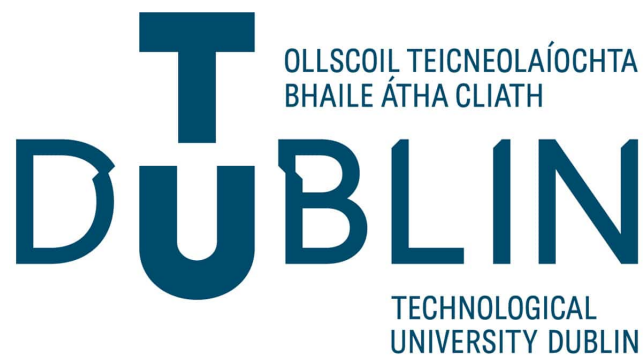




H-WORKLOAD
models & applications

The fifth International Symposium on
Human Mental Workload:
Models and Applications

Programme and Abstracts



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Day 1 - 24th of November, 2021

Welcome address 14:00-14:00

Dr. Chiara Leva, Dr. Luca Longo

Keynote 14:10-14:45 *Prof. Mark Young: In search of the redline: perspectives on mental workload and the ‘underload problem’*

For human factors researchers and practitioners, mental workload remains both a crucial concept and a nebulous one. After decades of work in this field, there is still no real consensus on the construct of mental workload, although there is wide agreement about its multidimensional nature and the main ways to measure it. With increasing automation in many domains, the issue of underload has attracted a considerable proportion of research effort. This paper summarises work to propose a theory of underload based on the notion of malleable attentional resources, but also raises challenges that this theory – and, perhaps, underload in general – may be specific to automation. The paper goes on to discuss the elusive ‘redlines’ of overload and underload, and concludes by considering both theoretical and applied challenges for current research into mental workload.

Session I 14:50-15:50 - Mental workload during COVID19: qualitative studies
[Chair. Dr. Chiara Leva]

14:50-15:10 - Suzanne Kelly and Maria Chiara Leva: *The Health Impact Of Remote Work During The Covid-19 Pandemic: A Quick Workload Snapshot From A Holistic Approach*

The declaration of the Covid-19 pandemic in March 2020 resulted in immediate remote work orders for millions of workers globally. The objective of this study was to determine the holistic health impact of remote work. In this study, mental workload was assessed using the Raw Task Load Index (RTLX). Higher RTLX scores were associated with a longer duration of remote work and increased availability of resources, with lower scores correlated with durations of remote work of less than 3 months. Higher RTLX scores were also associated with increased physical activity and pain, and lower overall satisfaction levels. Considering demographics, the highest RTLX scores were reported in the ‘no income’, full time worker and families with special needs groups. This research provides further evidence that high mental workloads can negatively impact mental and physical health. This methodology provides an efficient, cost effective and reliable method to holistically assess worker health remotely.

15:10-15:30 - Robert Houghton, Dalia Lister and Arnab Majumdar: *Examining Cognitive Workload during Covid-19: A Qualitative Study*

Covid-19 has caused a huge shift in the working environment, with people mandated to work from home where possible in the UK since March 2020. Cognitive workload is sensitive to environmental changes, so it’s possible that in moving from the office to working from home,

people's cognitive workload has been impacted. The research outlined presents findings from 11 interviews with office workers on whether their cognitive workload has been impacted due to changes in the working environment, consequence of Covid-19. Thematic analysis identified three themes that impact cognitive workload: The home environment, differing distractions and no longer having to commute. The paper finishes with a discussion of these themes in relation to cognitive workload and Covid-19 literature, as well as some recommendations on how employers should be flexible with employees to optimise workload.

