NORMALIZATION OF DEVIANCE: WHY ACCIDENTS ARE NOT ALWAYS ACCIDENTAL

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Abstract – On January 28, 1986, the world witnessed an accident that was, at the time, the worst disaster in the history of space flight. With seven astronauts on board, the space shuttle Challenger exploded just 73 seconds after its launch. The investigation into the Challenger disaster revealed cultural and systemic flaws in NASA operations; as a result, the concept of "normalization of deviance" was developed. Normalization of deviance is when unacceptable practices become acceptable behaviors. While the results of this process are often painfully clear, detecting and identifying this phenomenon can be extremely difficult. The Challenger accident, the loss of the space shuttle Columbia in 2003, and other disasters have been shocking reminders of how seemingly innocuous details play essential roles in the interactions of complex systems and organizations. This paper is not about NASA and space shuttles. Normalizing deviance in any safety-critical process or task can be disastrous; allowing deviations in operating, inspection, and maintenance procedures can seriously erode safety margins. Deviation occurs because of physical or psychological barriers to using the correct process; other drivers, such as time, cost, and peer pressure, also contribute. These are not problems that reside solely with the people performing the work. Looking at organizational safety through the lens of human performance recognizes that safety challenges are present at all levels of an organization, as do the opportunities to uncover and address them. This paper takes a human factors approach to organizational safety and outlines some critical features of process drift and normalization of deviance. It also reviews the reality that many accidents have causative factors in production areas and management offices. Finally, it evaluates recent accidents and how they display characteristics of organizational failure and proposes recommendations for improvement.

Index Terms — Safety, normalization of deviance, human error, process drift, accidents, cognitive bias.

I. INTRODUCTION

On January 28, 1986, the world witnessed an accident that was, at the time, the worst disaster in the history of space flight. The space shuttle Challenger exploded just 73 seconds after its launch, killing all seven astronauts aboard. The investigation revealed multiple factors contributing to the accident, including NASA's organizational culture and critical flaws in making flight safety decisions. The Rogers Commission, tasked by President Ronald Reagan with investigating the disaster, found that NASA had a history of violating its safety protocols. Due to difficulties meeting the requirements, engineering standards regarding the solid rocket booster (SRB) O-ring seals were waived. Evidence that the O-rings could harden and fail at low temperatures, as were experienced overnight and into the morning of the launch, was not thoroughly investigated and ultimately disregarded.

NASA's investigation, which began immediately after the accident, pointed toward the SRBs as the cause of the explosion. The Rogers Commission ultimately found that the failure of both the primary and backup O-rings in a union between two booster sections allowed hot gases to escape the SRB through and contact the external fuel tank, igniting the volatile hydrogen and oxygen for the shuttle's main engines. This catastrophic leak was visible on video footage a few seconds before the external fuel tank erupted into a massive ball of fire, smoke, and debris.

However, that would not be the last loss of a space shuttle. On February 1, 2003, the shuttle Columbia re-entered the atmosphere after 15 days in orbit. High over Texas and only minutes before its scheduled landing at the Kennedy Space Center in Florida, the shuttle disintegrated due to structural failure. Heat-resistant tiles on the left wing had been struck by a large piece of foam that detached from the main fuel tank during liftoff. Subject to the intense heat created during re-entry, these tiles could not prevent hot gases from penetrating the hull. As structural components weakened and eventually failed, the shuttle began to break apart. The risk of damage to the heat-resistant tiles by foam strikes had been recognized but was not considered significant since previous damage had not compromised the shuttle's integrity. Once again, an investigation revealed that NASA's culture led to lapses in safety protocols and poor decision-making, resulting in the destruction of the shuttle and the deaths of its seven astronauts.

The investigations into the Challenger and Columbia accidents clarified that the problems at NASA originated within its organizational culture. NASA was influenced by external and internal forces pushing the shuttle program to achieve an impossible level of performance; that safety could be adversely affected did not appear to have been considered by senior leaders. That same problem also occurs outside of NASA, where the potential consequences are severe despite safety records that may create a false sense of security. People naturally tend to rationalize deviation from formally accepted processes and standards in the quest to get things done, often under time pressure and resource constraints. This paper will examine the phenomenon known as the Normalization of Deviance and how it can propel people and organizations to disaster.

