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Working to rule, or working safely? Part 1: A state of the art review¹

Andrew Hale, HASTAM UK, and Safety Science Group, Delft University of Technology, Netherlands.

David Borys, Victorian Institute of Occupational Safety & Health, University of Ballarat, Victoria, Australia.

Abstract

The paper reviews the literature from 1986 on the management of those safety rules and procedures which relate to the workplace level in organisations. It contrasts two different paradigms of how rules and their development and use are perceived and managed. The first is a top-down classical, rational approach in which rules are seen as static, comprehensive limits of freedom of choice, imposed on operators at the sharp end and violations are seen as negative behaviour to be suppressed. The second is a bottom-up constructivist view of rules as dynamic, local, situated constructions of operators as experts, where competence is seen to a great extent as the ability to adapt rules to the diversity of reality. The paper explores the research underlying and illustrating these two paradigms, drawn from psychology, sociology and ethnography, organisational studies and behavioural economics. In a separate paper following on from this review (Hale & Borys 2012, this issue) the authors propose a framework of rule management which attempts to draw the lessons from both paradigms. It places the monitoring and adaptation of rules central to its management process.

1. Introduction

The focus of this paper is on safety rules and procedures used at the workplace level in organisations. We do not cover the procedures and rules at the safety management system or regulatory levels (but see Hale et al. 2011 for an extension of the arguments used here and in the companion paper in this issue (Hale & Borys 2012) to those levels of rules). Throughout this literature review we are using the term ‘safety rules and procedures’ to mean any rule or procedure that impinges on safety, directly or indirectly. Some rules are almost exclusively directed at safety (e.g. those rules requiring the use of personal protective equipment), but many have other primary or subsidiary objectives related to quality, productivity, health, environmental control, sustainability, as

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well as safety. We do not wish to imply by the focus of this review on safety that there should be a separate set of safety rules, either physically or conceptually, isolated from the rules for conducting all of the other actions necessary to achieve the organisation's multiple objectives. The experience of many companies (e.g. Waszink et al 1995) has shown that integration of all the rules directed at all of the objectives of a given activity, in other words a rule set matched to the company's processes, is far smaller and more efficient than one divided by objective. Hence, in what follows, the readers should always have this broad canvas in their mind's eye.

1.1 The Janus faces of rules

Safety rules and procedures are presented in many publications on safety management as one of the cornerstones of the risk control system, the translation into specific detail of the top management commitment set out in the safety policy. So obvious is their importance felt to be, that they sometimes receive only a passing mention as something uncontroversial. Procedures form part of the written documentation required under OHSAS 18001. In the OHSAS 18002:2008 guidance to the 18001 Standard for Occupational Health and Safety Management Systems (British Standards Institution 2008) 'procedure' is defined as a 'specified way to carry out an activity or process'. The guidance uses the word 'procedures' frequently, to talk both about directing and controlling the safety of the primary processes of the organisation and to specify the activities of the safety management system itself (hazard identification, risk assessment, communication, participation, monitoring/auditing, emergency response, etc.). Safety management systems (SMS) such as ISRS (ILCI 1990), TRIPOD (Groeneweg 1998) and ARAMIS (Hale & Guldenmund 2004), Hearts and Minds (Energy Institute 2008) identify the management of procedures, or their failure, as one of the principal elements of their safety management systems (SMS). Procedures are seen to be essential (Energy Institute 2008) because jobs are too complex for people to remember the steps, or to work them out in time, especially in emergency situations, because transparency of behaviour is needed to monitor and check it, to standardise tasks involving several actors and to provide organisational memory of the way processes work.

The literature on safety climate and culture also identifies rules and procedures and the workforce attitudes to them as key elements of safety climate/culture and perceptions (e.g. Pidgeon 1991, Diaz Cabrera et al 2007, Flin et al 2000, Guldenmund 2000, O'Toole 2002, Farrington-Darby et al 2005, Mohammed 2002, 2003, Prussia et al 2003, Törner & Pousette 2009). Studies such as that by O'Dea and Flin (2001) among Offshore Installations Managers in the British North Sea show 'failure to follow rules' as the third most important perceived cause of accidents, after 'not thinking the job through' and 'carelessness'. The plethora of legal rules and procedures surrounding safety and

health, either in the form of high level objectives, procedural requirements or detailed action rules (Hale & Swuste 1998), is seen as further proof of the need to define and document the way in which safety, and compliance with these regulatory rules, is to be achieved.

Reports of accidents, such as Challenger (Vaughan 1996) point to the normalisation of deviance from rules as a primary cause of such accidents, whilst the enquiry into the Deepwater Horizon disaster (National Commission 2011) castigates the company and the regulator for not having explicit procedures to govern changes in the well-drilling, -capping and -testing methods as used in that case. A Dutch study (Labour Inspectorate 1989), analysing incidents of loss of containment in the chemical process industry, found 50% related to procedures, of which 10% where there were no or unclear procedures, 12% where the procedure was wrong and 28% where a correct procedure was not followed.

In this view, rules and procedures are seen as largely desirable and certainly unavoidable to allocate responsibility (and later blame in many cultures and organisations) and to define and guide behaviour in complex and often conflicting environments and processes

Behind this logical, rational obviousness, however, there lies another ‘truth’ about the reality of safety rules and their use. Elling (1991) in his seminal study of safety rules in the Dutch railways showed that only 3% of workers surveyed used the rules often, and almost 50% never; 47% found them to be not always realistic, 29% thought they were used only to point the finger of blame, 95% thought that, if you kept to the rules, the work could never be completed in time, 79% that there were too many rules, 70% that they were too complicated and 77% that they were sometimes contradictory. Studies by DuPont for British Rail (Maidment 1993) showed similar problems in the UK. He and others (Norros 1993, Amalberti 2001) argue that there are already too many rules in most complex technologies and no more are needed to make them safer.

Figures from Embrey (1999) from a survey of some 400 operators and managers in the chemical industry about their reasons for non-usage of procedures include 40% finding them unworkable in practice and 62% that if followed to the letter the job could not get done in time, 48% find them too restrictive and 44% too time consuming, while 57% think people are not aware that there are procedures laid down for the job they do. 70% felt that people assumed they knew what would be in the procedure, 70% preferred to rely on their own skills and experience and 19% felt that experienced people do not need procedures, while 34% resent being told how to do their job and see rules as a restriction on their freedom of choice and a slur on their competence. Similar attitudes have been found in a number of studies since (e.g Sundström-Frisk 1998, Bax 1998, Martin 2001,

Parker & Malone 2004, Laurence 2005, Shaw et al 2007, CIRAS 2007) The CIRAS (2007) report also indicates that breaches of rules seem to be increasing as a proportion of confidential reports from the rail industry in the UK, with 51% on average being intentional violations of rules (100% of those concerning sub-contractors) and 31% ignoring best practice in favour of own methods. The expansion of rule books and procedural manuals, risk analyses and audits, planning, monitoring and reporting tasks and documents has also been linked to a significant shift of time spent by managers from hands-on leadership to dealing with paperwork, to the detriment of interaction, supervision, adaptation and learning (Lamvik et al 2009), a shift which the authors see as damaging to safety awareness and performance.

These Janus-faces of safety rules led Dekker to postulate in his book ‘Ten Questions about Human Error’ (2005) that there are two contrasting models of safety rules, what their function is, how they emerge, and how they should be managed. One is a top-down, rational, optimistic view of rules reflecting the first paragraph above; the other is a constructivist view of how rules operate, which turns the dark side revealed in Elling’s study and its later counterparts on its head and proposes a bottom-up, participative approach to rule emergence to avoid such negative attitudes. The second approach sees procedures as supports, not strait jackets, as tools to coordinate and structure creativity and innovation, not as controls to limit freedom.

Dekker presents these ‘model 1’ and ‘model 2’ approaches as conflicting and seems to imply that we have to choose between them. In this paper we want to explore the support for this dichotomy in the diverse literature on safety rules and procedures and their management, and assess whether they are indeed alternatives, perhaps even two steps in a progression to maturity of the rule management system, or whether there is a compromise to be struck between them which draws the positive aspects from both models and can lead us towards the definition of more generic best practice on the management of safety rules and procedures. However, before we present the two models in detail we wish to introduce two notions which we will draw on in the paper, firstly based on the ideas of Rasmussen (1997) to clarify the role of safety rules in a dynamic system (section 1.2) and secondly to offer a hierarchical classification of (safety) rules (Hale & Swuste 1998), based on how generic their formulation is (section 1.3).

