GUEST EDITORIAL

Fatigue management in practice — It's just good teamwork

An important review was published in this issue of the journal. The review by Banks et al. [1] is important for several reasons. Critically, it reviews a rapidly emerging area of sleep and fatigue science. Moreover, it emphasises the critical perspective that fatigue is much more than individual impairment. The review underlines the need to understand fatigue in a much broader context, that of individuals working as teams, and as part of larger organisational systems of work.

This review builds on the work of Jim Horne's group in the early part of this century. The landmark paper "The impact of sleep deprivation on decision making: a review" [2] written by Yvonne Harrison and Jim Horne in 2001 moved our field beyond the traditional lab-based measures of fatigue-related performance impairment to aggregate and summarise the extant literature on the effects of fatigue on real-world tasks and actual job performance.

This was an important step forward because it identified a key issue in the literature, that the standardised measures of performance impairment developed for the laboratory were not always representative of real-world tasks. While not intentional, the use of the term 'performance' in these tasks often overlooked that the measures of performance were actually assays of fatigue to be used in the laboratory, rather than real measures of complex human performance in real-world work environment. These lab-based tasks were designed specifically to eliminate the many complex behavioural adaptations that humans can make to preserve performance even at quite high levels of fatigue.

Measures such as the Psychomotor Vigilance Task (PVT) were designed to be highly sensitive to the effects of fatigue and, as a consequence, sometimes created the mistaken impression (especially in lay readers) that the effects of fatigue on performance were both profound and inexorable. While not wanting to underplay the effects of fatigue on task performance and workplace safety, it is also important to note that compensatory behaviours are a very real aspect of task behaviour in real world settings.

As with the Harrison and Horne paper, and alongside Hockey's seminal work on motivational aspects and compensatory effort in response to fatigue [3], the paper in this issue encourages us to move beyond a simplistic understanding of how fatigue negatively affects task performance. What is novel about this review is that it has gone a step further than previous reviews by incorporating a conceptual framework for understanding the effects of fatigue on human performance at the individual, team and organisational level. This not only enables the authors to explain some of the effects of fatigue at the individual level but to speculate as to how fatigue might also impact emergent aspects of task performance at the team level or organisational levels.

There is no doubt that this review represents a significant step forward in both understanding how fatigue may affect real-world task performance, as distinct to lab-based performance. On the other hand, it is also reasonable to ask whether they apply the most appropriate model in terms of advancing the field? The Banks et al. [1] paper in this issue frames the effects of fatigue on team performance in the context of Input-Mediator-Outputs-Input (IMOI) model, taken from the field of Industrial-Organizational Psychology.

It is probably fair to say that the use of the model and conceptual framework outlined in the review moves the field forward from a simple task-based perspective to understand broader factors related to team and organisational factors. However, it is also the case that the model presented by Banks et al. [1] may be less suitable for use by practitioners in the field than it is for organisational psychologists.

Given the primary focus of understanding fatigue and its effects on task performance is to ensure safety, it might also be reasonable to ask whether an purely organisational-psychology perspective is best-suited toward the ultimate goal of improved safety. Today, new models of safety and expert team performance provide additional insights into the way in which fatigue is *actually* managed in the complex world of day-to-day operations.

Safety II — safety differently

Many of the models used in the realm of organisational psychology are fundamentally based on old-fashioned and outmoded thinking about safety. They build a framework based on the assumption that incidents and accidents are caused simply by malfunctions of technology, failures of procedures, or errors caused by fallible human components of a system of work. We now call this thinking "Safety I", which sees safety being achieved by solely through concerted efforts to ensure an absence of these "causal" factors [4].

This purely *deficit* model of safety has more recently been challenged, with a new framework being offered, that of Safety II, which prescribes a different approach to safety management needs to be adopted. The likes of Eric Hollnagel, Sidney Dekker and other leading safety scientists now posit that we need a far more *naturalistic* approach to safety management, and one that better reflects how safety is actively produced by expert operators effectively managing the complex, dirty, and often unpredictable nature of real-world operations [5]. This so called "Safety II" approach places the emphasis on how safety is an active product of system performance, within which teamwork is a critical source of risk mitigation.

If we explore these contrasting models with respect to fatigue risk management, Safety I would attempt to achieve optimal system performance simply by eliminating fatigue. Conversely, Safety

II would suggest this "eliminate the deficit" approach is ultimately unable to be achieved. Rather, the Safety II approach would invest heavily in ensuring the systems of work are resilient to the impacts of fatigue. Within the new paradigm, the performance of individuals and teams are celebrated, with the vulnerabilities and performance variability associated with fatigue are accepted as inevitable and therefore should be anticipated and systems designed to tolerate such performance variability. This approach is embodied in the concept of "fatigue proofing" [6], which celebrates the real value of the human within the complex system − the ability to put in place compensatory and protective measures in the face of fatigue. This is a uniquely human gift that emerges as a function of our intelligence and volition.

The point of Safety II is not what types of deficits caused by fatigue that the team bring to work on any given day, but rather how their teamwork ensures optimal performance - even in the presence of fatigue. It is also a "call to arms" for the field of Human Factors more broadly, which is to celebrate the real strengths of being human, rather than simply bemoan our perceived deficiencies.

