Workload levels and their impact

by Dr. Beth Lyall

Workload has been described as an indicator of the level of total mental and/or physical effort required to carry out one or more tasks at a specific performance level.[1] The reason we pay attention to workload is because of the effects it can have on performance as it changes. When workload is too high or too low, it can significantly increase the probability of all types of errors.

1- Stramler, J. H., Jr. (1993). The Dictionary for Human Factors/Ergonomics. Boca Raton, FL: CRC Press, Inc.

The challenge in addressing workload is that it needs to be broken down into its components in order to understand what actions can effect an improvement in performance. In this article I will give one way of breaking down the concept of workload and how it can be addressed in design, training, and operations.

Workload is one element in a situation that impacts performance and the potential for making errors. In a safety-related situation we are interested in minimising errors and ensuring that errors that do occur can be recognized and managed.

Figure 1 presents a notional workload description that will allow a discussion of all the different components and their impact. The line depicts how workload moves from low to high. Many factors define the point along this line that workload will reside at for one point in time. That point will change as the tasks and situations change. The two threshold lines on the graphic indicate the level of workload at which the probability of errors increases. There is an error threshold when workload goes too low and one where workload goes too high. When the current workload level goes beyond either threshold, the occurrence of errors is much more likely. The challenge is that all of these are moving parts. Workload goes up and down, and the thresholds move based on certain factors. In the remainder of this article, I will address each of these components and how they are influenced.

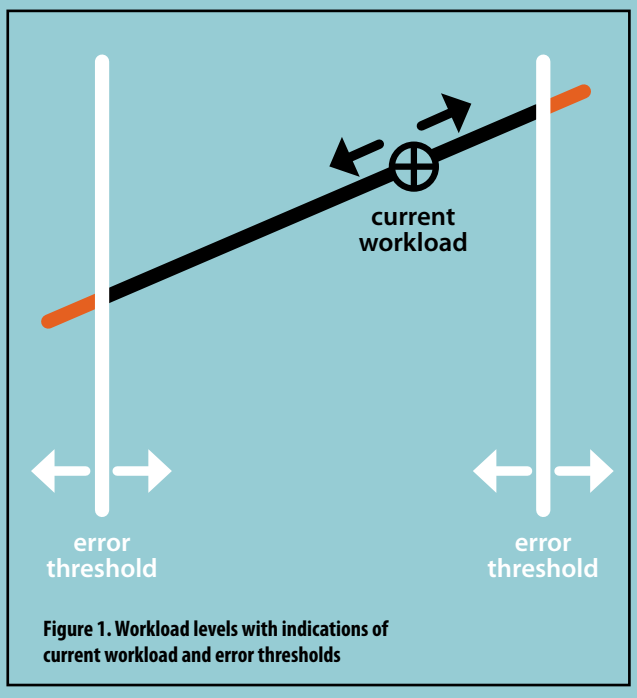


Figure 1. Workload levels with indications of current workload and error thresholds

Current Workload Level

The current workload point is determined by a combination of many factors including:

- Tasks being accomplished
- Design of systems and equipment
- Processes and procedures
- Situation and environment

Tasks: Some tasks are more difficult to accomplish than others. They require more mental or physical resources, making workload higher at the times they are being accomplished. However, tasks do not stand-alone.

Design of Systems and Equipment: The design of the systems and equipment used to accomplish the tasks will also impact the workload at that time. If the design is poor and requires a lot of effort to understand and use the system, then workload will be higher. Workload is impacted by the design of all systems, displays, controls, and equipment being used. If workload is significantly impacted, it can lead to critical performance errors. Human factors considerations in design have been developed[2] to reduce the potential for these design-induced errors.

Processes and Procedures: The availability and design of any required processes or procedures also impact workload. For example, performance in an emergency situation is easier if an appropriate checklist is available for that situation. And when that checklist is needed, the effort required to find the right checklist, understand it, and use it will impact the workload at the time of doing the tasks to deal with the emergency.

