self-confidence etc have been associated with leader effectiveness, research has only been able to show a weak relationship with organizational success (Yammarino and Bass, 1991)(Kirkpatrick and Locke, 1991). Due to a lack of consensus and a general overlooking of context (Stogdill, 1948) trait theories fell out of favour with academia for some decades, though remained popular with practitioners, and have recently regained the interest of researchers: the introductory editorial of a Leadership Quarterly special issue on 'leader individual differences', argued that 'leadership individual difference research is at the cusp of a renaissance' (Antonakis et al., 2012) and Daniel Goleman listed five components of 'emotional intelligence' as desirable attributes of leaders (Goleman, 1998).

As the new field of social psychology emerged in the 1930s, its pioneer Kurt Lewin observed that a leader's approach, especially to decision-making, affected group performance. He defined three styles: 'autocratic', 'democratic' and 'laissez-faire', and in a break with the 'authoritarian' tradition, proposed the democratic style as most effective (Lewin et al, 1939). Blake and Mouton's 'managerial grid' plotted more styles on the dimensions of 'concern for task' and 'concern for people' (Blake et al., 1964) and Fiedler proposed a 'contingency theory' that although assuming that a leader's style was fixed as oriented either more to task or to relations, argued that 'the performance of interacting groups is contingent upon the interaction of leadership styles and the favorability of the situation for the leader' (Mitchell et al., 1970) though support for the theory remains weak. Hersey and Blanchard's 'situational leadership' model described four different levels of subordinate work group maturity and prescribed a different leader style for each. Empirical evidence supporting this theory also remains weak, though its simplicity makes it popular with practitioners (Graeff, 1983). Despite these criticisms, these approaches to leadership do suggest that organizational effectiveness is improved if the leader's behaviour is adjusted to suit the particular situation (Yukl and Lepsinger, 2006) and recently Goleman has refocused his 'emotional intelligence' idea into a leadership style that could be learned (Goleman, 2004).

Lewin's questioning of traditional authoritarianism continued (Maslow, 1943) (Herzberg, 1959)(Katz, 1960) and was memorably crystallized by Douglas McGregor's 'theory X and Y'. He said, expanding on theory Y: 'we have not yet learned enough about organizing and managing the human resources of enterprise. Fortunately, an increasing number of managers recognize the inadequacy of present methods. In this recognition lies the hope of the future.' (McGregor, 1960). With this, McGregor anticipated the 21st century 'mega-trend' in the developed world away from compliance-based authoritarianism towards forms of leadership based on engagement and building commitment (Pendleton and Furnham, 2011).

Attempts to understand the leader-follower relationship led to 'path-goal theory' (House, 1971) that attempted to integrate authoritarian and considerate leader behaviours using expectancy motivation theory (Vroom V H, 1964) in different work situations of job scope, ambiguity and autonomy, an early introduction of context to leadership theory.

Further work in the early 1970s measuring differences in individual leader-follower relationships (so-called 'vertical dyad linkages') led to the development of Leader-Member Exchange Theory (LMX) theory (Dansereau et al, 1975). This theory attempts to explain the leadership relationship from both leader and follower perspective, analysing individual relationships in terms of latitude and influence or directive supervision, and in later developments of the theory numerous other nuances of those.

Until recently though, the main focus of leadership research has remained the leader. Analysis of charismatic leaders (House, 1977) led to the distinguishing of 'transformational' from 'transactional' leader behaviours (Burns, 1978) and more recently to 'authentic' leadership theory, introducing the idea of 'morality, conscience and the scope for altruistic intention' (Bass, 1999).

Leadership as more than just the leaders

The historical leader-centric view of leadership has recently been questioned. In 2000, Gronn claimed, building on socially distributed cognition and activity theory, that leadership invariably exists in distributed form (Gronn, 2000). He proposed that leadership is influence, frequently reciprocal, expressed in subtle ways and emerging from the flow of activities, and only makes sense in its context, which must include the temporal context of duration, speed and timing. This affirmed and developed a much earlier view that leadership is a shared phenomenon and that 'leadership is relative always to the situation.' (Gibb, 1947). The idea of distributed leadership has developed into a significant field of research and become a major influence particularly in the fields of public services and education, but how it is enacted has been criticised (Currie et al., 2009).