1.2. Safe envelope of operations: the objective of rules

Rasmussen (1997) introduced the valuable (if abstract) notion of a drift to danger, whereby an SMS establishes a safe zone of operation, guarded by risk controls. However, the operation of the activity is subject to pressures of competition, market and regulatory pressures, individual and

group/organisational motivations for less effort, etc., which push it towards the boundaries of that safe zone and may push it over into the uncharted waters outside it, which bring it closer to the real edge where damage and injury begin to occur (see also Snook 2002). Reason et al (1998), Leplat (1998), Amalberti et al (2006) and Howell et al (2002) used that concept to describe the objective of safety rules, to act as beacons defining the boundary of the safe zone. Hale et al (2004) and v.d. Top (2010) developed the notion more explicitly at an operational level to describe the task of railway staff (esp. drivers and train controllers). They explicitly distinguished a relatively narrow zone, defined by the organisation (either in combination with the workforce or imposed by management) as being the required safe operating zone (SOZ), usually defined by rules and well within the viable boundary, outside of which damage begins (giving a safety margin to operations). Between the two lies a ‘controllability’ boundary, within which the system controller being modelled can still recover and return the system within the SOZ. Between the controllability boundary and the viable boundary only interventions from other actors (if warned in a timely way), or chance, can prevent the system going over the viable boundary and producing harm. These zones also define types and functions of rules; for defining the control measures to be taken to navigate within the boundaries, to avoid going over the boundary (itself defined by rules) and to recover under emergency conditions from a position outside the boundaries. These categories define also the frequency with which the rules will be used and the time pressures whereunder. Also Schelling (1985) talks of devising graded rules, so that breach of one warns of approach to the boundary, but does not involve crossing it.

Making the boundary of safe operations visible is desirable in theory but is problematic in practice. The “rule of three” (Hudson et al. undated) is one example from the offshore oil and gas industry where the boundary of safe operations becomes visible through enhancing decision makers’ situation awareness of a range of work environment and other factors that could push the system across the boundary and into disaster. The “rule of three” refers to three threshold zones (denoted by a traffic light model – red, amber and green) that denote how close the operation may be to the edge of safety. Each threshold zone has a number of critical dimensions, for example weather, and sub-dimensions, for example, rain, wind and lighting. If all of the critical dimensions are green, then operations can proceed normally. However, if only one critical dimension is red, then operations cease. For cases judged to be in the amber zone, the decision to halt operations escalates as the number of critical dimensions judged as amber increases from one to three. In this case, three ambers may also be enough to halt operations. Similarly, some coal mines in Australia use trigger action response plans (TARPS) to help delineate the boundary of safe operations, again in relation to work and environmental factors that could push the system over the edge (Hopkins, 2007). Other industries have focused on developing the requisite mental skills to recognise when practice may be

operating close to the edge. One example relates to patient safety in the UK health system where work is underway to develop “error wisdom” in nurses and junior doctors (Reason, 1994, Reason, 2008). In the construction industry, a method that allows workers to know what zone (safe, hazard, loss of control) they are working in and how close to the edge they are working, has been proposed (Howell et al. 2002).

In this formulation, rules have two functions, defining the boundaries of the various zones of normal operations, controllability and viability, and supporting the process of manoeuvring to stay inside those boundaries. We will refer back to this picture at several points in this paper, and return to it in more detail in the companion paper (Hale & Borys 2012, this issue), when we discuss its implications for the development and management of the rules.

1.3. Categorisation of rules

Hale & Swuste (1998) introduced a useful distinction between different types of rules, which has been taken up by Blakstad (2006) (see also Blakstad et al 2010) and Grote et al (2009) in their analysis of rule management in railways (see also Energy Institute 2008 and Rasmussen 1997). This distinguishes three types, which differ in the amount of freedom they give to the person following the rule to determine their exact behaviour:

1. *Performance goals*, which define only what has to be achieved and not how it must be done. These may be in terms of numerical risk targets (e.g. risk contours around marshalling yards handling dangerous chemicals, target levels of incidents or accidents) or more qualitative ones such as ‘as low as reasonably practicable’, ‘of sound construction’, etc. Blakstad et al (2010) point out that this type of rule is only feasible if there is feedback of the results of actions, so that their achievement can be made visible. In contrast the two types below are compatible with feed-forward control
2. *Process rules*, which define the process by which the person or organisation should arrive at the way they will operate, but still leaves considerable freedom about what that operation will be. Rules under this heading include requirements of a process to prepare a risk assessment, either generically or at the last minute before starting work, requirements to set up a safety management system, and requirements to consult with defined people when an emergency situation arises in order to decide how to handle it. Both performance goals and process rules need time for them to be translated into specific actions, the more competent and experienced the people using the rules, the less time.
3. *Action rules*, which specify in terms of ‘If – Then’ statements exactly how people shall behave, or how hardware shall be designed or tested (e.g. wearing a seat belt when in a

moving car, checking that various equipment is working before taking off in an aircraft, counting surgical items before closing an incision, etc.).

Hale & Swuste (op.cit.) point out that every time a person carries out a piece of behaviour we should realise that a translation process has gone on at some point from the appropriate performance goals, through the process rules to an action rule for that behaviour at that moment in time. Hence what is interesting to know, and eventually to specify, is not whether a process or action rule has been specified, but when and by whom each translation takes place. Does the organisation trust or allow each individual operator (fitter, surgeon, pilot, machinist, etc.) to take the specified (or agreed) performance goals and translate them appropriately into process and action rules for every eventuality they meet, or does the management (or even the regulator) centrally make the translation at a design stage and hand down to the operators binding specific action rules for all situations they can envisage? For example, does a company operating on customers' premises instruct its workers simply to operate safely and leave it to their competence to decide on their detailed actions, or does it require them to go through a Last Minute Risk Analysis (LMRA), either documented or not – a process rule – before starting on any job, or do they require certain actions, such as the wearing of standard PPE, no matter what the task, an action rule. Each choice distributes the translation from goal to process to action differently between company experts and the field staff. Decentralising rule making requires that translation to be done at lower levels in the hierarchy, a process which we can truly call self-regulation. It should and cannot be deregulation, where nobody at the lower level makes the translation.

Grote et al (2009) point out that the process rules in particular offer a compromise between standardisation and flexibility, which is one of the dilemmas in dealing with diversity and the need for either problem solving to arrive at new ways to meet overarching goals, or adaptation of more specific action rules to make them fit exceptional circumstances.

This classification has some similarities to that reported by Perrin (1993) as being used in the US nuclear industry, where procedures were classified as either 'step-by-step adherence' (action rules), or 'general intent adherence', allowing some deviation at the discretion of the operator, or 'information use' permitting more latitude to achieve the same goal. These and other related categorisations also specified whether active checking of the written rule, or reliance on memory was required and whether only self-checking was required or checking by an external person.

We refer to the classification at several points in this paper to distinguish types of rules and their relationship to models 1 and 2. We return to it in more detail in the companion paper (Hale & Borys

2012, this issue), when we discuss its importance in deciding on what are appropriate rules to develop and how different types of rule should be used, optimised and enforced.

1.4. Structure of the paper

We will focus this paper on the use of rules and procedures for those working in the primary processes of hazardous technologies, the machine operators, fitters, pilots, surgeons, nurses, anaesthetists, etc. We will only touch in passing on the value and management of rules and procedures at the level of the safety management system, or the rules of the regulator imposed on that level. We believe that there may be interesting parallels to draw with these levels and refer the reader to a number of papers listed in a separate annex. The question of writing rules for safety culture was discussed in detail at a workshop run by the New Technology and Work Network in December 2010 (e.g. Grote 2010, LeCoze & Wiig 2010, Kringen 2010). The consensus there was that regulatory rules for such a subject, which is still so vaguely defined and where there is still not sufficient consensus over good practice, would be premature, except perhaps at the goal level of ‘addressing the development and embedding of a culture of safety’.

The paper begins with a section (2) specifying what the two models introduced in section 1.1 are, followed by a section (3) over what the support for each model is and what the strengths and weaknesses of rules devised under each model can be. This section draws out a set of underlying issues and influences which need to be dealt with in arriving at a good rule management process. In a separate but related paper in this issue of the journal we use a framework devised in an earlier study of rule and procedure management in the chemical and rail industries (Hale et al 2003, Hale & Guldenmund 2004, Larsen et al 2004) to draw conclusions and make proposals for a system of good rule management combining the lessons of models 1 and 2.