II. WHAT IS THE NORMALIZATION OF DEVIANCE?

A. Normalization of Deviance

People usually follow formal or informal rules or norms out of fear of social or professional repercussions; this is known as normalization [1]. Social learning theory suggests that social behavior is learned by observing and imitating the behavior of others. The desire to be part of the group or to avoid "rocking the boat" can be a powerful motivator. This is why poor safety practices may be banned in the safety manual yet accepted as standard practice by employees. The behavior behind the wheel of a motor vehicle is an excellent example of normalization at work. When we drive, we are not likely to exceed the speed limit when the police are watching. When there is no police presence, we are more likely to speed. Others also speed, and we are far more likely to exhibit disapproval of motorists who drive too slowly. The fact that higher speed increases the risk of a motor vehicle accident provides little deterrence. The lack of adverse consequences, such as traffic accidents or speeding tickets, reinforces the notion that we can drive safely at high speed.

In the wake of the Challenger disaster, Sociologist and University of Chicago Professor Dr. Diane Vaughan coined the term *normalization of deviance* to describe "the process by which unacceptable practices are transformed into acceptable behavior" [2]. The Center for Chemical Process Safety (CCPS) Process Safety Glossary defines the normalization of deviance as "a gradual erosion of standards of performance as a result of increased tolerance of nonconformance" [3]. Normalization of deviance is also described as a phenomenon where individuals, groups, or organizations accept a lower performance standard until that lower standard becomes the norm. This process does not occur solely due to deliberate misconduct or a conspiracy to circumvent policies and procedures; it also appears to result from "corporate cultures that promote counter-productive behaviors, seemingly with the best of intentions" [4]. Because the normalization of deviance is human-based, occurs repeatedly over time, and does not cause an immediate incident or noticeable adverse effect, the same sociological processes contributing to speeding on the highway also contribute to unsafe work practices and a culture that seeks proof that accidents will occur as a result.

Deviance can be defined as the violation of an established norm [5]. The drift toward failure often entails the "practical deviation from standards" that are "reinforced by success" [6]. Normalizing deviance is not limited to any particular industry. In health care, deviance has been blamed for poor hospital patient outcomes [7]. Construction workers take shortcuts to meet project timelines. Process-dependent industries, such as oil and gas and aviation, have also been affected by departures from established norms. The 1988 Piper Alpha accident, Three Mile Island, and Alaska Airlines 261 are all examples of the normalization of deviance in action.

Deviations occur because the concept of risk is subjective. The criteria for determining acceptable risk are unclear, even though policies and procedures may be. As the definition of acceptable risk becomes variable, the basic standards of acceptable risk also begin to slip. Deviation frequently occurs because barriers such as time, cost, and peer pressure inhibit proper procedures [8]. The pattern of deviation and success are mutually supporting as deviance becomes culturally acceptable and conformity to deviant practices and outcomes becomes internalized.

The idea that accidents result from the actions of single individuals has been largely discredited [9]. We recognize that people are involved in incidents, to some degree, because they make mistakes and take shortcuts in their quest to meet operational needs. The Challenger accident was caused, in part, by pressure to meet the goal of having the first teacher in space aloft in time for President Reagan's State of the Union address. Research into the causes of accidents, such as those already mentioned, has shown that incidents often result from interactions between people, complex systems, complex technology, and operational environments that can be unpredictable. The Columbia accident resulted from many of these same complex interrelationships that had doomed Challenger 16 years earlier.