In recent years a number of reviews of leadership research have been made, reflecting on leadership as broader than simply the leader. Firstly, in their review of LMX research, Graen and Uhl-Bien classified leadership theory in domains of leader-centric, follower-centric and relationship-centric. The simplicity of this approach could appear superficial but it underlines how much leadership theory is leader-centric, overlooking the other two domains. Their analysis examined the development of the relationship-centric LMX theory, expanding the leader-follower dyadic partnership to group and network levels that they suggest are more representative of reality. They propose that leadership is not formally designed but that its structure emerges from the network of relationships and mutual dependencies that people develop through enacting their organizational roles (Graen and Uhl-Bien, 1995).

This also concurs with Rost's proposed post-industrial model of leadership as a) non-coercive relationships with multidirectional influence between leaders, followers and others, but with power biased towards the leaders; b) leaders who take the initiative with leaderly acts, and multiple followers who are willing to participate; and c) mutual intent to work together to a common purpose to create substantial change (Rost, 1995).

Secondly, Bolden's major review of distributed leadership and its siblings e.g. 'shared', 'dispersed' and 'collective' leadership found consensus was limited to a) leadership is an emergent property of or network of interacting individuals (agreeing with Graen and Uhl-Bien) b) leadership has open boundaries and c) leadership expertise is varied and widely distributed. He concluded that the field remains immature and descriptive and cautioned against normative or rhetorical use of this theory, pointing out the inherently political nature of leadership (Bolden, 2011).

In a major analysis of the past century of leadership research, Hernandez et al sought principles that could eventually integrate into a unified theory of leadership (Hernandez et al., 2011). They offered a similar but slightly different analysis to that of Graen and Uhl-Bien, seeing leadership as a system of leaders, followers and context, concluding that all leadership theory tries to answer two key questions: 'Where does leadership come from?' and 'How is leadership transmitted?' and so took locus and mechanism as their classification dimensions.

They chose five loci: leader, context, follower, collectives and dyads, and four mechanisms: traits, behaviours, cognition and affect. They plotted all the main leadership theories on these two dimensions, providing perspective of the nature of each main theory, how they relate and where gaps exist and showing the dearth of focus on either context or affect theory relating to followers. This is interesting in the light of the Rost claim that leadership depends on follower willingness and intent. Including cognition and affect in this classification points out their importance; these writers emphasize that without cognition there can be no sensemaking, and that affect is important since the emotional connection between leaders and followers influences mutual perceptions and shapes their relationship.

Finally, Avolio et al, also wishing to guide future research, made a very structured critical review of current research and leadership theory development (Avolio et al., 2009). They noted the trend towards 'positive leadership' with followers integrated into leadership as a system of distributed or shared leadership, with leadership being viewed as an emergent property of complex systems. This idea is now developed further.

Enabling instead of controlling: complexity/adaptive leadership

During the last two decades of the 20th century a number of thinkers made the connection between organisations and complex systems theory. Already in 1979 Weick interpreted evolution and natural selection, adopted from the emergence of species in the natural world, as components of organising (Weick, 1979) and by 2009 he connected the self-organizing of complexity theory with social cognition as organizational sensemaking (Weick, 2009). Meanwhile in 2000 Lichtenstein described how effective self-organising in a rapidly growing start-up company was enabled by 'combining high degrees of structuring with high levels of openness and communication' and compared this with the failure of another start-up company that was led by traditional command and control. He claimed that 'by giving a few simple rules to all components of a complex adaptive system, highly coherent collective behavior can emerge of its own accord much more effectively than if the behavior could have been planned or directed from the outside…by trusting the insights of those nearest the organization's core, a system-wide intelligence is brought to bear that ultimately produces emergent systems that are far more effective than formally controlled ones.' (Lichtenstein, 2000).