2. Contrasting models of (safety) rules²

Dekker (2005) was the first to formulate the two models of safety rules in explicit terms, calling them ‘model 1’ and ‘model 2’. However, there is a wide range of earlier literature, which we will analyse, that points to this dichotomy of thinking about rules, deriving from different theoretical traditions and evidence bases. The models Dekker derives are models in the sense of mental representations, ways of thinking about rules and explaining how they arrive, or are arrived at, what their function is, what the drawbacks and problems there are in their use and what their strengths and

² From this point on we will generally use the words ‘rules’ and ‘procedures’ interchangeably to talk generically about the portmanteau of specified goals, procedures and action rules which form the complex of means to specify ways of carrying out activities and processes – see section 1.3.

limitations are. We draw, in the short sections below, a brief and somewhat stylised sketch of each model before going into the literature which we have used to derive that sketch.

2.1. Model 1

This model is rooted in Scientific Management (Taylor 1911, McCarthy et al 1998) and is rationalist and prescriptive in its approach, appealing to engineering concepts and truths. It sees rules, particularly action rules, as the embodiment of the one best way to carry out activities, covering all known contingencies. They are devised by experts to guard against the errors and mistakes of fallible human operators at the sharp end, who are more limited than the experts in their competence and experience, and/or in the time necessary, in the heat of operations, to work out that one best way. They should be derived and devised in advance, based on task and risk analysis. Once devised, they are ‘carved in stone’, communicated to, and imposed on, the operators or workforce by management (their elders and betters), to be enforced by suitable means to overcome the fallible human tendency to make errors and deviate from the rules, either intentionally or unintentionally. Violations (intentional deviations) and errors (unintentional deviations) are seen as essentially negative actions made with free choice, often by so-called ‘elitists’ (‘who think they know better’), and, at best, as actions to be understood, countered and suppressed. The rules are seen as essentially static and in a sense linear, to be worked out as a one-off exercise and only to be modified when the activity changes substantially, which is imagined to be not often. They are to be documented in manuals, or more recently in databases, made available to the workforce, incorporated in training and signed for to signify intent to comply. Their image is essentially top-down, applying to the operational workforce and only relevant to the management in their role as enforcers (though Martin (2001) shows that managers are just as fervent violators of rules as the workforce). In the terms of our safe envelope picture the existence of a range of acceptable behaviours, and indeed of a significantly sized envelope, is denied and every deviation from the defined ‘correct path’ is seen as a first step on the linear path to an accident. The dark side of this model is the widespread deviation from rules found in practice and the concern to understand why rules are violated and what can be done to remedy this.

This is the model which is triggered by the media response to major accidents, in which violations of rules are identified which contributed to the accident and more stringent or more extensive rules are called for to prevent recurrence. It is also the model which powers much of behavioural based safety (e.g. Krause et al 1999, Keil Centre 2002) as a set of tools to achieve workforce compliance. The quality management and auditing industry (Power 1997, Embrey 1999) fits largely into this model, with its emphasis on the scrutiny of written documentation and detection of non-compliance, as does

the work of the regulator checking on legal compliance. Both auditor and regulator emphasise the essentially written nature of safety rules. It is also a dominant view of rules, at least in high risk organisations, as shown in a study by Bax et al (1998) who found that 72% of a representative sample of Dutch workers in such organisations worked in organisations with (many) formal rules, half of the organisations having regular or frequent formal controls of those rules.

This is in some ways a caricature of the model, and there have been many attempts to file down its sharper edges, which we shall discuss below. It is also undeniable that this model has led to many improvements in safety, the achievements of behavioural based safety, under it different titles, being among the most significant and best documented (e.g. Laitinen & Ruohomäki 1996)

2.2. Model 2

This model, which has emerged from sociological and ethnographic studies particularly of high technology and complex industries, such as aviation and health care, sees rules (in the organisational literature often called ‘routines’) as patterns of behaviour, socially constructed, emerging from experience with actions and activities by those carrying them out. They are characterised as local and situated in the specific activity, in contrast with the written rules, which are seen as being at a generic level, necessarily abstracted from the detailed situation in order to be able to generalise them across essentially disparate local situations. This view of rules is essentially bottom-up and dynamic. It recognises that rules can never be complete and the written ones are seen as essentially underspecified, requiring a process of translation and adaptation before application to any given, specific situation. This implies that written rules should not be at the detailed, action level, but at most at the process rule level. Model 2 replaces the linear picture of model 1 with a circle consisting of the use of experience and expertise to deepen, update and refine action rules on the basis of feedback through experience filtered through tacit expertise. In the terms of our safe envelope picture model 2 recognises that many behaviours are acceptable as long as they do not lead too close to the boundary, a view that fits with systemic approaches to accident modelling. Variability, driven by human adaptation to diversity is inevitable and valuable (Hollnagel 2004) and must be managed and not suppressed.

The real experts in this conceptualisation are the operators (pilots, surgeons, maintenance fitters, seamen), whose ability to conduct and navigate this dynamic process of negotiation and construction of rules is seen as an essential part of their skill and identity. There can be a great resistance if attempts are made to impose rules from outside of this operational group, resulting in continued use of the informal, group rules, which are seen as violations by those on the outside, but as skilled

adaptations by those on the inside. Rules are seen in model 2 as a support and guidance for the expert, a template and resource for adaptation, but not something requiring strict compliance and no substitute for competence. This difference is symbolised by re-labelling them ‘Guidelines’ instead of ‘rules’ or ‘protocols’ (McCarthy et al 1998) or reframing rules as ‘resources for action’ (Wright et al 1998). However, even in this model they may be seen as more binding on the novice. ‘Violation’ is therefore seen as essential in specific cases where the rule does not match the reality, and is otherwise shunned as a pejorative term to demonise unsuccessful innovation and adaptation. Discovering what the rules are is a process of laying bare explicit knowledge, of activity analysis (McCarthy et al 1998) not task analysis. More recently, Wright & McCarthy (2003) have argued, based upon their work in commercial aviation, that it is through the processes of the construction of meaning and sense-making in specific situations that operators make procedures work. Therefore effort needs to be focused on incorporating operators’ experience into rule design.

The main support for this model comes from sociological (e.g. Mascini & Bacharias 2008), ethnographic (e.g. Knudsen 2008) and organisational studies (e.g. Zoller 2003, McDonald et al 2005, 2006) of the reality of the use of rules in organisations and the gap between that reality and the rules written to guide and control it (Borys 2007). Again this is somewhat of a caricature of the model, but it is clear that its main thrust is to differentiate the written from the acted rules in much the same way that Argyris and Schön (1978) distinguish ‘espoused theory’ from ‘theory-in-use’. It is this gap between rules and reality which is seen as ‘causing’ or explaining the apparent deviations and violations. In that sense model 2 starts from the realities of actions and considers (written) rules as inductions and abstractions, whilst model 1 starts from the written rules and deduces from them that actions are compliances or violations.

Despite this broad distinction between models 1 and 2 we do not yet conclude whether 1 is bad, or applicable only to simple tasks, and 2 is good, or applicable to complex ones. The literature is more nuanced than that and we believe it supports a view that elements from both models have their place in rule management, a case we argue in the companion paper to this one (Hale & Borys 2012, this issue). We turn now to a summary of the research findings from the two traditions, to identify the strengths and weaknesses of each.

3. Research evidence

3.1. Model 1

Much of the research inspired by model 1 has been aimed at trying to understand, explain and counteract violations from imposed or agreed rules, which are themselves seen as the ‘gold standard’

of correct behaviour. The large literature on behaviour-based safety (BBS), behavioural monitoring or other similar terms fits classically under this heading and dates from pioneering work by Komaki et al (1978). We do not have the space to review it in detail here, besides which there are excellent reviews available (e.g. McAfee & Winn 1989, Geller 1998, Krause et al 1999, De Pasquale & Geller 1999, Boyce & Geller, 2001, Keil Centre 2002, DeJoy 2005), however its findings are very clear. If simple and observable safety rules or critical behaviours are defined, schedules of observation set up and feedback given about the percentage compliance against targets which have been set, there is usually a very significant rise in compliance with the rules over time, typically ranging from 26% – 69% (Krause et al 1999) over one to five years. Compliance declines again if feedback is reduced or discontinued. Feedback is more influential than simple training (Komaki et al 1980) and is enhanced if there is direct dialogue between the observer and the observed about the feedback (Hale et al 2010a, 2010b). This approach has its roots in the classical behaviourism which associates learning and change with feedback and reward or punishment of behaviour. Its success as an approach has unequivocally been demonstrated by the literature, though it is possible to question how it needs to be adapted to fit different national, regional or professional cultures with different views of hierarchy.