B. Practical Drift

In 1999, the American Institute of Medicine reported that between 44,000 and 98,000 deaths were caused annually by preventable medical errors. Another study placed the number of premature deaths associated with preventable harm at more than 400,000 annually. What causes these otherwise avoidable errors? Missteps are often attributed to human error, but it is not as simple as blaming laziness or incompetence. Many incidents have precursors. A precursor is something that precedes or indicates the approach of something else. In many accidents, the warning signs were there. What is not so clear is why both individuals and the organization missed the warning signs. Cognitive biases play a significant role; people tend to see what they expect. Information that runs counter to the desired results may be rationalized or ignored. Another problem is that even when we notice them, taking appropriate corrective action may come too late.

The process of deviating from established norms is called *practical drift* and is defined as the "slow, steady uncoupling of practice from written procedures" [10]. Drift is seen as a practical solution to a problem without considering the long-term effects, especially without adverse consequences. Individuals adjust their behaviors to align with their perception of the current situation, especially when the rules and the problem do not match. Shortcuts, workarounds, and other forms of deviance occur more frequently as people gain more experience or are motivated to get the job done faster and for less cost. Valid justifications exist for such actions and are usually the product of a culture of efficiency reinforced by a less-than-optimal safety subculture. Drift usually is not malicious; it just is.

Often referred to as *process drift* or *procedural drift*, this form of deviance is often not apparent because the signs may not point to it, especially in facilities with a long history of reliable or accident-free operations [11]. Whenever an organization has a long run of accident-free operations, it can be easy to become complacent. It is important to remember that an absence of adverse events does not imply that what creates them has been eliminated. Humans make mistakes. These mistakes can take two forms. The first is active errors, which directly result from a person's actions. An example of an active error is an operator performing a valve lineup improperly. Latent errors are mistakes that can be attributed to poorly-written, absent, or overly-restrictive policies and procedures. An example of a latent error would be the lack of a requirement for operators to use a checklist to ensure the accuracy of the valve lineup.

Policies and procedures help guide decision-making but do not cover every possible scenario. Predicting the unknown is one of the risks inherent in risk assessments. The human mind tends to fill in the blanks where information is uncertain to develop viable courses of action. Variables include the situation's context, the problem's perceived urgency, and the perceived level of risk involved. Shifts in standards are contingent upon how issues are perceived, and perceptions of problems are contingent upon the changes in standards that affect them [12].

Workers and managers often incorporate deviations into processes and procedures [13]. Such deviations may be seen as improvements or innovations [14]. Some procedures, such as those implemented in emergency or casualty situations, can allow these. There are three significant causes leading to practical drift and the normalization of deviance. These are production pressure, impaired safety culture, and violations of standards of care [15]. These themes are generalizable across all industries.

III. DISCUSSION

A. Production Pressure

The drive to do more with less, increase productivity, and reduce costs is linked to the normalization of deviance. Time and cost pressures are strong motivators to get the job done, especially when there are potential consequences for not doing so. Managers are often graded on their production, encouraging an organizational culture emphasizing profitability over safety. The effects of production-related deviance on safety are difficult to see and often obfuscate safety concerns [16]. In the wake of the Challenger accident, the Rogers Commission reported that "operating pressures were causing an increase in unsafe practices" [17]. NASA's desire to have Challenger in orbit in time for the State of the Union address stemmed from perceived political and budgetary pressure. The agency resorted to quick fixes for safety-related problems that could interfere with an already rigorous launch schedule and jeopardize the agency's political and fiscal support in Congress.

Minor and seemingly harmless deviations are often defended as necessary and are reinforced by the lack of adverse reactions. Airline accidents, such as the crash of Alaska Airlines Flight 261, have resulted from modifications to maintenance intervals as a part of efficiency initiatives. That this may cause safety to become compromised is often not considered seriously, if at all. Alaska Airlines 261 crashed following the failure of the horizontal stabilizer jackscrew. The jackscrew is a component that allows the horizontal stabilizer to move up and down, maintaining aircraft pitch. The maintenance interval on the jackscrew threads had been increased as part of an effort to keep airplanes in the air and out of the hangar. Extending this interval was not seen as abnormal and had not resulted in any problems before the fatal crash. Likewise, at NASA, partial blow-by of gases past the primary O-rings was not perceived as abnormal since the backup O-rings contained the escaping hot gases. The mindset at NASA was to demand proof that the extreme cold forecasted for the launch would result in the failure of both O-rings instead of requiring verification that Challenger was safe to fly under such conditions.