15:30-15:50 - David Berney, Terry Byrne, Maria Chiara Leva, Karina Moody, Karen Bowden: *Physical and cognitive workload in factories that remained open during COVID 19: the benefit of considering the psycho-social factors.*

Ongoing research looks at identifying other factors, in addition to physical and cognitive workload which may be used to lever performance. This study took place in a meat processing factory in Ireland and looked at what occupational psychosocial factors were present and why workstation design was not enough to maintain acceptable levels of MSD and worker attrition. The sample cohort consisted of approximately 80 workers involved in a butchery process who used workstations previously redesigned to remove most physical risk factors, but overtime endured significant MSD and attrition rates. The study involved action research, mixed methods and cross sectional data, the NASA-TLX and COPSEQIII tools were used, baseline measurements were taken in Q4, 2019 and following an intervention involving a participatory job design exercise which adjusted perceived levels of control, using these tools the impacts were measured again in Q2, 2020. The intervention resulted in a reduction in head count, while positively effecting throughput, error rates, rework, MSD incidence, attrition rates, and occupational psychosocial factors, during the first wave of the Covid-19 pandemic in Ireland.

Coffee break 15:50-16:00

Session II 16:00-17:30 - Mental Workload Models and further developments

[Chair. Dr. Ivan Gligorijevic]

16:00-16:20 - Aidan Byrne: *Radical Connectionism – Implications for Mental Workload Research*

While Mental Workload has been widely described in terms of the limited power of a digital computer, this analogy is becoming increasingly untenable. More recently the philosophical concept of Connectionism and the computational model of Parallel Distributed Processing (PDP) have provided an alternative paradigm for Mental Workload which explains some of the unexpected findings in recent research. It also suggests both that cognitive overload is a common, everyday problem and one which is heavily dependent on the whole environment in which it is measured.

16:20-16:50 - Luca Longo, Murali Rajendran: *A novel parabolic model of instructional efficiency grounded on ideal mental workload and performance*

Instructional efficiency within education is a measurable concept and models have been proposed to assess it. The main assumption behind these models is that efficiency is the capacity to achieve established goals, at the minimal expense of resources. This article challenges this assumption via the presentation of a novel model that is grounded on ideal mental workload and performance, namely the parabolic model of instructional efficiency. A comparative empirical investigation has been constructed to demonstrate the potential of this model for instructional design evaluation. Evidence demonstrated this model achieved a good concurrent validity with the well-known likelihood model of instructional efficiency, treated as baseline, and a better discriminant validity for the evaluation of the training and learning phases. Additionally, the inferences produced by this novel model have shown to lead to a superior information gain when compared to the baseline.

16:50:-17:10 - Luka Bojović, Miloš Pušica, Aneta Kartali, Kosta Jovanović, Jelena Jovanovic and Bogdan Mijović: *Towards real-time Mental Workload Assessment from EEG using Convolutional Neural Networks*

Accurate, real-time and objective mental workload (MWL) assessment of human operators could help improve their performance and prevent accidents in safety critical situations. Despite the recent acceleration in the neuro-ergonomics research, that was brought by miniaturization of the neuro-imaging devices, the state-of-the-art performance in classifying MWL based on the electroencephalographic (EEG) data is still insufficient for the real-world applications. In this work, CNN-s were used to tackle the problem of creating an end-to-end learning model for reconstructing the level of Mental Workload that subjects experienced while performing the NASA MATB II task. Models were trained for 3-level and 4-level workload level classification problems. Obtained results confirm the suitability of CNN models for real-time estimation of the operators MWL, with the goal of developing a neuroadaptive system.

17:10-17:3 - Kunjira Kingphai and Yashar Moshfeghi: *The effect of EEG pre-preprocessing for mental workload level classification using deep learning models*

A high mental workload level could significantly contribute to mental fatigue, decreased performance, or long-term health problems (?). Recently, deep learning models have been trained on Electroencephalogram (EEG) signals to detect users' mental workload. While such approaches show promising results, they either ignore the noise element inherent in the EEG signal or apply a random set of preprocessing techniques to reduce the noise. Such a lack of uniform preprocessing techniques in cleaning the EEG signals would not allow the comparison of the effectiveness of deep learning models across different studies even when they use the data collected from the same experiment. Therefore, in this study, we aim to investigate the effect of preprocessing techniques defined by neuroscientists in the effectiveness of deep learning models. To do so, we focused on the preprocessing techniques that can be automated and do not need any human intervention, namely high-pass filtering, the ADJUST algorithm, and re-referencing. Using a publicly available mental workload dataset, STEW, we investigate the effect of these preprocessing techniques in three state-of-the-art deep learning models named Stacked LSTM,

BLSTM, and BLSTM-LSTM. Our results show that ADJUST has the most significant effect on the performance of our models compare to other steps. Our findings also show that EEG signals that were prepossessed using the high-pass filter ADJUST algorithm and re-reference provided the highest classification performance across the investigated deep learning models. We believe this paper provides an important step towards defining a uniform methodological framework for using deep learning models on EEG signals.

