DEGRADED MODES OF OPERATION: ANTECEDENTS FOR RAILWAY ACCIDENTS.

M Mathebula[1] and Dr PN Sopazi[2]

[1]Affiliate1Railway Safety Regulator, South Africa & [2]Affiliate Railway Safety Regulator, South Africa

ABSTRACT

Technology has replaced the primitive way of thinking and yet trains are still run in a restricted manner as though they are still horse-drawn wagons. It is true that in today's society railways have increasingly become a backbone of many economies and South Africa is no exception. Frequent railway system failures due to poor maintenance and other causes result in abnormal and degraded modes of operation. Simply put, a degraded mode of operations occurs when either a part or some parts of the railway system continue to operate in a restricted manner over a sustained period of time. This paper attempts to elucidate and discuss differences that exist between a normal operation and a degraded mode of operation. This is achieved by drawing from a South African experience and in contrast with normal modes of operation. South African experiences and cases from other parts of the world will be discussed to explore the manner by which people (a human factor element) can adopt and maintain best practises (normal operations). Furthermore, a culture of tolerance for a degraded system and its overall impact on standards, performance, and safety will be discussed. Reviewed literature, as well as studied cases, provide insights and in some ways also suggest that; degraded modes of operations are an antecedent to a number of railway accidents. This paper also aims to distinguish between degraded modes of operations in comparison with other 'familiar' modes of operations. The authors believe that this is an area of research that is still open for further research and it will require an in-depth exploration.

Keywords: Culture of production, normalisation of deviance, production of culture and structural secrecy.

INTRODUCTION

The advent of railways in the 1820s was a 'killer application'. A killer application is a concept that changes the way society functions. With railways, people could travel only between fixed points on one track, based on dictated timetable. People went into raptures at a new way of transportation, but, safety was relegated to the background in that; the primitive railways placed more emphasis on utility rather than safety. Wagons were drawn by horses before the introduction of locomotives and the current signalling systems had not yet been developed to control the movement of trains. Many trains shared the same track and had to keep a schedule to prevent collisions. That mode of operations was normal and chimed well during the formative years (Shaw, 1978).

According to the UK Railway Group Standard (2007) there are four types of operations namely; normal operations, abnormal operations, degraded operations and emergency situations. "*Normal operations* describes the way in which the railway was designed to operate, including planned peak periods, *abnormal operations* arise from extreme loading on a part of the railway system, for example as a result of severe weather, or delays to a train service impinging on others, *degraded operations*, occur when part of the railway system continues to operate in a restricted manner, for example after a failure of signals and *emergency situations*, include an unforeseen or unplanned event which has a life-threatening or extreme loss implications and requires immediate attention, for example a fire or an obstruction on a line".

Operations Management literature more often than not place more emphasis on quality management systems whilst students are inundated with Japanese concepts such as *Kiazen* with a view to equipping them with the 'tools' to properly manage a system efficiently and effectively. These literatures hardly introduces learners and practitioners to a degraded mode of operations because its focus oscillates between normal and abnormal operations. Heredity has always been associated with biology, but an organisation could also inherit a degraded mode of operations culture from its predecessors and hand down such a culture from generation to generation.

In 1986 a commission of inquiry led by Dr W.J. De Villiers was appointed to look into South African Transport Services' Strategic Planning, Management Practices and Systems. The De Villiers Report recommended that capital investment in the railways should be restricted to an absolute minimum. Briefly put, railways were advised to cut back on infrastructure investment. In the railways; infrastructure means the following: (a) Track and Formation, (b) Bridges and Structures, (c) Signalling Systems, (d) Communication Systems (e) Electrical Traction Systems and (f) Rolling Stock Fleet. The lack of investment as well as the shortage of critical skills compel our railways to operate in a degraded mode of operations. For example, signal failure and poor communication systems are commonplace in daily operations.

More than a century and a half later, advanced technology has replaced the primitive way of thinking and yet trains are still run in a restricted manner as though wagons were still being pulled by horses. It is true that in today's society railways have become a backbone of many economies and South Africa is no exception. If trains have to share the same track for example; due to signals failure, that system would not be operating under normal operations but under a degraded mode operations. Briefly put, a degraded mode of operation occurs when part of the railways system continues to operate in a restricted manner.

It is important to note that degraded modes of operation is not only confined to the railways. Other modes of transport do also operate under a degraded mode of operation. Johnson and Shea (2010) argue that airline disasters such as Uberlingen, Linate and Charles de Guale were attributable to a degraded mode of operations. According to the National Road Safety Strategy 2016-2020, defective traffic lights are attributable to 2.8% of fatal crashes. For example, in Johannesburg, traffic lights fail when it rains and thus create a traffic gridlock. The Star (2016), which is a local newspaper publication, reports that: "cities such as Seattle, London and Cape Town experience wet weather conditions throughout the year and yet the traffic lights operate normally". Johannesburg Road Agency (JRA) levelled damaging criticisms on thieves and vandals for the failure of signals. Conversely, railway operations in South Africa are also affected by a number of challenges. For example, cable theft and vandalism.