Accidents such as those at Chernobyl and Bhopal were not caused by a coincidence of independent failures but by a systemic drift of organizational behavior toward accidents under pressure to achieve more cost-effectiveness in an aggressive, competitive environment [18]. In Chernobyl's case, electricity production was the priority that overshadowed reactor safety and proper operating procedures.

B. Impaired Safety Culture

Safety culture is a popular and common construct used to discuss safety incidents[19]. Safety culture has been defined by the International Nuclear Safety Advisory Group (INSAG) as "that assembly of characteristics and attitudes in organizations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance" [20]. Safety culture is also identified as the collection of "individual and group attitudes, beliefs, values, and behavior regarding occupational safety and health in an organization" [21]. A strong safety culture is often cited in organizations with few safety-related incidents; where there are more safety problems, a weak culture is frequently suspected.

A common refrain in safety classes is that "management does not want to hear about problems, so the less they know, the better." This attitude applies not only to production processes but also to safety procedures. A concern from the field is that complaints about awkward or unworkable safety rules are dismissed quickly. The apparent lack of concern leads workers to create their own deviations to get around what they see as a bureaucratic problem that makes their jobs unnecessarily difficult. In turn, people begin to look for ways around the obstacles. People will look for courses of action that align with their perception of the situation and act accordingly. These "practical actions gradually drift away from the originally established procedures" [22]. As a result, practical drift unhinges the safety culture within an organization by gradually creating and tolerating lower standards in safety practices, thus, increasing the organization's vulnerability to errors and adverse outcomes[23].

Safety behaviors are also affected by cognitive biases and heuristics. Cognitive biases and heuristics have a powerful influence on decision-making. Because people are limited in their ability to process information [24], they use simplification strategies to reduce the amount of information that must be considered at any given time. Cognitive bias is a systematic error in thinking that occurs when people are processing and interpreting information. Heuristics are approaches to problem-solving using calculated guesswork derived from previous experiences. These approaches can cause people to make decisions they believe to be correct yet based on flawed assumptions or incorrect or non-existent "facts" that support or preserve their beliefs.

One of the best-known cognitive biases is *Confirmation Bias*. This phenomenon causes people to emphasize information that supports currently-held views while discounting conflicting information. Confirmation bias can inhibit the ability to correct one's own mistakes and lead to overconfidence[25]. Other employees and previous experiences can influence safety decision-making processes. Workers will often look for evidence that a potentially risky behavior is safe (e.g., others engaged in similar behaviors) or attempt to justify the potentially dangerous behavior (e.g., past performance with no adverse consequences). The result is often an inability to examine opposing viewpoints and poor decision-making skills. Functionally, a lack of adverse effects can reinforce the belief that risky behavior is safe despite evidence to the contrary.

The Dunning-Kruger effect is a cognitive bias in which people tend to overstate their capabilities. Commonly attributed to those with less knowledge or skills, Highly skilled and unskilled workers were more likely to be subject to the effects of Dunning-Kruger[26]. Such cognitive bias exists because there is an ill-defined line between where knowledge ends and ignorance begins. We do not know what we do not know but think we know more than we do. Experience, however limited, combined with intellectual scaffolding of thoughts and intuition, may convince us that we have a false level of expertise [27]. Cognitive bias can convince well-intentioned workers that their actions are correct given their interpretation of the circumstances and that workarounds do not present any increased risk. The implication for safety is that the human propensity to drift away from standards, combined with their overestimation of the skills, plus confirmation bias, can lead to catastrophic results [28].