Day closing address 17:35-17:40

Dr. Chiara Leva, Dr. Luca Longo

Day 2 - 25th of November, 2021

Day Opening address - 09:00-09:10

Dr. Chiara Leva, Dr. Luca Longo

Session III 09:40-11:00 - Mental workload and well being
[Chair. Dr. Bujar Raufi]

09:40-10:00 - Jing Zhang, Andrew P Smith: *A new perspective on the effects of different types of workload on the wellbeing of a sample of Chinese workers*

Workload is a multi-faceted concept and can be incorporated into the well-being process. By adding new variables, namely a multi-dimensional demands measure and work-related rumination, this study developed a version of the Wellbeing Process including different aspects of workload. One hundred nine employees from a variety of other jobs in mainland China participated in the survey. The Wellbeing Process Questionnaire contained 38 questions measuring 11 dimensions. The results showed that the scales had good reliability. Analyses controlling for the combined effects of established predictors of well-being showed that work uncertainty had a negative impact on well-being. Affective rumination was negatively associated with well-being, whereas problem-solving pondering was positively associated with well-being. The combined effects of established predictors of well-being must be controlled when assessing the impact of other variables. When this was done, unpredictable job demands and rumination were shown to be associated with well-being.

10:00-10:20 - Jialin Fan, Juqing Liu and Andrew Smith: *Effects of perceptions of information overload, noise and environmental demands on wellbeing and academic attainment*

The present research investigated the relationship between workload, fatigue, and sleep quality of physicians and nurses in psychiatric hospitals by conducting a cross-sectional survey and a diary study. Both studies were conducted in China in early 2021, investigating the effect of workload on fatigue and sleep quality among psychiatric staff in a real-life setting. Study 1 was a cross-sectional survey, investigating 334 responses from physicians and nurses in five psychiatric hospitals, and Study 2 was a diary study examining the association between workload, fatigue and sleep quality in the working week of 48 psychiatric staff. The findings from the first study showed that the staff reported a high workload, and fatigue and poor sleep quality were very prevalent. Workload was the strongest predictor of fatigue. In the diary study, workload and fatigue increased over the week, and sleep quality declined. This research has identified the importance of studying workload and its effects on psychiatric staff.

10:20-10:40 - Hasah Alhenieidi and Andrew P Smith: *Exploring the Influence of Information Overload, Internet Addiction, and Social Network Addiction, on Students' Well-being and Academic Outcomes*

This study explored how students' main information problems during the information age, namely internet addiction, information overload, and social network addiction, influence holistic well-being and academic attainment. The participants were 226 university students, all UK

based and regular internet users. They answered the Internet Addiction Test, Information Overload Scale, Bergen Social Media Addiction Scale, and the Wellbeing Process Questionnaire. Data were analysed with SPSS using correlation and linear regression analysis. The univariate analyses confirmed the negative impact of information overload, internet addiction and social media addiction on positive well-being but not academic attainment. However, multivariate analyses controlling for established predictors of well-being showed that the effects of information overload, internet addiction and social media addiction were largely non-significant, which confirms other research using this analysis strategy. Future research should examine the type of internet use as well as the extent of it.