A year later, Marion and Uhl-Bien argued that complexity theory focuses leadership on enabling rather than directing or guiding organizational effectiveness. They suggested that innovation is most effective with moderate organizational coupling; sufficiently loose to generate creativity and sufficiently tight to enable the effective communication necessary for cross-fertilization of ideas and avoidance of too much duplication, with clear implications for leaders: 'complex leaders drop seeds of innovation rather than mandating innovation plans… create opportunities to interact…tend networks… they catalyze more than they control. Complex leaders…can perceive those networks; they can help enable useful behaviors, including the expansion and complexification of the networks. They cannot, however, control those networks' (Marion and Uhl-Bien, 2001). Interest in complexity theory and adaptation has focussed on organizations' ability to innovate, but the same issue of organizational learning is important for sensemaking in the area of high hazard technology risk management.

The need for leadership to enable 'adaptive work' that would generate necessary change in the face of complex problems had been emphasised earlier (Heifetz and Laurie, 1997)(Heifetz and Laurie, 2003). These writers re-framed the role of leaders as distinguishing between 'technical' and 'adaptive' challenges and then, for the latter, instead of attempting to provide answers, 'giving

the work back to the people' by asking questions that encouraged everyone in the organization to contribute to finding solutions to such complex problems, challenging rather than clarifying current roles and norms, sharing the external environmental pressures internally rather than shielding the organization from them and provoking constructive conflict rather than defusing it. This set of leader behaviours was later re-stated as 'adaptive leadership', derived from a recognition that corporate adaptability comes from 'the accumulation of microadaptations originating throughout the company in response to its many microenvironments' rather than some 'sweeping new initiative dreamed up at headquarters' and so fosters such experiments by 'using leadership to generate more leadership deep in the organization' (Heifetz et al., 2009). These behaviours indicate the processual nature of enabling leadership.

'Relational' leadership as process

After making a deeper analysis of the social interactions between entities and reviewing research on this, Uhl-Bien proposed a 'relational leadership theory' as a framework for understanding leadership as a process of social influence that leads to the emergent changes discussed earlier (Uhl-Bien, 2006). She interpreted the term 'relational' as having the meaning of 'socially-constructed', that is, creating mutual understanding of some aspect of reality as a shared process between two or more people. A relational perspective thus sees organizations as constantly changing networks of people working together and reacting with each other and with the wider system they are part of. She made the distinction between 'entity' leadership, that focuses on interpersonal relationships in conditions of a relatively stable organization (i.e. formed of nouns) and 'relational' leadership that focuses on the processes of relating and sees leadership as a dynamic process of organizing (i.e. formed of active verbs).

An explanation of how an emergent system may be more effective than a controlled one has been offered by Lichtenstein and Plowman. They claim that leadership may emerge from interactions at all organizational levels. Their 'meso' theory is that such 'micro-level' behaviours, enacted by anyone, aggregate to four contextual 'macro-level' conditions that can lead to constructive emergence: 1) disturbance of the system's equilibrium, so that it becomes metastable and thus 2) sensitive to small inputs, which then can create large non-linear effects that can lead to 3) recombination, that is emergence of a new (assumed to be improved) configuration and finally 4) stabilizing feedback that allows consolidation of the emergent new order. This analyses leadership as coming from the dynamic interactions between entities (individuals whether formal leaders or not) rather than the behaviours of those entities, 'aiming for the "space between" individual and context - the meso space' (Lichtenstein and Plowman, 2009).

Context

Although overlooked by much research until recently, the view that leadership is embedded in context, formed of local, cultural and historical processes now seems well-accepted (Gronn, 2000)(Uhl-Bien, 2006). Offering a 'contextual theory of leadership' Osborn, Hunt and Jauch proposed four contexts: stability, crisis, dynamic equilibrium and 'edge of chaos'. They concluded that a different schema or mental model of leadership is needed for each context, dimensionalised in terms of position in the hierarchy, patterning of attention (how information is used) network development and organisational performance (Osborn et al., 2002). In a later study of the leadership of technical alliances between innovating firms, Osborn and Marion made similar conclusions, specifically that when faced with such complexity, interaction leading to creative emergence was positively influenced by the patterning of attention and the external network development of the alliance head (Osborn and Marion, 2009). This is not surprising since their characterisations of context are very equivalent to Snowden and Boone's 'simple, chaotic, complicated and complex' model, with the 'edge of chaos' the same as the metastable condition of complex adaptive systems described by Lichtenstein and Plowman. This concurrence of analysis and view gives some confidence in the practical utility of this context typology for interpreting and modelling leadership and also in its potential normative and predictive value.