Rigid rules defined either centrally, or with discussion with those subject to them are therefore still very popular. For example Shell, which has pioneered many new approaches to safety culture and management, such as TRIPOD (Groeneweg 1998) and ‘Hearts and Minds’ (Parker et al 2006), has recently (Shell 2009, see also Energy Institute 2008) developed a set of 12 ‘life-saving rules’ at the action rules level, which are strictly enforced, with breach of them resulting in a default decision of dismissal, unless convincing mitigating conditions can be marshalled in defence of the violation. The rules apply both to workforce and (importantly) to managers and have resulted already in the use of those extreme sanctions. The rules are chosen as having as few as possible valid exceptions and cover topics such as smoking, seat belts, gas tests, work permits, fall protection at height, speed limits and journey management plans. It will be interesting to see if such a policy is successful and does not prompt concealment of breaches of the rules to avoid such seemingly draconian punishments.

3.1.1. Reasons for violations

Reasons for violations of safety rules have been studied in a range of papers: (Baker 1979, Peters 1999, Norros 1993, Battmann & Klumb 1993, Zeitlin 1994, HFRG 1995, Åberg 1998, Lawton 1998, Ng & Dastalmachian 1998 Reason et al 1998, Hudson et al 2000, Martin 2001, Besnard & Greathead 2003, Polet et al 2003, Parker & Malone 2004, Wilson 2004, Mascini 2005, Laurence

2005, Shaw et al 2007, Iszatt-White 2007, Alper et al 2007, 2008a & 2008b, Loukopoulou 2008, Alper & Karsh 2009, Drach-Zahavy & Somech 2010). The results can be summarised under the headings used by Alper & Karsh (2009) for their review, see table 1, which also incorporates findings from the other papers in the list in the previous sentence which were not reviewed by Alper & Karsh. The list is phrased to show what is positively correlated with violations.

Most entries are self-explanatory, but a few need clarification. Self-efficacy (Iszatt-White 2007) or powerfulness (Hudson et al 2000) is the individual feeling that a person has the skill to violate without reaping the consequences that a less competent or expert person would incur. It matches the similarly worded factor under organisation climate, where that has become a group norm. Hudson et al (2000) also make a classification of those feeling comfortable with violation as ‘wolves’, and those not as ‘sheep’ and relates this to the actual violations in a study in the offshore oil industry. They found that 22% of the workforce were not inclined to violate and had not done so (sheep in sheep’s clothing), 30% were inclined to and had already done so (wolves in wolves’ clothing), 14% were not inclined to but had (in their eyes exceptionally) done so (sheep in wolves’ clothing), whilst 34% were comfortable with violation but had not (yet) had occasion to (wolves in sheep’s clothing). He advocates (see also Energy Institute 2008) keeping the wolves at bay by involving them in planning and communication and the rewriting of procedures they are tempted to violate, and measures to provide explicit authorisation to deviate that keeps management and supervision in the loop. For the sheep, who tend to follow rules even unthinkingly, he advocates a high quality of procedure, so that this unthinkingness does not lead them into error.

Alper & Karsh (2009) in their review do indicate that violation becomes necessary if the rule in existence does not cover the situation facing the person, or would result in harm if followed, but remark that, in all 13 empirical studies they reviewed in detail, and the 30 additional ones they comment on more superficially, violations were seen as exclusively negative. They also report that there is a correlation in driving tasks between reported violations and accident involvement (Reason et al 1998), confirming the negative view of violations. However, there is no proof of a similar relationship for work-related violations.

<u>Individual factors</u>	<u>Organisational or safety climate factors</u>
<ul style="list-style-type: none"> - Attitude to and habits of non-compliance - Intention to comply/violate 	<ul style="list-style-type: none"> - Management turns a blind eye or is inconsistent in sanctioning - Poor supervisor-worker cooperation

<ul style="list-style-type: none"> - Previous accident involvement - Worker low level of knowledge/training/ experience - Sees way to make short cuts - High value on macho, exciting, quick, money- or energy-saving way to work - Self-image & status among peers favours risk and violation - Tiredness - Perceived low risk/threat/consequence - High self-efficacy/powerfulness - Does things on the fly/lack of planning - <i>Sex</i> (males in driving, not in other arenas) - <i>Age</i> (young in driving, not in other arenas) - <i>Exposure time</i> - <i>Communication</i> 	<ul style="list-style-type: none"> - Non-participative style of supervision - Poor (work)group cohesion - Not checking procedures - Site organisation failures - Conflicts between trades - Norm that: 'A skilled person can violate this way with impunity' - Time pressure - Conflicting demands, esp. with productivity - Subjective group norm to violate - Lack of trust - <i>Workload and work pressure</i> - <i>Management commitment</i> - <i>Supervisory position</i> - <i>Participation in safety programme</i> - <i>Incentive pay vs. fixed hour rate</i>
<u>Hardware/activity factors</u> <ul style="list-style-type: none"> - Unfamiliarity with design - Complicated, difficult or changed design - Design/layout making violation necessary to achieve objectives - Use of incorrect materials - Compensate for poor equipment 	<u>Rule related factors</u> <ul style="list-style-type: none"> - Difficult to understand - Difficult to comply/work with, - Violation needed to get job done - Outdated rule - Conflicting rules, no priorities given - Rule seen as not appropriate for the organisation/activity (rule-maker has no knowledge of reality of activity) - Too many rules

Table 1. Factors tested for their relationship to tendency to violate.

Bold = correlated, *italic = tested, but found unrelated*, ***bold italic = conflicting findings from different studies.***

The four topics found to be relevant can be summarised as follows:

1. Individual characteristics suggest a relatively stable personality trait linked to over-confidence, an effect of risk perception, one of poor planning, and the effect of a risk-taking culture.
2. Organisational factors combining a laissez faire attitude, coupled with a lack of monitoring or indeed an active acceptance of rule breaches, coupled with conflicting goals and a non-participative style of culture and leadership
3. Hardware factors centring on poor ergonomic design
4. Rule-related factors centring on poorly designed, out-dated and conflicting rules.

An often used classification system for violations is that based on Reason's (1990) work, further developed by the work of Free (1994) – see also HFRG (1995). This classifies violations into four categories and implies different causal patterns for each, picking up some of the factors mentioned in table 1:

1. Routine violations, which have become normal and accepted ways of behaving by the person's peer group (and often their supervisors), linked to rules perceived as overly restrictive or out-dated, and where (management) monitoring or discipline is lacking.
2. Situational violations, in response to specific situations where the rule does not appear to work or be relevant, winked at by supervision in the name of production.
3. Exceptional violations often to situations never before encountered, where the consequences of the violation may not be thought through and may be very serious. These appear to be a special category of type 2.
4. Optimising violations, done to solve trade-offs of safety with other objectives (boredom, production pressure, effort, etc.) or to explore the boundaries of system operation and find new solutions to these trade-offs.

Whilst this adds some useful notions to model 1, particularly in distinguishing routine violations from the rest, it does not incorporate or clarify all of the issues addressed in table 1.

3.1.2. Organisational complicity

Mascini (2005) charts the self-perpetuating cycle of violation characterised by the existence of rules which are hard to follow if production is to be achieved and are seen as simply covering the backs of

management in case something goes wrong; this engenders at worst the enticement by supervisors of workers to breach the rules to achieve production, or at least turning a blind eye to violations (see also HFRG 1995), accompanied often by a breach by the supervisors themselves of the same rules if the enticement fails, which, in turn contributes to the reluctance by those supervisors to report or discipline violations by others of rules they also violate. The upshot is a conspiratorial silence about the poor rules. Iszatt-White (2007) calls such double binds the ‘gambits of compliance’.