10:40-11:00 - Andrew Smith: *A combined effects approach to the Demands-Resources-Individual Effects (DRIVE) model of workload and well-being*

This article starts with approaches that examine single concepts and suggests this is not representative of the real-life situation. Theoretical approaches based on several dimensions are then discussed, with detailed coverage of the Demand-Resources-Individual Effects (DRIVE) model. Empirical research on the combined effects of occupational risk factors is also discussed. The well-being process model covered positive and negative predictors, appraisals and outcomes. The effects of the predictors are mainly independent and can be combined into a single score. The impact of new potential predictors can then be assessed with control for established predictors. The outcome measures can also be combined into a single score. Analysis of the individual components of the well-being process can still be made, but the single predictor and single outcome approach are simple and ideal for inclusion in studies examining the effect of other factors on well-being.

Coffee break 11:00-11:20

Session IV 11:20-12:40 - Mental workload in transport [Chair. Prof. Andrew Smith]

11:20-11:40 - Mário H. C. da Silva, Thiago F. Macêdo, Cinthia C. Lourenço, Ivan S. Rehder, Ana A. C. Marchiori, Mateus P. Cesare: *Mental Workload Verification in Military Pilots Using Flight Simulators and Physiological sensors*

This study evaluated the mental workload of military pilots when they are subjected to different flight conditions, during the day and at night using night vision goggles (NGV), in order to rectify and ratify the correction factor used for flights that use NGV. The task used in the experiment was a flight in a flight simulator with some common tasks done in military operations. During the activities, physiological data, specifically data on cardiac activity and galvanic skin response, were collected. After collection, the data were subjected to treatment in order to correct possible errors during data acquisition and later analyzed in the domains of time and frequency. The analysis did not show a great change in mental load between the day and night periods, which can be explained by the small sample, the small period between flights and the variations in the results of the sensors used.

11:40-12:00 - Bojana Bjegojevic, Maria Chiara Leva and Nora Balfe: *Objective Indicators of Train Drivers' Attention, Mental Workload, and Performance*

Train-driving is a safety-critical job involving a prominent disbalance in drivers' mental workload, affecting their attention and driving performance. Therefore, having objective indicators of these constructs is of great importance to improving railway safety. In this paper, we first discuss theoretical approaches to defining attention and mental workload, and their relationship, as a prerequisite to measuring these constructs in the train-driving setting. Adhering to the neuroergonomics approach, we present physiological indicators of different aspects of attention including alertness or arousal, and focused attention or engagement, relevant to train-driving context. Regarding the driving-performance indicators, we consider the use of On-Train-Data-Recorders (OTDR). We propose to validate and assess OTDR performance parameters in terms of their ability to capture variations in drivers' attention during driving, as indicated by particular physiological variables presented in this paper. That would allow for a greater exploitation of this system with the aim to improve railway safety.

12:00-12:20 - Bilal Khan, Maria Chiara Leva and Sam Cromie: *A systematic review of older drivers in a level 3 autonomous vehicle: A cognitive load perspective*

With current advancement in technology, it is expected and hoped that even a conditional or level 3 (L3) autonomous vehicle could alleviate older adults' mobility issues. These conditional or level 3 autonomous vehicles allow the driver to engage in non-driving task (NDRT), but, it can request the driver to assume control of the vehicle via 'Takeover request' when it has reached its operational limits. Considering this could be a challenging for older drivers with their declined cognitive, perceptual, and motor capacities. A systematic review has been conducted to produce literature on their issues in a L3 autonomous vehicle. This review mainly focuses on older drivers' challenges, perception of workload in AVs and takeover performance. This review is hoped to provide relevant literature on the subject and may help researchers improve and pursue research gaps identified in this paper.

12:20-12:40 - Maria Gabriella Pediconi, Michela Brunori and Glauco Maria Genga: *insight and shared resilience in the sky: How military pilots' master the unexpected from a dynamic perspective*

If unforeseen events are an integral part of military pilots' workload, the analysis of how pilots deal with the unexpected increases our knowledge of the Human Factor and provides information about the subjective factors of resilience. Our work presents a qualitative analysis - based on Freudian discoveries - of military pilots' testimonies about the most significant unexpected events of their career. We explore the Resilient Subjective Factor (RSF) as a subjective dimension that allows pilots to develop both a resilience as a trait in leading their daily tasks and performances and a shared resilience in facing the unexpected. We found that in mastering daily job as well as the unexpected, the Resilient Ego is based on realism and cooperative thoughts. The Resilient Ego in the sky feeds daily risky tasks with the affective relationships cared for on earth, even when pilots need to manage dangerous conditions. On the one hand we found that interpersonal thinking supports subjective perceptions during flight performances, giving a strong psychological support to the intuition (first insight) in managing the difficult decision making facing the unexpected.