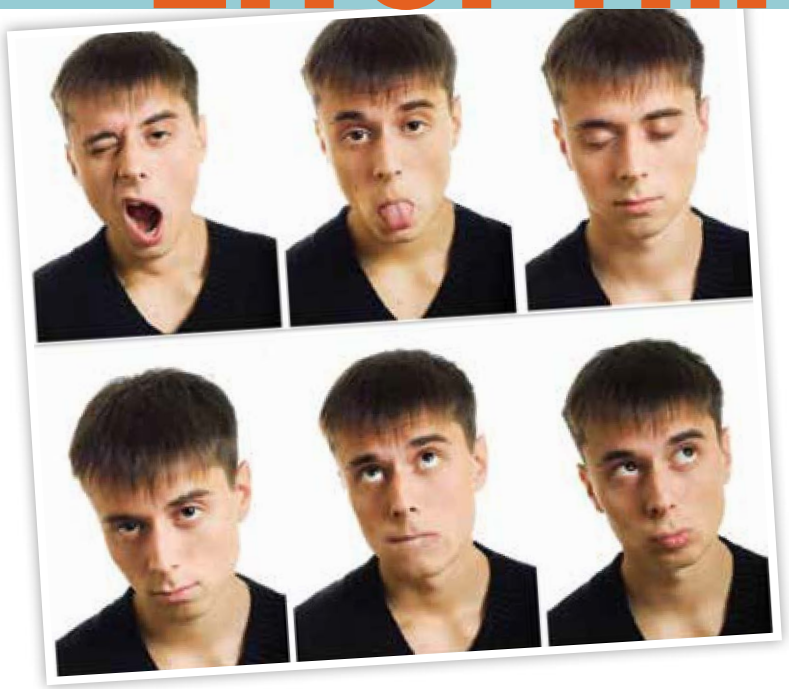
Situation and Environment: Finally, the situation in which the tasks need to be performed will impact the workload experienced. Attributes of the situation that affect the level of workload include urgency, competing tasks, time of day, ambient lighting, noise, and the availability of other team members to help.

Each of these four factors vary throughout a work session, causing the current level of workload to go up and down as the four factors come together at any one point in time.

2 - Lyall, B. and Harron, G. (2005). A Systematic Approach To Addressing Human Factors Considerations In The Design Of Flight Deck Components. Proceedings of the Thirteenth International Symposium on Aviation Psychology, April 18-21, 2005, Oklahoma City, Oklahoma.

Workload levels and their impact (cont'd)

Error Thresholds



The big reason we care about the level of workload is that it can lead to performance errors. Workload levels can contribute to many types of errors including physical errors of data entry or manual handling; perceptual errors of not recognizing a change in display label, not identifying a system failure, or not hearing an aural alert; and cognitive errors related to planning, decision-making, problem-solving, troubleshooting, communicating, task management, and many more. It is the relation between the current level of workload and the error threshold that determines the likelihood of these errors. If the current level of workload is at or beyond the error threshold – either at the high or low end of the workload range – errors become more likely.

Along with the four factors (tasks, design of systems and equipment, processes and procedures, and situation and environment) that impact where the current level of workload will be along the range of workload, there are factors that are associated with the error thresholds. The workload threshold for error is determined by a combination of several attributes related to the person performing the tasks at a particular point in time. Four of these attributes are:

- **Level of expertise**
- **Fatigue**
- **Distraction**
- **Stress**

Level of Expertise:
We usually think of a person's expertise as encompassing their knowledge, experience, and training for accomplishing tasks. That is important here too with the knowledge, experience, and training someone brings having a big impact on their performance and the likelihood that they will make an error in general. I want to expand expertise for this discussion to also include the knowledge, experience, and training for using the systems, equipment, processes, and procedures – and in facing the situations and environments. So all of the factors that contribute to the existing level of workload are important when considering how prepared a person is for dealing with those tasks and situations. This combination sets the threshold for error. If expertise is high, the threshold is higher, and, considering the threshold at the high end of the workload range, a person can handle increasing levels of workload before significantly impacting the probability for error. But the threshold for error for novices will be lower, more likely leading to errors when facing lower levels of workload. **Figure 2** illustrates this difference in error thresholds for people with lower and higher levels of expertise for the current tasks and situation at the high end of the workload range. The impact would be similar at the low end with more expertise resulting in less likelihood of errors.