Peters (1999) also shows in an interview study in mining that supervisors and their attitudes are a key stumbling block in disciplining violators. They were very reluctant to report to higher levels of management those miners violating the rule not to venture under unsupported roof in the mine, at least the first time it happens (86% would confine their action to a verbal warning and bawling out at their level), a reaction firmly agreed by the miners. For a second offence in a short time 83% of supervisors said they would report the offender to higher management for sanctions; 70% of miners agreed, but only 53% of miners believed the supervisor would actually do so. The reasons given by the majority of the supervisors for not wanting to report violators were remarkably similar to some of the factors in table 1: too busy with production, breaking the rule themselves and therefore having a double standard, considering the danger slight, or being afraid of a hostile reaction from the miner or the trades union. A minority pointed also to lack of higher management support, miners who do not take any notice of reprimands, and a feeling that it was not their job to enforce rules, but the individual miner’s responsibility. These double standards of supervisors and also of teachers in a study of rule violation in school sport (Theodoulides 2003) point to the pervasive ‘conspiracy’ of violation throughout a culture. On the other side of the coin Simard & Marchand (1997) show, in a modelling study looking at the macro- and micro-organisational correlates of compliance with rules, that a high quality of worker-supervisor cooperation is the biggest predictor of rule compliance (see also Hofmann & Morgeson 1999), followed by the use of a participative style of supervision and high group cohesion. They enter the caveat that this positive relationship will only be found provided that the pervasive norms in the company favour safety; otherwise those good leader-group member relations can just as effectively convey the message that violation is accepted.

3.1.3. Behavioural economics

Another research tradition which fits with model 1 is that of behavioural economics (e.g.; Battmann & Klumb 1993). This sees violation of rules as a cost-benefit trade-off for the worker (or manager), which handles many of the factors in table 1 and optimises them with safety as a trade off of behavioural efficiency which is learned over a number of experiences or trials. They see the formulation of desired behaviours as rules as providing a forcing function which introduces added

cost for their violation per se (punishment, loss of face, etc.), over and above the injury cost in the percentage of cases where that does follow breach of the rule, and so tries to tip the balance towards safe behaviour. Based on this theory they advocate scrapping all rules where violation costs are low. They also warn against the skewed trade-off of short term productivity gain for long term safety loss (see also Polet et al 2002 in relation to rules about designed barriers on machinery & Iszatt-White 2007 on road maintenance teams). This implies that long term costs such as injuries are discounted at a high rate compared to short term gains. Åberg (1998) also adopts a cost-benefit approach and sees the definition and enforcement of rules as adding costs of non-compliance to the already present benefits of the safety rules he assesses (seat belt use, speed limits and prohibition of drunken driving). His figures show the major improvement to compliance when the legal rules are backed by well-organised, conspicuous police enforcement. He too advocates only keeping rules which are enforceable. In addition he points to anomalies in subjective acceptance of rules; e.g. speeding reduction would objectively have far more effect on safety than further reductions in alcohol in blood levels, yet public acceptance of tightening of the two types of rule would favour tighter alcohol limits.

The work of Drach-Zahavy & Somech (2010) revealed the qualitative trade-offs people were making in deciding whether to comply with safety procedures. These included their need to demonstrate their care and concern for their patients, causing them not to want to wear PPE against infections for fear of the patients sensing revulsion, and a neglect of their own safety when it clashed with that of their patients or the speed they needed to show in responding to patient emergencies. Other factors weighing against their own safety were a desire not to disturb colleagues in their work to come and help, e.g. to lift a heavy patient. There were also effects of the recency of particular accident types, or publicised exposures, weighting the nurses in favour of the safety procedures relevant to those. Finally, the presence of a head nurse (supervisor) or trainee nurse (triggering an extra sense of responsibility), which increased the likelihood of following safety rules. Such studies link to the extensive literature exploring the theory of planned behaviour (Fishbein & Ajzen 1975)

3.1.4. Conclusion on model 1

Hopkins (2010) seems to advocate model 1 when he argues that front-line workers, particularly in tightly coupled technologies, should comply as strictly as possible with (good) rules to prevent them from indulging in casual non-compliance or risk-taking. He seems to consider that risk assessment is not for them to indulge in. If they meet a rule that cannot be complied with, they should appeal to management to authorise a work-around rather than devising one themselves (see also Bourrier 1996). He does recognise that rules can never be complete and compliance should never be blind, but sees the solution in a modification to model 1, not its scrapping.

We could see this multitude of factors leading to violation as either a set of potentially correctable problems with the details of Model 1, or we can see them as indications that there is a paradigm shift necessary (in this case to model 2), because model 1 cannot be amended to cope with this weight of problems. In terms of the gap between rules and reality (Dekker 2005), model 1 sees the solution in modifying reality to match the rules, while model 2 advocates changing the rules and their definition fundamentally to match reality. We look first at the papers making this fundamental shift towards model 2, and then discuss the other research traditions which have produced model 2. In the final part of the paper we return to the question of ‘repairing or replacing’ model 1.

3.2. Contrasting model 1 with model 2

Marchand et al (1998), working from a social psychological paradigm of model building demonstrated in a study of 898 workers from manufacturing firms drawn from different technologies, hazard ratings and accident rates that it was not only the score on the scales measuring compliance with rules that was predictive of accident rate. There was also a strong correlation with a scale measuring worker initiatives in safety. This led them to postulate a bi-dimensional relationship in which workers were not simply seen as dumb robots being forced to comply with rules imposed on them, but were also playing an active part in formulating and changing those rules, reporting hazards and being involved in the problem solving to remove them (see also Clarke 2006). This is already a step towards model 2.

Iszatt-White (2007) reporting an ethnographic study of road maintenance gangs pointed to the limitation of imposed rules as ways of controlling two types of risk in particular: the violation of rules controlling long term health risks, such as noise and vibration, could be analysed using model 1. It fits the trade-off of the short term costs of wearing personal protective equipment (PPE), combined with the short-term benefits of getting the job done, against the long term and often unclear or unacknowledged risks of deafness and vibration-induced white-finger. However the risks from motorists crashing into the cordoned off work area or knocking down workers crossing lanes of traffic to put up warning signs, which were also supposed to be governed by written rules, could not be realistically controlled in that way, because the road maintenance company had no real control over the main causal factors – the motorists’ behaviour. These risks were coped with by what she called increased heedfulness (a term analogous with Weick’s ‘mindfulness’ (Weick 1993) and even with the term safety consciousness’ common in the 1970s), a state of enhanced attention to the risk and local innovation or adaptation to avoid the danger. This leads us further towards model 2.

Loukopoulou (2008) contrasts the procedure book's picture of pilots taking off (which is pure model 1, with its apparently linear, predictable, controllable task sequence set out in the training manual), with the reality of a set of tasks that have to be time-shared, displaced, compressed, overlapped or interleaved because of interruptions and delays. Reality is much more diverse than rules give credit for, and all of these changes give more opportunities for error and deviation and make some violations necessary. The inevitability of violations, indeed their positive necessity, in contrast with the negative image of them in model 1, is also emphasised by Besnard & Greathead (2003). They claim, based on an analysis of two major accidents (the Sioux City plane crash in the USA and the Tokai-mura nuclear criticality incident in Japan) that violation coupled with a good mental model is acceptable, if not actually essential for safety, as shown by the violations which allowed the pilots to land the plane at Sioux City despite a complete loss of hydraulics and the tail engine. Only if violation is coupled with an incorrect mental model, as in Tokai-mura, is it bad for safety. Dekker (2005) points out that the negative image linking violations and major accidents is based on fallacious reasoning, which takes no account of the thousands of occasions when violations led to positive outcomes (and were relabelled innovations or expertise) rather than to accidents. He also reminds us that a number of very safe, but very complex activities such as aircraft carrier operation at sea are not proceduralised in any detail, relying on training and competence and highly sophisticated social control instead, whilst other major accidents such as Mann Gulch and Piper Alpha have shown that it can be those who violate rules who survive such emergencies, whilst those who obey die.