Panel Discussion - 13:40-14:30 - Management of Operator Workload in Unmanned Aerial Systems, from Past to Future [Andrew Batty, Fiona Cayzer and Jake Green BEA Systems UK]

BAE Systems has been actively involved in UAS research programmes for many years, with human factors being integrated into the development of these systems. In this discussion forums, members of the BAES HF team along with representation from our Flight Operations Test Pilot community, will discuss some of the major projects of the past decade and the HF issues that were encountered. They will go on to discuss how the field is evolving, with greater need for one-to-many control philosophies and goal based systems to manage workload to control them. We will focus particularly on our work in the ASTRAEA programme, explaining the research conducted into integrating UAVs with civilian airspace. Questions around awareness, trust and transparency will be explored and how these all impact on the workload experienced by ground control station operators. We will also discuss the typical set up of Remotely Piloted Air Systems, which require multiple operators to perform discreet roles in what can be challenging environmental conditions. Moving into an exploration of the future, we will look at the way UAS are envisaged for use and what this means for human operators. Specifically, we will look at how we need to move from the traditional RPAS set up with multiple human operators controlling a single vehicle, to a situation where one human operator can control many vehicles. We will also look at how this might be achieved from settings outside the traditional ground control station and what this means for workload management. We will look at novel tools and techniques that could support operator workload management in these scenarios, including virtual agents and adaptive autonomy (including objective workload measurement through psychophysiological monitoring). Overall, the session will be aimed at highlighting to listeners that just because a system has ‘unmanned’ in its title, it doesn’t mean that there are no humans in the system. In fact, the HF challenges become, in many cases, more complex and nuanced.

Coffee break 14:30-14:45

Session V 14:45-16:10 - Mental workload and other applications

[Chair. Enrique Muñoz-de-Escalona]

14:45-15:00 - José Juan Cañas, Enrique Muñoz-de-Escalona and Jessica Morales-Guaman: *Fundamental frequency as an alternative method for assessing mental fatigue of distance learning teachers*

Online education is gaining ground in our society due to the introduction of new educational technologies and the pandemic situation we are experiencing. The experience is showing that online teaching makes an extra demand on mental resources as compared to face-to-face teaching. For this reason, we are in need of methodologies to measure this demand for resources in order to propose how to mitigate it. In this paper we propose a methodology based on acoustic voice analysis to measure the mental resource demand of teachers. This methodology is similar to that being used successfully in other fields. The advantages of this methodology are that it does not require any costly and intensive instrumentation to record and analyse data. The only two instruments that the methodology requires are a tape recorder and a software for analysing the

acoustic parameters of the voice that can be installed on the teacher's own computer.

15:00 - 15:20 - Maria Chiara Leva, Hector Diego Estrada-Lugo, Aoife Burns, Gernot Stubl, Thomas Hoch and Gerald Czech: *Teamwork between humans and AI informed automation: mental workload as a performance indicator*

In collaborative intelligence systems, we have considered deploying EEG measurement to support the assessment of the workload for the task before and after the intervention. The assessment is carried out after informed consent is given by the operators involved in accordance with legal and ethical obligations. The AI algorithm allows for the identification of any mental workload parameters that deviate the most from their expected values. This, in turn, supports the prediction of potential deviations and the identification of their root causes. One of the challenges in this work, is that, currently, there are no optimal curves for mental workload in the product injection process. However, they can be derived. To achieve the above the correlation between EEG spectral power and task complexity must be collected. An increase in frontal midline theta band (4-7 Hz) and a decrease in parietal midline alpha band (8 -12 Hz), would show that the task complexity has increased. A ratio between these two power bands is proven to be a reliable estimate of mental workload [8]. The identification of the factors affecting the human performance will work together with intelligent diagnosis system. In order to assess the value of the before and after AI intervention, first gather a current estimate of the time and effort needed to diagnose and correct defects, as they happen. After the teaming system check, the AI algorithm decision support is capable of correcting issues before they become a problem. This will decrease the number of defective parts produced as it allows the operator to correct the injection process early on, and/or allows for faster detection of root causes and therefore corrections. In this sense, a process map of both the process as it is and the to-be process after AI intervention should be provided. For this a plan of the process of detection, identification of root causes and possible solutions as it happens for one of the specific parts selected for this concrete use case is denied.

