

# Creation of a Human-in-the-Loop Simulator Environment for Fifth Generation Stressor Research

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## ABSTRACT

The introduction of fifth generation platforms has led to a more information-driven air operation. It is characterized by the communication between different platform types within a mission and an increased operator autonomy due to improved information availability. Current research lacks understanding of the subtle differences between fourth and fifth generation stressors. Consequently, this requires additional knowledge on the interaction between stressors induced by fifth generation operations and human performance.

The fundamental challenge is to create a research environment in which (1) multiple fifth generation platforms operate together and (2) the equipment to measure impact of stressors on the operator is integrated. A second challenge is to generate scenarios that can be used in a research environment in which traditional (e.g. fourth generation) and potential new (e.g. fifth generation) stressors can be generated and manipulated. This paper describes the design of a research environment, which is suitable to measure the effects of these stressors.

The research environment consisted of an F-35 and an MQ-9 simulator with human operators. Mission scenarios were generated to simulate both traditional and potential new stressors. Workload and stress levels were measured using functional near-infrared spectroscopy (fNIRS), electrocardiography (ECG), and the NASA Task Load Index.

An experimental evaluation was carried out with former F-16 pilots using the developed missions and research environment. The evaluation results showed that the research environment can be used operationally and the equipment is able to measure impact of stressors on the operator. Furthermore, the environment allowed dynamic adjustment of scenario complexity during experiments, enabling adaptation to pilot performance. The research environment opens up possibilities for further generation specific stress-mitigation and training methodology development research. Ultimately, the study paves the way for future research on the impact of fifth generation platforms and operations on human performance.

## ABOUT THE AUTHORS

**Maykel van Miltenburg** earned his Master's degree in Applied Cognitive Psychology (MSc) in 2014 and is an Human Performance expert within Royal NLR's department of Safety and Human Performance. He participated in many of the recent Royal NLR's human-in-the-loop studies in the military domain. His expertise lies on measurement tools such as rating scales and a combination of (psycho)physiological measurements such as electroencephalography, functional near-infrared spectroscopy, electrocardiography and eye-tracking.

**Lodewijck Foorthuis** is an R&D Engineer at the Training & Simulation department of Royal NLR. He has a degree in Mechanical Engineering and Aerospace Engineering from Delft University of Technology. He specializes in simulator federations: using multiple simulators in one integrated environment. Currently, he is working on the integration of fourth generation and fifth generation platforms in the same federation.

**Rolf Zon** is a well-recognized Human Effectiveness researcher. He holds a Master's degree in Cognitive Psychology from Leiden University in the Netherlands. Prior to his employment in 1997 at the Royal NLR, Rolf worked with his own consultancy company. At the Royal NLR he works as a senior consultant on Human Effectiveness in the Safety and Human Performance department. His current and past activities encompass a wide variety of human factors related research areas such as: Validation, (team) Situational Awareness, (mental) Workload, Usability, Fatigue. Further, designing and running human-in-the-loop experiments is a recurrent theme in Rolf's involvement in NLR projects.