A typology of 'extreme' contexts as they relate to form of leadership has been proposed (Hannah et al., 2009). Thinking of such contexts as being associated with events or situations with severe threats including potential for loss of life, they characterise extreme contexts in terms of the form of threat, level of risk (magnitude and probability of consequences) proximity (physical or psycho-social) and location in time (recognising that what is appropriate and effective leadership of an extreme event is likely to be different for the preparation, response and recovery phases). Although they report conflicting evidence that in extreme contexts followers want strong, decisive leaders, centralised authority and clear initiating structure but also that more collaborative leaders were more effective, their view is that for leadership to be effective it should be adaptive with the enactment determined by context, and that this is important not only for organizations that normally operate in extreme contexts (e.g. emergency services, military) but also naïve organizations that may face such threats only rarely.

Discourse analysis provides another view of how context relates to leadership (Fairhurst, 2009) Discourse analysis is focused only on understanding the specific problem under examination, and therefore is very concerned with historical, cultural and political aspects of context. She quotes Weick: 'order in organizational life comes just as much from the subtle, the small, the relational, the oral, the particular, and the momentary as it does from the conspicuous, the large, the substantive, the written, the general and the sustained' (Weick et al., 2005). And, referring to Grint in his analysis of 'problem-oriented contexts that leaders enact with willing followers' (Grint, 2005) she describes how context can be socially constructed as a framing of a situation; for example, 'a crisis, real or fabricated, can justify a command posture…casting a problem as tame can justify a managerial response… complex or 'wicked' problems…require a leadership response'. Researchers need to be aware of this phenomenon.

Finally, temporal aspects of context, timing and velocity, are also important. For example, the urgent time constraints in emergency medicine traditionally have encouraged a directive, 'command' approach to leadership in these situations but evidence from some research counters this, suggesting that enabling leadership behaviours can produce more positive outcomes from better teamwork (Yun et al., 2005).

In summary, leadership cannot be usefully separated from its context, so any reconciliation of the paradoxes of organisational reliability and safety must include analysis and understanding of context.

Reconciling Paradox

March stated 'the basic problem confronting an organization is to engage in sufficient exploitation to ensure its current viability and, at the same time, devote enough energy to exploration to ensure its future viability' (March, 1991). Earlier it had been shown that

different organisational forms are better suited to different activities (e.g. research and production) within the same organization, and complex organizations with multiple separate activities need to balance this differentiation with integrative processes, and this takes energy and effective management (Lawrence and Lorsch, 1967). This built on the observation that a stable environment suited a 'mechanistic' hierarchical organizational form with defined roles and standardised operating procedures, while organisations operating in turbulent environments need to be more 'organic' with more informal ways of working and more lateral coordination (Burns and Stalker, 1961). A later more nuanced theory of organizational form and function based on five idealised organisation types (Mintzberg, 1980) describing how effective organizations configure their structural elements to suit their activity and environment, proposed that for sophisticated innovation in complex and dynamic environments a form of 'adhocracy' is needed, organic and project-focused, relying on matrix structures and coordination by mutual adjustment between experts. Mintzberg pointed out that this typology is simply a conceptual framework; many real organizations are hybrids, and hybridity could be a means for organisations to find a good balance between exploitation and exploration.