15:20 - 15:40 - Hector Diego Estrada Lugo and Maria Chiara Leva: *Mental workload influence on human reliability during crisis management for system resilience*

The advanced engineering systems that sustain a modern society is increasingly incorporating the resilience concept into the design process. A resilient system is not only capable of minimising failures but quickly recovering from the mishaps while preserving operative conditions [3]. A key component of a resilient system is the restoration process. This consists of a series of repairing and adapting actions that enable a system to respond to disruptive events to gain back the lost availability. There are multiple factors involved in the system recovery process. For example, complex engineering systems require the interaction of human operators, organisational policies, spare parts and maintenance personnel availability [4]. Despite the increasing automation and incorporation of artificial intelligence- based systems, the dynamic nature of human-machine interaction is crucial in an emergency scenario. Conditions such as situation awareness and mental work- load have been found to play an important role in determining the operator performance during dynamic threat scenarios [1]. In light of this, it is crucial to effectively assess how factors such as metal workload affect human performance as part of the recovery process of a resilient system. In this research, an integrated framework to quantitatively assess the effects of mental workload in the human performance within the control room of a nuclear power plant is introduced. The proposed technique is based on a novel machine learning

technique to incorporate time-changing human factors including their interactions with critical infrastructure in a resilience model for different threat scenarios [2]. The probabilities of successfully recovering the system upon a disturbance are computed through the resources of situation awareness and workload factors. Moreover, the model allows for the inclusion of aspects that influence human performance in the operating environment such as experience and stress level, quality of Human-Machine Interface as well as the time available to perform the recovery task. A number of scenarios are defined to study the resilience levels for different levels of mental workload and situation awareness. The results demonstrate the effects of mental workload and situation awareness of the operator within the system resilience during crisis management.

15:40-16:00 - Adrian Kelly, *Towards a General Model of Situational Awareness and Decision Making for the control room of the future*

Most models of situational awareness follow the maxim for all models – wrong, but useful. While the models developed in the last 70 years are unique; they then to be similar in several important ways, with focus on assessment and action. They tend to be static not fluid. They tend to be abstract, not useful to operators in real time situations and rarely useful to user interface designers or trainers. They typically stop at the point of decision making and support, wrongly defining situational awareness as a concept separate from the decision-making process, usually before the decision gets made and implemented. They disregard human cognitive aspects of normal operation, and some assume a state constant vigilance or hyper-vigilance, which does not reflect normal practice. This discussion and paper aims to address the limitations in existing situational awareness and decision making models for real time operations in high reliability organisations. A new ‘complete’ model is proposed, that combines the key aspects of existing models such as the Cooper Colour Code, Scan / Focus, What, So What Now What, Boyd’s OODA Loop, Endsley’s SA model and Cynefin. Critically, it combines the general situational awareness model with a combined model for both structured decision making (the Rasmussen Ladder) and recognition primed decision-making (Klein’s model for expert intuition). Crucially, it is grounded in the system 1 and 2 model of how the human mind works. The aim of the new model is to be useful to real time operators, showing why and where lapses, errors, mistakes and panic can occur. It is a fluid model, showing transition between states depending on how the mind is operating. Its intent is to be useful for user interface design, automation design and training. The aim of the talk and paper is to showcase it to the wider human factors and cognitive psychology community for the first time, to get feedback and refine, based on best practice and experience

Panel and community discussion 16:00-16:15 - Future Direction for H-workload symposium Future editions

Conference closing address 16:15-16:20

Dr. Chiara Leva, Dr. Luca Longo

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