Polet et al (2003) also consider violations to be endemic and trace the way in which rules and procedures devised by designers of machinery (in their case a printing press) become informally modified or deviated from in the process of installation of the equipment and its use, as these circumstances gradually drift away from what the designer envisaged them to be (see also Rasmussen 1997 and Hale et al 2004 for consideration of this concept of a safe envelope of operation, and Fleury 1998 for a treatment of rules across the designer – user interface in road infrastructure design). These include cleaning of running machinery, removal of designed physical barriers and operating outside the defined manning, competence or maintenance regimes. Polet et al. (op.cit.) label these violations 'Borderline Tolerated Conditions of Use' (BTCU), since they are tolerated by supervision as ways of getting production done more efficiently and quickly, often without negative consequences because of the defence-in-depth from other barriers. They criticise the mental models designers have of operators as inadequate, and hence the rules they define to control that behaviour as also inadequate and optimistic about the rationality of actual operations (see also Perrin 1993, Energy Institute 2008). This point is confirmed by Dien (1998), who found in

the nuclear industry that designers saw operators in emergency situations as mechanistic and static in their response, like robots needing to be fed, and to follow, step-by-step rules (model 1) without recourse to significant skills or competence in order to control an essentially sequential process of operation or recovery (c.f. Loukopoulou. op.cit). This contrasts with the much more uncertain and chaotic nature of reality. Norros (1993) found a similar perceptual and knowledge gap between work planners and those carrying out maintenance work.

The inevitability of violations to get the work done (routine violations in the terms of Reason et al [1998]) and the gradual drift this engenders leads to the normalisation of deviance (Vaughan 1996) as all concerned accept the violations informally as normal and permissible, yet without any modification of the formal rules system to reflect and legitimise that drift (see also Snook 2002).

Parker et al (2006), in their formulation of the development of procedures (rules) and attitudes to them in Hudson's 'Hearts and Minds' scale of development of the SMS, capture some of the shift from model 1 to model 2. They see procedures in the pathological organisation as only devised to avoid lawsuits and harm to assets, in the reactive company as written to prevent the last accident, without considering the consequences of having to work to them, in the calculative firm as a proliferation of behavioural barriers linked to training, in the proactive company as a vehicle to spread good practice, but with the acknowledgement that a competent workforce can see them as occasionally inconvenient and that limited non-compliance is seen as acceptable. The generative organisation is almost pure model 2, trusting expert operators to challenge procedures where necessary and to refine them for efficiency, using the appropriate channels.

In table 1 we included the finding from a number of studies that most organisations had too many (safety) rules. This is also repeated in studies derived from the traditions of model 2. The sheer volume of rules in the rule books of complex technologies, such as nuclear and railways, have been shown to be a barrier to their use (e.g. Elling 1991, Norros 1993, Maidment 1993). Amalberti (2001), in a paper discussing the improvement of technologies that are already ultra-safe, warns of the danger of increasing regulations and procedures beyond a certain point; more rules then simply mean more violations and a stultification and suppression of creativity to be able to operate outside the boundary of the envelope defined by safety procedures (see section 1.2 above). Similarly, Katz-Navon et al (2005) in a study of treatment errors in the Israel health care industry found that an increase in procedures was associated with lower safety performance. Fucks & Dien (2010) point out that, in the energy generation sector it is simply impossible to have procedures which deal with more than average conditions. The range of non-nominal conditions that can occur is so great that

thick volumes of procedures would be needed to cover them (and indeed these are sometimes written), making the use of the procedure system impossible.

Weick (1996) gives a cogent analysis of the behaviour of fire-fighters in the Mann Gulch and South Canyon fires, which both saw loss of life when the fire-fighters stuck to their rules instead of dropping their tools to aid their escape. He uses this metaphor of ‘dropping the tools’ to argue for the adaptations and flexibility needed in such conditions to survive, when defined rules are counter-productive. We might take this as a call, as he intends, to consider whether we should drop the tool of model 1 when considering the subject of safety rules and escape to model 2. We return to that in the final part of the paper. However, such an escape is not likely to be easy. In a number of cases the papers also document the strength of the defences built in to model 1 in resisting such a change (Thackaberry 2004, Dekker 2005, Blakstad 2006, Knudsen 2008, v.d. Top 2010, Blakstad et al 2010). Vested interests and the influence of a culture derived ultimately from notions of hierarchical (military) command (in the case of railways and fire-fighting) can frustrate the open discussion of rules and violations. In a similar vein, Wright et al (1998), in discussing the role of procedures on the flight deck, argue that different communities of practice attach different meanings to the role of procedures. For example, where pilots may regard procedures as ‘resources for action’, regulators may regard them as ‘artefacts’ of accountability to be wielded after an accident to demonstrate what should have been done. The double binds mentioned earlier also inhibit those who breach rules, however nonsensical they may privately consider them to be, from admitting openly to that, for fear of legal or managerial censure and punishment, particularly when rules are wielded as the fore-mentioned artefacts of accountability. Without a clear signal that model 1 type rules are not working, there is no pressure to shift paradigms.

3.3. Underpinning model 2

A much more detailed critique of model 1 as a basis for defining rules is given in a series of papers dealing with healthcare (Parker & Lawton 2000, McDonald et al 2005, 2006, Alper et al 2007, 2008a, 2008b, Høyland et al 2010), seamanship in the maritime world (Knudsen 2008), aviation (McDonald et al 2000 and Corrigan 2002 on maintenance fitters and Dekker 2003, 2005 and DEGAS 2010 on pilots, McCarthy et al 1998 on both groups – together with ambulance dispatchers), railways (Ranney & Nelson, 2004, Grote 2006, Blakstad 2006, Grote et al 2009, Blakstad et al 2010) nuclear power and its emergency procedures (Norros 1993, Dien 1998, Woods & Shattuck 2000), fire-fighters (Weick 1993, 1996, Thackaberry 2004), energy companies (Mascini & Bacharias 2008) and other cases (Reason 1997, Schulz 1998, 2003, Gherardi & Nicolini 2000). These studies have been undertaken partly as a response to the external ‘wisdom’ that managers

from outside/above were planning to impose or had imposed, namely that these activities (particularly health-care and seamanship) should become more proceduralised (McDonald et al 2006) and partly in recognition that the current high level of proceduralisation has flaws (aviation – pilots and maintenance fitters) or is hiding a different reality. The papers uniformly advocate a shift from the situation described in model 1 to that in model 2, especially in placing centrally the competence, experience and ability to adapt to diverse situations of those at the sharp-end, rather than relying on imposed rules. DEGAS (2010) summarises the viewpoint succinctly by saying that ‘rules should be the expression of the concentrated experience of the professionals’, by which they mean the pilots, and that the responsibility for deciding on behaviour should be laid as close as possible to the task execution level. Also relevant to model 2 are papers derived from the traditions of ‘organisational routines’ (e.g. Reynaud 1996, 2005, Becker 2005a, 2005b, Levinthal & Rerup 2006, Bruns 2009, Grote et al 2009) and, to a lesser extent, papers on mindfulness (Weick 1993, 1996), and trust (Kramer 1999, Adler et al 1999, Jeffcott et al 2006, Conchie & Donald 2008). We also see links to the work of Karasek (1979) and others on the ‘job demand – control model’ which relates occupational stress to the balance between job demands and the degree of control or decision latitude that the worker has over the pressures and the way work is done

3.3.1 Coping with the diversity of reality

The message coming from these studies is that Model 1 does not remotely describe the way in which these activities are done in practice. It may describe how novices operate and what support is needed for them. Because they do not yet have their own action rules as translations of the broad task goals, and have not yet learned the process rules to derive them, they need, at least temporarily, action rules from experts to be imposed on them. However, moving from being novice to become an expert – a process which Mascini & Bacharias (2008) compare to the traditional steps of apprenticeship enshrined in the guild system for reaching mastery, (see also Dreyfus & Dreyfus cited in Knudsen 2008) - the beginner follows a path which gradually leaves imposed action rules as the translations of generic goals behind them. This is a move from the sequential, analytical, rule driven and context- and outcome-independent performance of tasks to an increasing concern for the consequences of actions and the need for prioritisation of approaches and solutions at the stage of the advanced learner. This is succeeded, in the competent practitioner, by a level of pattern-recognition, intuition and situational experience, and in the final expert stage, by a holistic, completely situated competence that arrives at decisions not on a rationally analysable and queryable basis (based on problem decomposition and solution), but on a far more automatic and richly contextualised linking of situation to response. This parallels the development through Rasmussen’s K- and, R-levels, to the S-level of operation, interpreted by Reason (1990) as the way in which tacit knowledge is built

up and used in highly skilled performance. The expert has goals and process rules to cope with diversity and complex and fine-grained sets of personal and tacit action rules derived from long application of those process rules. At the final expert level, rules imposed from outside can be seen as an attack on the treasured identity of the experts, a sign of mistrust of them and lack of respect towards them, and an attempt to limit their autonomy. It is also seen as being in danger of stifling innovation. Instead of generic, formal company rules the studies find that experts have their own personal sets of information, heuristics and reminders, often kept in 'little black books' (Perrin 1993, McCarthy 1998, Embrey 1999, Dekker 2005), or shared by the socially enacted culture of what is 'acceptable behaviour'. Only this tacit knowledge is seen as able to cope with the diversity of different individual patients, contingencies such as equipment failures or the competences of different team members (in operating theatres), or flights, weather conditions and equipment operation (in aviation) and the equivalents in the other activity spheres. To avoid this imposition of alien rules, the papers recommend that rules should be formulated as support for the expertise and not as replacements for it and that those using them at operations level should be specifically trained how to adapt the rules and when. Bourrier (1996) describes the latter solution to rule modification working in a French nuclear station (model 2), and contrasts it with an alternative solution in an American nuclear station where an expert was always on tap to modify and agree any rule that could not be carried out by the operators as it stood (model 1). She portrays these as alternative solutions adapted to the local cultures, without giving any preference, implying that the most important consideration is to match the solution to the culture.