LITERATURE SURVEY

Degraded mode of operation

The analogy of a "pitcher plant" to describe a degraded mode of operations (EUROCONTROL, 2009) is instructive: "When an insect lands on a 'pitcher plant' it is attracted to the nectar in its deep neck. As the insect moves from the top over the crest of the flower it falls; it has passed a point from which it cannot escape. The sides of the plant are too slippery and steep for it to escape. The insect drowns". When this analogy is applied to the degraded mode of operations, it is called the 'incident pit'.

The following push organisations into the pit:

- (Skilled and well trained) Staff shortage
- Limited secondary systems
- Limited experienced resources
- Legacy equipment
- Intermittent failures and
- Concurrent breakdowns

The following keep organisations out of a pit:

- Training
- Risk assessment
- Contingency plans
- Spare personnel
- Fully functioning equipment
- Incident investigation and learning
- Safety maturity
- Planned upgrade programme
- Risk awareness
- Spare equipment
- Experience personnel

The Space Shuttle Challenger Disaster

The Challenger disaster demonstrates how degraded modes of operation can lead to disasters. The Challenger Shuttle disaster on 28 January 1986 claimed the lives of seven astronauts and exploded just over a minute into flight.

Events and Role players

Marshall Space Flight Centre – in charge of booster rocket development.

The engineer's decision not to launch was challenged. NASA contracted someone to build the Solid Rocket Booster (the shuttle solid rocket boosters are key elements in the operation of a shuttle without the boosters, the shuttle cannot produce enough thrust to overcome the earth's gravitational pull and reach an orbit).

Director of the Solid Rocket Motors Project.

Vice President.

Engineer who worked under McDonald.

Engineer who worked under McDonald.

Engineer in a management position.

Senior executive who encouraged the Vice President to reassess his decision not to launch.

Key dates

1974 – Someone was awarded the contract to build solid rocket boosters.

1976- NASA accepts the booster design.

1977- The designer discovers a joint rotation problem. November 1981 –O-ring erosion discovered after second shuttle flight.

January 24, 1985 –shuttle flight that exhibited the worst O-ring blow-by.

July 1985 – The designer orders new steel billets for new field joint design.

August 19, 1985 – NASA Level I management briefed on booster problems.

August 19, 1986 – night teleconference to discuss effects of cold temperature on booster performance.

January 28, 1986 –Challenger explodes 72 seconds after take-off.

Findings

The Presidents Commission of Inquiry (1987) into the Challenger disaster found that NASA managers were anxious to launch the *Challenger* for several reasons, including economic considerations, political pressures, and scheduling backlogs. The structural causes were identified as:

- Budget cuts and compromises and safety to meet cost constraints.
- A widening gap between NASA goals and the means to achieve them.
- Flawed decision making processes.
- Substantially reduced work forces.

- Managers overriding concerns and warnings.
- In short: production pressures and managerial wrong-doing.

The production of culture

"A culture is a set of solutions produced by a group of people to meet specific problems, which they commonly face. These solutions become institutionalised, and passed on as the rules, rituals and values of the group" (Pitzer, 2004). When an organisation operates under a degraded mode of operations culture, incidents and accidents will inescapably be linked to the operational culture of the organisation.

Prior to the shuttle program, early tests indicated that the Solid Rocket Boosters (SRB) joints (which contain O-rings) showed deviations in performance. Management was alerted (as per procedure), management re-interpreted the deviation and officially labelled it: "acceptable risk". The workgroup accepted this as a new standard and treated each new program deviation within the wider band of acceptable risk, and this became a standard way of action. Vijay (1996) terms this: *the normalisation of deviance*. Between 1977 and 1985 the first abnormality was normalised to accept that the primary O-ring will withstand erosion by hot gases, and if in a rare case it did not, the secondary O-ring would. During the formative years of NASA, the organisational culture was purely technical. Culture is not static, but dynamic, the NASA's culture gradually became structurally more complex and bureaucratic, and later budgetary constraints transformed it into a technical production system (Vijay, 1996).

The culture of production

According to Pitzer (2004), NASA had two formal processes in the organisation, which were designed to facilitate the management of launches, namely the Acceptable Risk Process (ARP), and the Flight Readiness Review (FRR). The O-ring joints were investigated, tested and reviewed over many years and was accepted as risk – never would they have serious doubts about the O-ring's resistance, because:

- The Apollo programs for many operated with the same design on Titan rockets.
- They even added a secondary O-ring as a back-up, should the primary ring fail. Many laboratory tests showed that the O-ring would hold.
- Most of the Challenger and SRB's parts and systems can and will only ever be fully tested under real flight conditions. When they disassembled the SRB's of previous launches (a routine process) they found no problems with the O-ring.
- "Flying with flaws" was not abnormal in that culture. It was normal, acceptable, and even essential. For outsiders, it was seen as "known flaws". For insiders, it was simply "residual risk" which they analysed and rationalised through the Acceptable Risk Process.
- Organisations that constantly have to deal with high risks developed means (mind-sets) to deal with that. If they don't, the continuous risk will destroy them.