Reviewing research on organizational ambidexterity, O'Reilly and Tushman suggest 'the difficulty in achieving this balance is a bias in favour of exploitation with its greater certainty of short-term success' (O'Reilly and Tushman, 2013). Exploration, they claim, is by its nature, inefficient and 'associated with an unavoidable increase in the number of bad ideas'. This is reminiscent of the system safety theorists' criticism that HRO theory apparently encourages people at the sharp end of high hazard technology, e.g. pilots, chemical plant control room operators, to improvise when they think that established procedures seem inappropriate, with potential negative unintended consequences (Leveson et al., 2009). This notion lies at the heart of the difficulty of reconciling the two paradigms, since in contrast, as discussed earlier, without mindful sense-making the slavish following of rules can also lead to danger (Dekker, 2003). O'Reilly and Tushman's observation of bias in favour of exploitation also speaks to the bias towards the hierarchical, standardised 'mechanistic' structures prevalent in high hazard technology operations. O'Reilly and Tushman identify three ambidexterity mechanisms: 'sequential', i.e. changing structures over time, 'simultaneous or structural', i.e. separate groups within the organization for the two separate strategies and thirdly 'contextual', referencing Gibson and Birkinshaw's seminal 2004 ambidexterity study of 4,195 individuals from 41 business units in ten multinational firms.

Gibson and Birkinshaw describe contextual ambidexterity as 'the behavioural capacity to simultaneously demonstrate alignment and adaptability across an entire business unit'. By 'alignment' they mean coherence in patterns of activities, thus similar in meaning to exploitation, and they use the term 'adaptability' in the sense of capacity for rapid reconfiguring of activities in response to changes in the environment, implying the problem-solving and learning that exploration involves. They define context as 'the systems, processes and beliefs that shape individual-level behaviours in an organization' and propose that contextual ambidexterity is achieved by 'building a set of processes or systems that enable and encourage individuals to make their own judgments about how to divide their time between conflicting demands for alignment and adaptability' (Gibson and Birkinshaw, 2004). This view of ambidexterity is the most interesting of the three in the search for complementarity between the 'System Safety' and 'HRO' paradigms since it implies that there are indeed processes that enable individuals to reconcile in 'real-time' such conflicting demands depending on how they interpret the particular situation facing them. Analysis of the sequence of events in high hazard technology disasters shows that they often develop over significant periods of time, and give out warning signs in the minutes, hours, days, weeks or even months before the event (Reason, 1997)(Hopkins, 2005) so successful interventions to avert them need to be made in those time-frames. Because of this timing, intervention decisions sometimes need to be made by people at the sharp end of operations, who therefore, in HRO theory, need to be empowered to respond with a strong response to a weak signal and 'to see and to do' (Roberts, 1990).

Gibson and Birkinshaw suggest this ambidextrous capacity is enabled by the existence of an organizational context with four attributes: discipline, stretch, support, and trust (Ghoshal and Bartlett, 1994 quoted in (Gibson and Birkinshaw, 2004) which together induce individuals to act with initiative, cooperation and learning and 'to do whatever it takes to deliver results'. They characterise 'discipline' as having clear standards of performance and behaviour together with open, candid and rapid feedback, 'stretch' by collective identity in which people find personal meaning in their contribution the organization's purpose and shared goals, 'support' by having access to shared resources, freedom of initiative and senior people providing help and guidance rather than authority, and 'trust' by just and fair decision processes, involvement of individuals in decisions and activities affecting them, and the staffing of positions with competent people. Finally, Gibson and Birkinshaw emphasize the important influence of senior leaders on the creation of a supportive organization from which contextual ambidexterity can emerge.

Managing tension between 'control/administrative' leadership and 'adaptive' leadership

Snowden and Boone, presenting a framework for analysing the nature of issues facing an organisation that differentiates the complex from the complicated, the simple and the chaotic, also put forward a similar list of specific leader actions that enable emergence of the adaptive behaviours needed in an organization facing complexity. They claim that attempts to over-control will stifle the emergence of informative patterns and instead leaders should encourage dissent and diversity, stimulate democratic discussion and establish simple rules, saying that 'leaders who try to impose order in a complex context will fail, but those who set the stage, step back a bit, allow patterns to emerge, and determine which ones are desirable will succeed' (Snowden and Boone, 2007).