The 'rules' or 'routines' which experts have devised through this apprenticeship and accumulation of experience are depicted as situated, locally adapted, explained and justified, present as largely tacit knowledge, which copes well with local diversity by translating, expanding and finding alternatives to imposed rules and protocols. However there is always a balancing act between failing to adapt when the signs were there (certainly in hindsight) that the 'normal' (generic) procedure was not appropriate and trying to adapt without the necessary complete overview and expertise and still failing to cope with the actual situation (Woods & Shattuck 2000, Dekker 2005, Grote 2006). This double bind is made worse the stricter the imposed procedures become. The papers also document another self-perpetuating cycle, namely that experts would have to reveal that they were having to violate the imposed rules and risk punishment for that in a blame culture, in order to highlight the fact that the rule system needs changing (Dekker 2005, Knudsen 2008).

In following this line of reasoning we should not assume that, because an activity such as medicine, surgery or aviation is complex and requires flexible responses to diverse realities that there is no

place for model 1. As Gawande (2010) eloquently demonstrates, the very complexity of the operating theatre can flood the surgeons' ability to remember in the heat of the complex and pressing reality some of the simple 'golden rules' they well know. The sort of checklists derived from model 1 can help to stop this inadvertent straying over the safe envelope boundary. Have we removed all of the items from the body cavity before sewing up the patient? Have we isolated the machine and made all safe for opening it? Are we clear for take-off?

3.3.2 Expert routines

In the health-care sphere (McDonald et al 2005, 2006, Parker & Lawton 2000, Høyland et al 2010) it is the doctors, and particularly the surgeons, who are most negative about rules/protocols and most positive about the need for violations. Nurses and midwives hold views diametrically opposed to doctors, equating the use of protocols with professionalism and being in favour of compliance, considering that deviations should be reported even if they produce good consequences. They see the views of doctors as 'cavalier' and elitist. Hospital managers too fit model 1 much more than model 2 and see the protocols as evidence of an evidence-based approach. In summary managers see surgery as a science, but surgeons see it more as an art, where rules do not belong. Grote et al (2009) find similar difference between shunters (model 1) and signalmen (model 2) in their willingness to use discretion, and attribute it to differences in skill level, signalmen being more willing to use discretion. Rayner (1986) captured the differing attitudes of different occupational groups in hospitals to radiation hazards and rules in a 'grid/group' matrix, showing hospital specialists (doctors, low grid, low group) aiming to rely on individual competence and expert judgements, and not on formal rules, whilst technicians and administrators in the opposite quadrant of the matrix (high grid, high group) relied bureaucratically on rules to reassure themselves that the risk was low. Taking a different perspective, Otsuka et al (2010) studied creative mental sets and their relationship to rule violations among Japanese nurses. They argue that top-down (model 1) approaches to rule design may cause workers with strong creative mental sets to find ways to violate the rules to reduce the workload imposed by the rule. Conversely, bottom-up approaches to rule design (model 2), incorporating a more flexible approach to safety rules, would allow creative mental sets to be directed toward adapting and improving the rules, suppressing the need to violate. Drach-Zahavy & Somech (2010) studied nurses and the way they decided which safety procedures and rules to apply and to breach and found a set of meta-rules or routines overriding specific action rules, such as putting their patient's safety above their own.

Implicit, or explicit in many of the studies, including those discussed above (e.g. Brady 1987, McDonald et al 2005, 2006, Knudsen 2008, Dekker 2005, Polet et al 2003, Peters 1999, Gherardi &

Nicolini 2000) is the notion that rules are a tool in the game of power and control of one group by another. Leplat (1998) among others (see above), points to the danger that management devise rules under model 1 in order to cover its back and to hide behind and shift blame in the event of an accident onto the ‘violating’ operators.

Mascini & Bacharias (2008) have devised a questionnaire to try to translate the insights from these sociological/ethnographic/organisational studies into a measuring instrument. They defined three scales of what they called ‘craftsmanship’:

1. The value of discretion: de-emphasising formal rules, because the rule maker cannot foresee all risk situations and is not in the best position, even for those foreseen, to know what is the best way to control them.
2. Tacit knowledge: learned by exposure, interaction with experts (often with hard-handed correction, banter, testing with near misses or other indicators of mettle and trustworthiness) and situated experience, to a greater extent than by formal training.
3. Personal responsibility: attribution of accidents as a shameful proof of lack of personal professionalism.

These scales demonstrate also the ethical and social correlates of model 2. In a study in an energy company he found the first two craftsmanship scales, coupled with a scale measuring attitudes to the formal safety policy of the company, to be predictive of safe behaviour and low involvement in accidents and incidents.

3.3.3 Organisational routines

There is a research tradition from organisational studies which relates closely to model 2. This is the study of so-called ‘organisational routines (e.g. Reynaud 1996, 2005, Becker 2005a, 2005b, Becker et al 2005, Levinthal & Rerup 2006, Nathaniel & Marmaras 2006, Bruns 2009, Grote et al 2009). The field has flourished over the last 50 years since Gouldner (1954) proposed routines as alternative means of organisational control to direct supervision. March & Simon (1958) saw them as essential building blocks for control, to be adapted to diverse situations by judging their appropriateness. However, Becker (2005a) indicates that, in that long period the field has been characterised by a lack of clarity over the definition of ‘routines’. We utilise the results of his attempt to produce this clarification. He distinguishes the enacted, recurring patterns of behaviour at an organisational (not an individual) level (called in his tradition ‘routines’), from representations of those routines in written rules. This parallels the distinction between imposed rules and emerging expert enactments of coping behaviour as described in model 2. Becker makes the point that it is not possible, from knowing the written rule, to deduce what behaviour will be shown in practice, nor to

induce the written rule from the enacted behaviour. They are related, but the relationship is not simple; it requires a trigger to activate the routine, which may be, but is not always, the rule (c.f. the theory of planned behaviour (Fishbein & Ajzen 1975). Becker also emphasises the need for rules to be embedded in context and therefore interpreted to a greater or lesser degree in local situations (see also Bruns 2009). He considers law and safety as contexts for little discretion in interpretation, something which contrasts with the papers directly concerning safety rules, which we have discussed under model 2 above. These papers consider operational safety rules much more as the guidelines, heuristics and building blocks which Becker sees at the high discretion end of his spectrum. This formulation comes close to the idea that these tacit rules and the motivations which lie behind their use or violation form the structure of an organisational culture ('the unwritten rules of the game' as Scott-Morgan [1994] calls them). We do not pursue this line here, as a review of culture would take this report into a vast additional area.

Becker sees routines as emerging from experience and repetition in a social context in a way that is essentially informal and not written down. They form, in this analysis, the repository of organisational memory, and as such are necessarily subject to change as learning takes place. He also discusses the pressures leading to routinisation of activities, namely the saving in cognitive resources, facilitation of learning across 'similar situations', coping in a harmonised way with diversity and variety and promoting coordination across different actors in a group. It is the process of abstraction of the enacted routines to form generic written rules which is problematised by this direction of analysis.

Reynaud (2005), making the same distinction, sees formal written rules as complete, but only in an abstract, generic sense, whilst routines are necessarily incomplete as they have to be adapted to cope with unpredictable diversity. She sees the routines as organisational sense-making tools, located, context-bound and tacit, often as heuristics leading towards solutions (c.f. the process rules advocated by Hale & Swuste (1998)), whilst the written 'Standard Operating Procedures' (SOPs) are explicit, finite, but generic instructions, leading in a guaranteed way in defined situations to reproducible solutions, but not able to cope with diversity unless interpreted. This equates also to the distinction by Argyris & Schön (1978) between espoused theory and theory in use.