C. Violation of Standards

Human factors, such as fatigue and distracted driving, are some of the leading causes of motor vehicle accidents worldwide [29]. Cell phone usage is one of the leading causes of distracted driving, increasing the likelihood of a traffic accident by a factor of four [30]. Research also shows that 71 percent of traffic accidents involved drivers engaged in activities unrelated to motor vehicle operation [31]. Other factors, such as driving too fast and following too closely, are documented as significant contributors to traffic accidents [32] [33]. Lack of experience, stress and decision fatigue contribute to cognitive biases and standards violations.

Scientific and anecdotal evidence demonstrates that violating highway safety rules is both common and expected. When driving on major thoroughfares, it is easy to conclude that unsafe driving has become a social norm. In any environment, actions and consequences are related. Behaviors that are positively reinforced, e.g., where the individual obtains the desired result, will drive behavior in that direction. Driving too fast is rewarded by the perception of arriving at the destination sooner. Excessive speed may also be reinforced by the emotional and psychological satisfaction of driving at high speed. Negative reinforcement of poor driving behaviors includes traffic tickets, crashes, and the loss of driving privileges.

Workers violate safety standards because a similar risk-versus-reward relationship exists. Employees can violate procedures that they may perceive as creating unnecessary time constraints or requiring steps that may be bypassed effortlessly, especially if no one is looking. Violating safety standards is positively reinforced when the task is accomplished with no adverse consequences, such as an injury or near-miss. Adverse consequences, such as disciplinary action, are negative reinforcers. As shown by alcohol-related accident statistics, however, 40 percent of drivers injured in crashes while under the influence of alcohol had a history of alcohol-related offenses [33].

D. Deviance and Human Decision Making

Safety-critical activities require employees to make decisions in both normal and abnormal operating conditions. A decision is defined as a systematic cognitive process used to identify and evaluate alternatives before arriving at a conclusion. Making decisions is both analytical and intuitive; dependent on our ability to process information and our cognitive agility. Intuitive decision-making emphasizes experiences. Reliance on intuition increases with experience with inexperienced workers being more dependent on rules rather than the context of the situation.

Stress compounds decision-making and affects decision quality. There are two sources of stress: job stressors and decision stressors. Job stressors involve working conditions that are perceived as negative. These can result from excessive overtime or excessive work demands resulting from being understaffed. Decision stressors relate to the decision to be made and can result from the perceived importance of the decision to the individual or the organization. Information overload, time pressure, complexity, and uncertainty are common decision stressors. Cognitive resources become overworked under duress, resulting in failure to process information efficiently, to consider all available options, and to ignore information that does not conform to existing beliefs.

Decision-making is challenging to study in real-time; most of what we know about incidents and the thought processes that influenced them has been learned after the incident has occurred or from questionnaires and other quantitative and qualitative instruments. Individuals respond differently under stress; such retrospective and hypothetical information gatherings can assess knowledge about a situation but not how the respondents would act during one.

E. The Challenger Disaster

The loss of the space shuttle Challenger is perhaps the most well-known disaster in the history of space flight. Although the cause of the disaster was attributed to the failure of solid rocket booster (SRB) O-rings, there were failures in other areas of the shuttle program that also contributed. The engineering problems with the O-rings, and their implications for safe flight, were well-documented [34].

Had the failure of the O-rings been the sole cause of the accident, then the event would likely have been attributed to an unforeseen mechanical failure. Because there was written and anecdotal evidence that questioned the performance of the O-rings when exposed to extreme cold, the decision-making process at NASA also came under scrutiny. The Roger's Commission investigation revealed that a flawed decision-making process placed management concerns ahead of engineering expertise [35]. This flawed process also affected decision-making at Morton Thiokol, the prime contractor for the SRB. Management at Thiokol made the critical decision to recommend the launch of Challenger over the objections of engineers, partly due to perceived pressure from NASA officials [36]. Five factors that, in combination, appear to account for the mindset in which the decision to launch was made were identified. These influences include (1) perceived pressure, (2) rigid conformity to perceived role requirements, (3) questionable reasoning, (4) ambiguous use of language, and (5) failure to ask critical relevant questions [37].