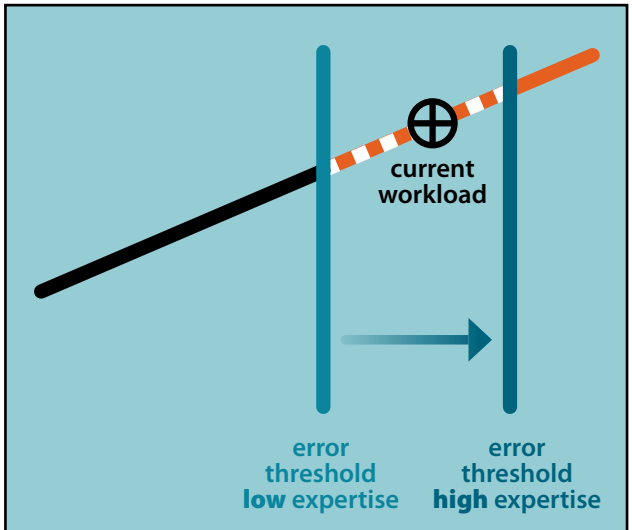


Figure 2. Impact of expertise level on the upper error threshold. The impact on the lower threshold will be similar in that in increase in expertise will move the threshold to reduce the likelihood of errors.

Fatigue:
The impact of fatigue, whether physical or mental, is to reduce the threshold for error and make it more likely that errors will occur for particular workload task and situation combinations. One of the challenges with fatigue is that it usually increases as a work session progresses. It also changes with levels of alertness and changes in the circadian rhythms. We all know that we feel more tired or fatigued in the middle of the night than we do during the day. The error thresholds change with these changes in fatigue throughout a work session, resulting in errors being more likely with less workload at the high end and less tolerance for lulls in workload at the low end. This means that the same challenging tasks that are accomplished easily with no errors early in a work session will be more prone to error occurrences later in the session if fatigue increases. **Figure 3** shows this effect along with the similar impact of distraction and stress.

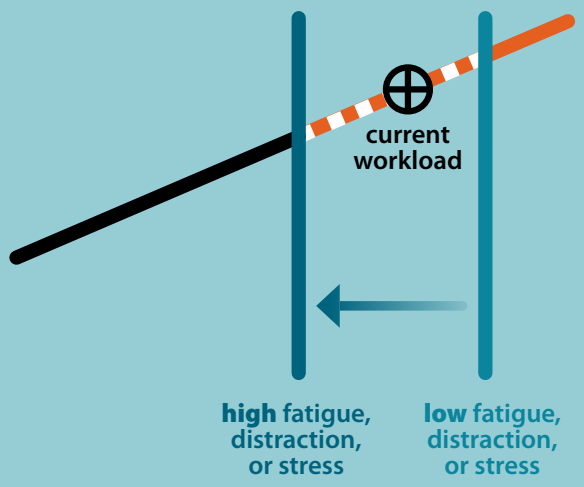


Figure 3. The impact of fatigue, distractions, and stress on the upper-end error threshold. The impact would be similar on the lower-end threshold with increases in fatigue, distractions, or stress increasing the likelihood of errors.

Distraction:
Distractions can come from many sources including competing tasks, voices of others nearby, noise, and lights and reflections. When we are distracted, many areas of performance are affected. For workload, distraction moves the error threshold (either high or low), making it more likely that errors will occur.

Stress:
Our level of stress impacts the error threshold by moving the high-end threshold to the left – or moving the low-end threshold to the right – and making it more likely to commit errors for a given current level of workload. Stress can also increase the levels of fatigue and distraction enhancing their associated impacts as well.

What Can You Do?

1. **Understand the impact of the different factors related to workload**
   Everyone is different. Review and continue to try to understand how the current workload levels change for you in your work situations, which factors have more impact for you, and what you can do to recognise the current levels of workload and when you are getting close to the error thresholds.

2. **Be prepared**
- Stay current on your training and engage in getting new knowledge about incidents and situations you may not have yet encountered.
- Reduce your stress by having a regular exercise and relaxation routine.
- Manage your level of alertness by getting enough sleep, eating a well-balanced diet, staying hydrated and limiting your use of caffeine as an alertness strategy.

3. **Develop strategies to use while at work**
- Review and brief about the expectations for changes in workload situations – at the beginning of a shift and as expectations change.
- Recognise changes in workload and take steps to address their impact.
- Develop routines to keep yourself alert and reduce the risk of fatigue.
- Try to avoid the impact of distractions by coming to work prepared and ready to focus by employing the fatigue avoidance strategies mentioned earlier and taking a professional attitude to each work session.

Dr Beth Lyall
is founder and president of Research Integrations, Inc. For over 25 years she has been improving safety through the enhancement of human performance in design, certification, training, and operations in aviation and other safety critical domains by conducting and applying human factors research. She has served on a number of international aviation industry committees including the Flight Deck Automation Working Group.