Grote et al (2009) combine the literature on organisational routines with that on management of uncertainty to tackle the compromise needed between standardisation and flexibility of rules in railways. They contrast high uncertainty activities, needing high flexibility of rules and coping mechanisms, with low uncertainty activities, being best achieved and coped with by standardisation

of rules. However, high risk also goes with the need for standardisation to shut out high consequences, leaving the dilemma of combining high risk and high uncertainty in complex, high-tech activities. This creates the need for some form of compromise between standardisation and flexibility (see also Adler et al for a treatment of this dilemma in relation to product design). Grote et al use the notion of 'flexible routines' (Feldman & Pentland 2003) to arrive at a compromise and a loose coupling to be able to cope with the two extremes. These flexible routines are adapted and enacted translations of generic rules. In particular they point to the process rules of Hale & Swuste (1998) as flexible guidance on how to arrive at the specific behaviour to meet any possibly unique situation and see them as potential tools for bridging the gap between detailed rules and diverse reality. In a study of railways they point to some shift in more modern rule sets towards these process rules, but still catalogue far more rules specifying concrete actions, many with complex exceptions. Nathanael & Marmaras (2006, 2008) tackle the same issue of combining prescription (the written rules) with practice (the enacted diversity). They distinguish three mechanisms in practice: 'repetition of action', from which emerges the distinction between different (normal vs. abnormal) enactments, the latter leading to 'reflection on action' (often in the form of stories about notable exceptions) and alteration or expansion of the repertoire of actions. A linked activity of 'description' of these linked processes leads to institutionalisation of the rules in either formal or informal format. They go on to argue that top-down formalisations which deny work communities the ability to form their own descriptions, not only render the community impotent in adapting to novel situations, but inhibit organisational flexibility and learning. However, if work communities secretly reject top-down formalisations and develop their own descriptions based upon day-to-day realities, then this may lead to a breakdown in organisational cohesion and even the erosion of safety defences.

3.3.4. Sense-making and trust

The tradition of research on organisational routines has clear links to the research of Weick (e.g. 1993, 1996) on mindfulness and sense-making. Once we accept that rules cannot cover all eventualities and that all rules have exceptions, it becomes essential that operators, or others somewhere in the system but in close contact with those at the 'sharp end', use their deep competence and tacit knowledge to exercise discretion in applying any rules that are defined, so that they are able to come up with adaptations, improvisations and extensions of them to cope with the unexpected and unforeseen situations. This requires mindfulness to be alert to the need to modify procedures and devise new coping strategies, and expert sense-making to make those innovations or adaptations. At this point the burgeoning literature from Weick and his colleagues, becomes relevant, as does that on resilience (e.g Hollnagel et al 2006). It is beyond the scope of this paper to

review the bulk of that literature in detail here, since it lies, by definition, beyond the point where written rules and procedures play a central role, however abstractly they are formulated.

The literature on trust in organisations points to some of the same factors being important in combining standardisation and flexibility, namely the importance of trusting the operators as experts in defining and writing routines and rules, rather than imposing rules made by experts on operators perceived as recalcitrants (e.g. Adler et al 1999, Jeffcott et al 2006). The latter paper, describing research in train operating companies, also points to the negative, iterative link possible between an increased culture of proceduralisation (trust in rules) and a high blame culture. In this compliance is used as a means of self-preservation, leading to a prescriptive, inflexible, compliance culture. They point to a shift from a 'job for life' culture to one with many new non-rail staff being recruited, leading to more reliance on procedural rules to fill the gaps in tacit knowledge left by the abandonment of long apprenticeships and to replace the trust of known colleagues based on long histories of mutual interaction (see also Maidment 1993, Larsen et al 2004). The knowledge to vary and adapt the procedures is no longer present, so much more is done 'by the book'. Borys (2007 & 2012) also pointed to the trust felt in immediate supervisors to adapt rules as important factors in rule compliance on his Australian construction sites.

Conchie & Donald (2008) and Schöbel (2009) point to the need to balance trust in rules with mistrust, leading to a critical view of rules and their applicability and a culture that will support checking and monitoring of the behaviour of others (institutionalised mistrust), manifest in turn as the challenging of violations. Too much trust leads to unquestioning rule following when it is not appropriate; too much mistrust of rules leads to needless violations of them.

3.3.5 Job demand and control

Karasek's (1979) model of the balance between job demands and the control that the worker has over the work methods used, the timing and work pressure associates low control and high demand with occupational stress and high control, high demand with learning (see also v.d. Doef & Maes 1999). This would predict that more involvement in the making of safety procedures would lead to more feelings of ownership and control and hence lower stress, which Snyder et al (2008) seems to find, although Torp & Grøgaard (2009) fail to find more than a marginal correlation between job demands and procedure compliance, far less than the correlation of the latter with high management or social support. The job demand and control model would, however, fit with the proposals from other studies (Embrey 1999, Borys 2012) that procedures are needed most, as tools of control, for complex, high risk and infrequent tasks, all of which have high task demands. However, taking

account of the earlier studies in section 3, one can question whether these situations require action rules, or whether it would be more appropriate to rely on ability, based on deep tacit knowledge, to adapt generic rules at the process rule or goal levels to this challenging diversity.

4. Summary & Conclusions for the management of rules

The review of the two models of rules and their development and use has resulted in the definition of a broad set of concerns and dilemmas. We sum up the strengths and weaknesses of the two models in table 2. The picture that emerges is of a gap between the reality of work and its routines and the abstraction of the (often written) rules that are supposed to govern it and guide behaviour to carry out that work safely (see also Borys 2007). We have described two contrasting perceptions of violations of those written rules, either as deviations to be stamped out, or as inevitable and sometimes necessary adaptations to local circumstances to be used and reinforced. Are significant levels of violations signals that the rules being violated are bad, or that the violators are misguided? We have contrasted also the bottom-up development, through social interaction, of domain expert rules embodied in tacit knowledge, with the top down imposition of rules devised by external experts on operators perceived as fallible and relatively unskilled. Central to any system of management of rules is how to cope with diversity and exceptions to whatever rule is formulated. Central also is the need to see rule sets as dynamic and to place the focus of their management on the processes around monitoring and change (flexibility), rather than purely on development and communication. These characteristics define the gap between procedures and practice; Dekker (2005) urges us to monitor the gap and try and understand why it occurs, while Knudsen (2008) urges us to stop bitching about the fact that the gap exists and set about closing it.

We also believe that much of what we have said in this paper is not limited to the use and management of safety rules. It can be applied more broadly to any rules and procedures, no matter what their objectives (production, quality, environment, etc.). Section 3.3.3 among others makes this clear, as the majority of the studies cited there are not about rules for safety

In the companion paper in this issue of the journal (Hale & Borys 2012) we will attempt to meet the challenge of reconciling or combining models 1 and 2, by modifying a number of steps in rule management from essentially model 1, top-down steps towards model 2, bottom-up steps.

Model 1	Model 2
<p>Strengths</p> <ul style="list-style-type: none"> • Makes rule-making explicit & easy to audit • Makes consequences of rule violation explicit • Emphasises competence in rule-making & role of subject experts • Logical, rational, engineering approach • Works well for novices • Proven effectiveness for simple, ‘golden rules’ (Behavioural Based Safety) • Emphasises the role of organisational complicity in rule violation 	<p>Strengths</p> <ul style="list-style-type: none"> • Recognises operators as experts central to rule making • Recognises social processes as key to rule use • Sees rule-making as a continuous, dynamic process • Links rules to the crystallised competence of organisational memory • Recognises the importance of managing exceptions & their link to violations • Recognises the centrality of experience
<p>Weaknesses</p> <ul style="list-style-type: none"> • Sees operators as robots, lacking competence & social motivation & needing imposed rules • Encourages a blame culture & negative view of rules & violations • Sees rule-making as a one-off, static process, until accidents trigger rule modification • Fails to deal adequately with exceptions except as triggers for rule book growth • Tendency to bureaucracy & gap between rules & reality 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Rule-making & modification process lacks transparency for auditing and for novices learning the skills • Undervalues the need for the organisation to explicitly manage rule development & use • Hides differences of interpretation & competence

Table 2: Summary of main strengths & weaknesses of models 1 and 2

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8. Additional references

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