As the shuttle program progressed without serious incidents, NASA's success created a culture of increased risk tolerance over time combined with shrinking safety margins. NASA's culture was primarily to blame for the Challenger accident because it suppressed dissenting views in the absence of hard data and fostered complacency rather than confronting potential problems. Budgetary and production concerns exacerbated the problem, contributing to the decision stressors that were present when the launch decision was made.

F. Deviance in Health Care

Health care is another industry where process drift and normalization of deviance have been identified as significant safety concerns. Medical error has been defined as an "unintended injury to patients caused by medical management" [38]. Other definitions of medical error define the term as an "unintentional act (either of "omission" or "commission") or one that does not achieve its intended outcome, the failure of a planned action to be finished as intended ("errors of execution"), using an incorrect plan to achieve a goal ("errors of planning"), or a deviation from the method of care which could or might not cause harm to the patient" [39]. Approximately 1 million preventable errors occur annually in the U.S., resulting in between 44,000 and 98,000 deaths [40].

Just as many process deviations in industrial settings do not result in injuries or damages, medical errors do not always lead to patient harm [41]. Errors such as ordering the wrong medication, failing to record test results in a patient's record properly, or medical transcription errors will not typically result in patient harm and usually go unreported and uncorrected [42] [43]. Like other instances of drift, these errors are seen as harmless when viewed in isolation. Unintentional errors such as these may also be combined with other shortcuts and workarounds, such as failure to wash hands after each patient interaction or to fail to check patient identification before procedures can lead to tragic consequences.

Normalization of deviance in health care occurs just as in other industries and for many of the same reasons. A common reason for deviance is that employees are in situations where organizational culture and pressures, such as time commitments and productivity pressures, push them to migrate past the boundaries of what is deemed safe. The tendency is to blame individuals when deviations occur rather than looking at systemic causes. Recently, a Tennessee nurse was convicted of criminally negligent homicide and gross neglect that resulted from a medical error. In this case, the defense argued that short staffing and overwork contributed to the tragedy [43]. Overwork and related mental stress may have contributed; research has shown that nurses in poor physical or psychological health reported significantly more medical errors than their counterparts [44].

Despite the presence of systems and procedures intended to prevent such errors, the nurse administered the wrong drug to the patient. This is an example of what Banja called "negative deviance," which can occur when practitioners perform a task differently than they should and lead to adverse consequences for patient safety [45]. Negative deviance may be intentional or unintentional and may become accepted practice, especially when leaders or managers appear to condone such behaviors or are themselves deviating.

IV. CONCLUSIONS

We train people to follow procedures but know that sometimes they do not, regardless of what we want to believe. The constant need to do things faster and cheaper means that people will set their own rules to meet the demands of the moment. While the Challenger disaster and others, such as Piper Alpha, Deepwater Horizon, and Chernobyl, have cast a harsh light on the problem, the root causes remain out of sight and frequently out of mind. Organizations often become defined by what they ignore. When something goes awry, the quick fix is to blame the person closest to the problem and set even stricter rules. Rules are important, but what is more important is understanding why the rules exist and the potential ramifications of altering them arbitrarily or violating them outright.

We need to understand that big problems often begin as small ones. Many safety incidents start as small decisions, deviations, and errors made repeatedly over time. What Snook points out, and what reinforces, is that our policies and procedures are often the culprits [46]. This is the reason why accidents are not always accidental. The rules-based solutions to our safety issues can create the problems that safety programs are supposed to prevent. We know that there will be system errors in safety programs. These complex workflows, poor system designs, or inadequate procedures may set the stage for human errors [47]. Uncertainty is created where the problem and the rules do not align. It is not what we do in times of certainty that matters. It is what we do in uncertainty that makes the difference.

V. REFERENCES

[1] Foucault, M. (1977). Discipline and Punish: The Birth of the Prison. Vintage Books.

[2] Vaughan, D. (1996). The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA. University of Chicago Press.

[3] Mize, J. F. (2018). The roundabout way to disaster: recognizing and responding to normalization of deviance. Process Safety Progress, 38(2), e12014.