Structural secrecy

Structural secrecy means "the way that patterns of information, organisational structure, processes, and transactions, and the structure of regulatory relations systematically undermines the attempt to know" Middle management did not inform the senior managers of the teleconference with the Thiokol, and the potential problems with the O-ring. NASA had a history of decision-making where economics weighted heavily against the risk of decision making (Vijay, 1996).

It important to note that secrecy is built into the very structure and fabric of organisations. According to Pitzer (2004): "Top management in organisations do not get all the information in the organisation. In fact they get little, and that is so by design and by necessity. Information, especially in our electronic age is so massive that we cannot make sense of or interpret these".

The Titanic Disaster

The Titanic disaster in 1912 is a typical example of a system that operated under a degraded mode of operations. The Titanic had 16 lifeboats and four collapsible boats. At full capacity they could hold about 1700 people. But there were 2200 passengers and crew on board. Lifeboats was but one of the contributing factors to the disaster, including legislation, design changes, schedule changes, rivet hammering method changes, schedule pressures, starlight refracting on calm waters, complacency, radio priorities, fatigue and chance (Parsons, 2012).

RESEARCH

Method

The researchers sampled three railway related incidents that were related to a degraded mode of operation. The accidents happened in Australia, the United Kingdom and New Zealand.

The Case study of Incidents

Australia: the Glenbrook accident

Seven people were killed and 51 injured when an inter-urban train collided with the Indian Pacific in the Blue Mountain suburb in 1999 (Burrows, 2002).

Management priorities and degraded modes

The State Rail Authority of New South Wales embraced a 'culture of on-time running'. The pressure that was placed on train drivers to meet the timetable deadlines led to drivers to operate trains without functioning radios or with defective brakes.

Lessons learnt

Management pressures may compel employees to take short cuts in order to satisfy management at the cost of safety.

New Zealand: Waipahi train collision

At about 0702 hours on Wednesday, 20 October 1999 Train 938, a northbound express freight, collided with Train 919, a southbound intercity express freight, which was stationary on the main line within station limits at Waipahi on the Main South Line (Transport Accident Investigation Commission New Zealand, 1999).

The train driver of Train 919 was fatally injured, and the train driver of Train 938 was seriously injured.

The two locomotives on Train 919 and the single locomotive on Train 938 were extensively damaged, as were a number of wagons and containers.

Causal factors and the degraded mode of operation

Causal factors included one train driver' misunderstanding of his track warrant limit and the limited effectiveness of the action taken by the operator to minimise the possibility of the misunderstanding.

There was recognition at all levels of Tranz Rail staff that there were recurring occasions when points for the opposing train to enter the loop were not set as required by the regulations, but these exceptions were not defined or controlled.

Had the train driver of Train 919 at the end of Waipahi and set the points for the opposing train into the loop, he would have provided three possible defences against the collision despite the misconception of the train driver of Train 938:

- Train driver of Train 919 may have noticed the facing points indicator showing his route was set for the loop and slowed or stopped Train 938.
- Train driver would have seen Train 919 earlier, possibly in time to stop the train.
- If Train driver 938 had not stopped it would have diverted into the loop.

Lessons learnt

The failure by the Tranz Rail staff to set the point was abnormal, but the staff embarked on the normalisation of deviance.

United Kingdom – Land brook accident

The Ladbroke Grove accident in the London, England on the 5th of October 1999. The Ladbroke accident could have been prevented by an operational Automatic Train Protection (ATP) system which the operator was reluctant to install because the cost far outweighed the benefit (Burrows, 2002).

Causal factors and the degraded mode of operation

According to the accident report, the driver of the inter-urban train did not appear to have proper training in the operation and effect of Safeworking unit 245. Safeworking Unit 245

specifies that extreme caution should have been exercised after passing an automatic signal at stop. Johnson and Shea (2010) argue that: "Problems in training did not create the degraded modes of operation. However, lack of appropriate knowledge and skills may have undermined the drivers' attempts to cope with the failures that were associated with these degraded modes".

Lessons learnt

Appropriate knowledge and skills is vital in the prevention of some of the accidents.

CONCLUSION

It can therefore be concluded that; organisations should desist from the normalisation of deviance because such deviation could lead to disasters. Organisations should not allow a degraded mode of operations to be a permanent state (i.e. attempts should be made to roll operations uphill into normal operations. The culture of production, and the structural secrecy are the main elements of a degraded mode of operations that should be avoided at all costs.

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