In similar vein, Uhl-Bien and her co-authors argue that 'simple, rationalized structures underestimate the complexity of the context in which the organization must function and adapt', and refer to the 'law of requisite variety' that says that 'it takes complexity to defeat complexity'. [This same concept is applied to managing the risks of organisational accidents with 'defences in depth' and dispersed decision-making (Reason, 1997).] They point out the need for leadership of knowledge-based activity to move away from the currently dominant leadership paradigm of formal hierarchical structures aimed at production efficiency and 'other bureaucratic notions that likewise mute uncontrolled behaviors', and propose a 'complexity leadership theory' that has three aspects they see as entangled with each other: 'adaptive', (e.g. enabling creative problem-solving) 'administrative' (e.g. planning) and 'enabling', this latter minimizing the constraints of the (necessary) bureaucracy (Uhl-Bien et al., 2007). Entanglement of adaptive and administrative leadership manifests in the avoidance of undue constraint of creativity by micromanagement while providing the framework and conditions within which adaptive behaviours can take place. Uhl-Bien et al emphasize that it is the entanglement of 'enabling' leadership with the other forms that is critical for achieving balance and so managing the tension between them. They give examples of enabling leadership as injecting strategic direction while encouraging autonomy to implement within limits, providing resources for adaptive work, setting recruitment policies to increase diversity and acting as 'agents' by championing the implementation of new

ideas and recognising when too much consensus may stifle creativity, so welcoming constructive tension, playing devil's advocate and addressing 'elephants on the table'.

The meaning of Ghoshal and Bartlett's terms of 'support' and 'trust' resonate with 'adaptive leadership' as described by Uhl-Bien, and the meaning of 'discipline' and 'stretch' with her 'administrative leadership'. Altogether, Gibson and Birkinshaw's analysis of how contextual ambidexterity is created is very reminiscent of the entanglement of leadership forms that construct enabling leadership. The enactment of enabling leadership described above by Uhl-Bien et al: 'injecting strategic direction while encouraging autonomy to implement within limits, providing resources for adaptive work, setting recruitment policies to increase diversity…etc' producing the conditions for emergence of adaptive change seems very well aligned with the concept of contextual ambidexterity.

A good example of contextual ambidexterity in action may be seen in the observation from early HRO research (Roberts, 1990)(La Porte, 1996) that as operating conditions changed the authority structure changed from hierarchical, becoming flatter, integrating skills and experience and allowing decisions to migrate to lower organizational levels. These authors did not explain the enabling mechanisms that made that happen. Contextual ambidexterity from enabling leadership that allows both operational discipline and sensemaking may be the key to understanding how the paradoxes of organizational form and leadership are reconciled effectively to improve the reliability and safety of high hazard technology.

Conclusions and Current Research

The traditional and still dominant paradigms of system safety, hierarchical organizational form and leader-centric command and control do not provide a complete enough description of how high reliability and safety of high hazard technology is obtained. These paradigms, by failing to reconcile control/adaptation paradoxes of operational discipline vs sensemaking, clarity of structure vs flexible decision-making and leader vs leadership inhibit valuable adaptive processes of sensemaking and naturalistic decision-making inherent in HRO theory.

Recent developments of leadership theory based on complexity and emergence and leadership as a socially constructed relational and processual phenomenon embedded in context reveal ways to reconcile these paradoxes. This offers the possibility of a new paradigm of 'enabling leadership and contextual sensemaking' that facilitates effective balancing of these tensions, regarding them as interdependent dualities instead of conflicting dualisms. 'Enabling' leadership, enacted by formal leaders and also distributed in the organization, enables contextual ambidexterity by providing structure, bureaucracy and discipline as well as encouraging sensemaking and creative competent improvisation.

A research project is currently being undertaken at Cranfield, seeking evidence of 'enabling leadership' and ambidextrous organizational form creating the conditions for emergence of the highly effective risk reduction activities of HRO theory whilst respecting the foundational engineering and operational discipline of system safety.

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