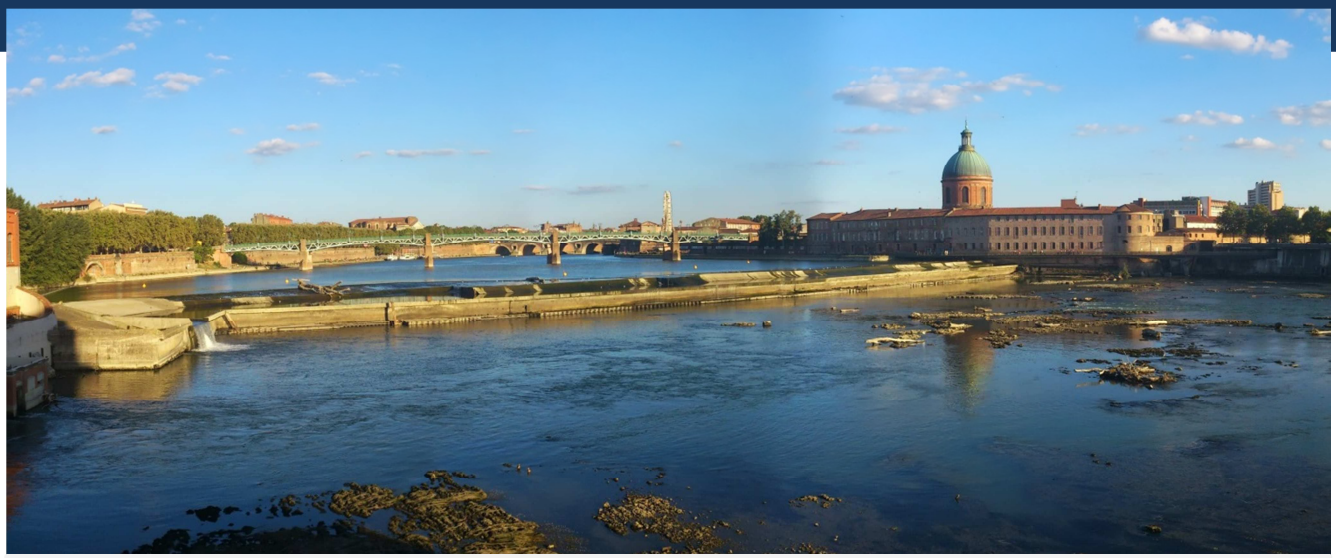

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Challenges and considerations for in-flight monitoring of pilots and crews

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Content

Human functional state assessment research has employed neurological, physiological and behavioral monitoring for several decades, but few real world applications have emerged in safety systems. For instance, physiological monitoring of flight crews is done experimentally, but is generally not available for normal operations despite safety incentives. This presentation will address critical challenges in research and development of monitoring solutions, and how they can be overcome. We will consider three applications: health monitoring in exploration class space mission crews; vigilance monitoring in civilian commercial airline crews; and pilot state assessment in military flight training.

The first critical challenge is the magnitude of required input. Multiple sensors are needed to capture a sufficient breadth of data to reliably document physiological state. Sensors must be robust, reliable, easy to place, unobtrusive, and able to function safely in the operational environment. We will show how systems can be implemented for the monitoring of vigilance of commercial crews.

The second challenge is signal integration. Following the capture of sufficient input, there must be effective integration to contextualize changes in a complex and dynamic system. Any single or related parameter can be influenced in complex ways, making meaningful analysis dependent on high level integration. For example, blink rate and eyelid closure may be related to fatigue or drowsiness, but light levels, local airflow, contaminants, and a host of other factors may also affect them. Similarly, heart rate may be related to arousal or workload, but it may also be influenced by a wide array of variables. We will demonstrate how trainees' progression can be quantified through the integration of complementary sensors in a military flight training scenario.

Meaningful interpretation requires both signal integration and strategies to overcome signal degradation and/or partial loss of input. The inherent "distance" between sensors and concepts is a critical consideration in signal integration. Qualitative concepts such as fatigue, acute stress, and engagement require assumptions, definitions, and relational matching to be operationally assessed. The process of formalization allows for the establishment of boundaries and patterns to characterize non-finite concepts. Proper pitch is essential, since both overly narrow and overly broad boundaries will reduce the utility and validity in the operational environment.

Signal degradation and other input compromises can be mitigated through multilayered analyses that include relational assessment of variable measures. We will illustrate this approach in a solution developed for monitoring astronaut health during extended space missions. Critical parameter identification and definition is important for the development of shareable platforms. We will discuss how this can be applied to physiological parameters and relations to help develop a reference structure useful to industry, regulators, and academia.

Keywords : Mental workload, Acute stress, Emotion, Fatigue