[4] Pinto, J. K. (2014). Project management, governance, and the normalization of deviance. International Journal of Project Management, 32(3), 376–387.

[5] Courtois, C., & Gendron, Y. (2017). The "Normalization of Deviance": A case study on the process underlying the

adoption of deviant behavior. Auditing: A Journal of Practice & Theory, 36(3), 15-43.
[6] Ortmann, G. (2010). On drifting rules and standards. Scandinavian Journal of Management, 26(2), 204–214.
[7] Everson, M. G., Wilbanks, B. A., & Boust, R. R. (2020). Exploring production pressure and normalization of deviance and their relationship to poor patient outcomes. AANA Journal, 88(5), 365–371.
[8] Price, M. R., & Williams, T. C. (2018). When doing wrong feels so right: Normalization of deviance. Journal of Patient Safety, 14(1), 1–2.
[9] Banja, J. (2010). The normalization of deviance in healthcare delivery. Business Horizons, 53, 139-148.
[10] Snook, S. A. (1996). Friendly fire: The accidental shootdown of U.S. Black Hawks over northern Iraq. Princeton University Press.
[11] Shapiro, S. (2010). Decision-making under pressure. The Futurist, Jan-Feb, 42–44.
[12] Ortmann, G. (2010). On drifting rules and standards. Scandinavian Journal of Management, 26(2), 204–214.
[13] Mize, J. F. (2018). The roundabout way to disaster: recognizing and responding to normalization of deviance. Process Safety Progress, 38(2), e12014.
[14] Petruzelli, E. (2020). Normalization of deviance in the time of COVID-19. Chemical Engineering Progress, 3, 3.
[15] Everson, M. G., Wilbanks, B. A., & Boust, R. R. (2020). Exploring production pressure and normalization of deviance and their relationship to poor patient outcomes. AANA Journal, 88(5), 365–371.
[16] Vaughan, D. (1996). The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA. University of Chicago Press.
[17] Guthrie, R., & Shayo, C. (2005). The Columbia disaster: Culture, communication & change. Journal of Cases on Information Technology, 7(3), 57–76.
[18] Petruzelli, E. (2020). Normalization of deviance in the time of COVID-19. Chemical Engineering Progress, 3, 3.
[19] Cole, K. S., Stevens-Adams, S., & Wenner, C. (2013). A literature review of safety culture. Sandia National Laboratory.
[20] Besnard, D., & Hollnagel, E. (2014). I want to believe: some myths about the management of industrial safety. Cognition, Technology & Work, 16(1), 13-23.
[21] Tappura, S., Jääskeläinen, A., & Pirhonen, J. (2022). Creation of satisfactory safety culture by developing its key dimensions. Safety Science, 154, 105849.
[22] Snook, S. A. (1996). Friendly fire: The accidental shootdown of U.S. Black Hawks over northern Iraq. Princeton University Press.
[23] Prielipp, R. C., Magro, M., Morell, R. C., & Brull, S. J. (2010). The normalization of deviance: Do we (un)knowingly accept doing the wrong thing? Anesthesia & Analgesia, 110(5), 1499–1502.
[24] Simon, H. A. (1976). Administrative behavior (3rd ed.). The Free Press.
[25] Peters, U. (2022). What is the function of confirmation bias? Erkenn, 87. 1351–1376.
[26] Burson, K. A., Larrick, R. P., & Klayman, J. (2006). Skilled or unskilled, but still unaware of it: how perceptions of difficulty drive miscalibration in relative comparisons. Journal of Personality and Social Psychology, 90(1), 60-77
[27] Dunning, D. (2011). The Dunning–Kruger effect: On being ignorant of one's own ignorance. In Advances in experimental social psychology (Vol. 44, pp. 247–296). Academic Press.
[28] Stojiljković, E., Bozilov, A., Golubovic, T., Glisovic, S., & Cvetkovic, M. (2018). Human error prevention by training design: Suppressing the Dunning-Kruger effect in its infancy. In Occupational Safety and Hygiene VI, 219-223. CRC Press.