Non-technical skills and team performance

This idea that teamwork is a critical component of the optimal performance of safety critical systems is by no means new. However, this focus on humans working together as a team as a *solution*, has had to overcome the stigma associated with human being constructed as the vulnerable and fallible part of systems of work that are otherwise "engineered" to be safe.

During the latter half of the 20th century, across a wide range of industries the rapid forms of technological enhancements and ultra-reliable engineered systems revealed a substrate of variability in human performance. Humans became seen as the "weak-link" in system safety and human error implicated in the vast majority of catastrophic industrial accidents [7]. With the rise of the human error paradigm came the inevitable hunt for error producing conditions and the desired to improve safety by removing these conditions from play. Of the wide range of error producing conditions, fatigue quickly became a focus point, among other human factors catch-alls such as decision-making, situation-awareness and communication [8].

However, research post-WWII had began to utilise simulation to explore team performance, and in the late 1970 a game-changing piece of work from NASA underlined the critical role of teamwork, leadership, and the effective use of all available resources [9]. In a flurry of industry workshops and NASA guidance, non-technical skills training programs were born. Initially called Cockpit Resource Management (CRM), today these programs have spread across a wide range of industrial contexts, and form a bedrock of enhancing team performance in high risk industries.

The early CRM programs met some cultural resistance, particularly with respect to the unwillingness of expert operators, such as highly experienced airline pilots, to accept their own vulnerability to performance shaping factors such as fatigue [10]. Slowly but surely, in some industries, these cultural barriers were overcome, the types of performance changes associated with fatigue better-understood, and team-based countermeasures put in place and rehearsed in simulation-based training and during everyday operations.

Today, we see these programs that develop team competencies in the management of complex gritty real-world problems as a critical element of "fatigue-proofing". Most importantly, we now have considerable evidence that describe a wonderfully diverse and occasionally idiosyncratic suite of strategies used by teams in high risk work environments to protect team performance against the effects of fatigue-related impairment [11,12].

Today, the commercial aviation flight deck is an exemplar of such a high-risk work environment where fatigue-proofing strategies are actively used by team-members. Moreover, formalised training programs such as Threat and Error Management (TEM) are used to train and assess well-defined competencies in the anticipation and response to inevitable forms of human error [13].

In commercial aviation fatigue is a ubiquitous and a normalised part of everyday operations. Studies of commercial flight crew regularly report a high frequency of circadian disruption [14] and sleep restriction [15], with estimates of between 5% and 10% of flights being operated by teams with at least one crew member experiencing significant sleep restriction (<5 h sleep in prior 24 h). However, the prevalence of sleep restriction and circadian disruption is not associated with a prevalence of accidents, with the commercial accident rate being far less than one in one million lights in most parts of the world.

With fatigue-related impairment conservatively a factor in one in 10 flights, then in the transition to an accident-rate of one in 1,000,000 must be testament to some pretty effective fatigue-risk management. Indeed, the evidence suggests that effective teamwork is one of a few critical controls in this tale of fatigue risk mitigation [16].

Unfortunately, other high-risk work environments have been slower in the necessary cultural reforms. While the operating theatre has seen significant cultural change over the last decades, and teams are well versed in the use of simulation-based training in non-technical skills, there remains a vestige of invulnerability across all of healthcare and the badge of honour of excessive hours and high levels of fatigue remains.

In environments such as healthcare, effectively managing the risks associated with fatigue lie not in a better understanding of potential deficits they bring to team performance, as Banks et all would suggest. Rather, effective fatigue risk management in these teams involves: 1) a successful challenge to the culture of invulnerability; and 2) a celebration of the ways in which non-technical skills training for teams can ensure optimal team performance.

Cultural change and celebrating teamwork

The lessons we have learned from decades of training teams in non-technical skills is that we *can* make good teams excellent, and that a large part of this excellence involves teams being resilient to the effects of negative performance-shaping factors such as fatigue.

Our investment in programs that enhance team performance in the face of fatigue is perhaps just as important as our attempts to reduce the occurrence of fatigue in real-world work environments. Ultimately, we most likely will never eliminate fatigue from our work-places. Fatigue is simply a part of being human, and being human needs to be celebrated because we bring to the workplace extraordinary strengths that we have not yet been able to successfully engineer into our so called "high-reliability" systems.

We need to move beyond seeing fatigue through the simple "Safety I" lens of performance deficit, but rather we need to embrace fatigue as yet another operational risk or workplace hazard that we need to effectively manage. The opportunity we currently have is to reject the idea that fatigue has a negative impact on team performance, but that effective teamwork, and the unique array of "fatigue proofing" strategies teamwork brings, is a positive component of maintaining safety and achieving resilient systems in practice.

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Drew Dawson, Matthew J.W. Thomas[*]
Appleton Institute − CQUniversity, Wayville, South Australia,
Australia

[*] Corresponding author.
E-mail address: matthew.thomas@cqu.edu.au (M.J.W. Thomas).