[29] [30]Chand, A., Jayesh, S., & Bhasi, A. B. (2021). Road traffic accidents: An overview of data sources, analysis techniques and contributing factors. Materials Today: Proceedings, 47, 5135–5141.
[30] World Health Organization; 2018. License: CC BY- NC-SA 3.0 IGO, Global Status Report On Road Safety 2018, Geneva.
[31] Olson, R. L., Hanowski, R. J., Hickman, J. S., & Bocanegra, J. (2009). Driver distraction in commercial vehicle operations (No. FMCSA-RRT-09-042). United States. Department of Transportation. Federal Motor Carrier Safety Administration.
[32] Piccardi, L., Palmiero, M., Guariglia, P., Dacquino, C., Cordellieri, P., & Giannini, A. M. (2021). Is the risk behaviour related to ordinary driving violations? Psychological studies, 66(1), 26-35.
[33] Lapham, S., Baum, G., Skipper, B., & Chang, I. (2000). Attrition in a follow-up study of driving while impaired offenders: Who is lost? Alcohol, 35, 464–470.
[34] Meyer, D., Muir, S., Silva, S. S. M., Slikboer, R., McIntyre, A., Imberger, K., & Pyta, V. (2021). Modelling the relationship of driver license and offense history with fatal and serious injury (FSI) crash involvement. Journal of safety research, 79, 83–93.
[34] Mahler, J. G. (2009). Organizational learning at NASA: The Challenger and Columbia accidents. Georgetown University Press.
[35] Herndl, C. G., & Fennell, B. A. (1991). Understanding failures in organizational discourse. Textual dynamics of the professions: Historical and contemporary studies of writing in professional communities, 279.
[36] Hirokawa, R. Y., Gouran, D. S., & Martz, A. E. (1988). Understanding the sources of faulty group decision making: A lesson from the Challenger disaster. Small Group Behavior, 19(4), 411–433.
[37] Gouran, D.S., Hirokawa, R., & Martz, A.E. (1986). A critical analysis of factors related to decisional processes involved in the challenger disaster. Communication Studies, 37, 118-135.
[38] Oura, P. (2021). Medical adverse events in the US 2018 mortality data. Preventive medicine reports, 24, 101574.
[39] Karande, S., Marraro, G. A., & Spada, C. (2021). Minimizing medical errors to improve patient safety: An essential mission ahead. Journal of postgraduate medicine, 67(1), 1–3.
[40] Kohn, L.T., Corrigan, J.M., Donaldson, M.S. (2000). To Err is Human: Building a Safer Health System. Washington (DC): National Academies Press (US). Institute of Medicine (US) Committee on Quality of Health Care in America.
[41] Rubin G, Meyer A. (2021). Diagnostic errors and harms in primary care: insights to action. BMJ Quality & Safety, 30. 930-932.

[42] Banja, J. (2010). The normalization of deviance in healthcare delivery. Business Horizons, 53, 139-148.
[43] Kelman, B. (2021, March 25). Former nurse found guilty in accidental injection death of 75-year-old patient. NPR. https://www.npr.org/sections/health-shots/2022/03/25/1088902487/former-nurse-found-guilty-in-accidental-injection-death-of-75-year-old-patient
[44] Melnyk, B. M., Tan, A., Hsieh, A. P., Gawlik, K., Arslanian-Engoren, C., Braun, L. T., ... & Wilbur, J. (2021). Critical care nurses' physical and mental health, worksite wellness support, and medical errors. American Journal of Critical Care, 30(3), 176-184.
[45] Banja, J. (2010). The normalization of deviance in healthcare delivery. Business Horizons, 53, 139-148.
[46] Leemann, J. E. (2011, August). Practical drift and writing safety rules: Behaviors get loose when procedures are too tight. ISHN, 45(8), 20–20, 22.
[47] Harvey, H., & Sotardi, S. T. (2017). Normalization of deviance and practical drift. Journal of the American College of Radiology, 14(12), 1572–1573.

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