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Denham L. Phipps, Thomas M. Blakeman, Rebecca L. Morris & Darren M. Ashcroft. *Mapping the territory of renal care: a formative analysis of the cognitive work involved in managing acute kidney injury*. Pages: 1117-1133.

The design and evaluation of healthcare work systems requires an understanding of the cognitive work involved in healthcare tasks. Previous studies suggest that a formative approach would be particularly useful to examine healthcare activities for this purpose. In the present study, methods from cognitive work analysis and cognitive task analysis are combined in a formative examination of managing acute kidney injury, an activity that occurs across primary and secondary healthcare settings. The analyses are informed by interviews with healthcare practitioners and a review of practice guidelines. The findings highlight ways in which the task setting influenced practitioners' activity, and ways in which practitioners approached the activity (for example, how they used data to make decisions). The approach taken provided a rich understanding of the cognitive work involved, as well as generating suggestions for the design of work systems to support the clinical task. **Practitioner summary:** Healthcare tasks often require decision-making in complex and dynamic circumstances, potentially involving collaboration across different practitioner roles and locations. We demonstrate the use of a formative analysis to understand the cognitive work in managing a clinical syndrome across primary and secondary care settings, and consider the implications for work design.

- **Keywords:** Cognitive work analysis, cognitive task analysis, decision making, healthcare ergonomics, ergonomics tools and methods

Ben R. Lane, Paul M. Salmon, Adrian Cherney, David Lacey & Neville A. Stanton. *Using the Event Analysis of Systemic Teamwork (EAST) broken-links approach to understand vulnerabilities to disruption in a darknet market*. Pages: 1134-1149.

Darknet markets provide an anonymous, online platform for users to trade illicit drugs, fraudulent identity data, and other commodities. Although law enforcement agencies have been successful in seising many markets, the Darknet is an agile and dynamic

environment and market activities often persist and emerge in a new form. Given this constantly changing environment, new ways of disrupting darknet markets are required. This study used Event Analysis of Systemic Teamwork (EAST) to analyse market activity and understand vulnerabilities to disruption. This involved using the EAST broken-links approach to assess the effects of compromising the transmission of information between tasks and between agents. The analysis identified critical vulnerabilities in the system, which included information involved in registering, depositing funds, communicating listing details to buyers, and communicating dispute resolution messages. This study indicates that systems ergonomics methods—in particular, EAST—can provide insight into system vulnerabilities that might be targeted for disruption. **Practitioner summary:** This study provides a conceptualisation of the processes, people, structures, and information involved in the buying and selling of goods on a darknet market. Law enforcement agencies may use broken-links analyses to systematically consider the effects of their interventions.

- **Keywords:** Broken links, cryptomarket, Darknet, Event Analysis of Systemic Teamwork, sociotechnical systems

Cyrus K. Foroughi, Ciara Sibley, Noelle L. Brown, Ericka Rovira, Richard Pak & Joseph T. Coyne. *Detecting automation failures in a simulated supervisory control environment*. Pages: 1150-1161.

The goal of this research was to determine how individuals perform and allocate their visual attention when monitoring multiple automated displays that differ in automation reliability. Ninety-six participants completed a simulated supervisory control task where each automated display had a different level of reliability (namely 70%, 85% and 95%). In addition, participants completed a high and low workload condition. The performance data revealed that (1) participants' failed to detect automation misses approximately 2.5 times more than automation false alarms, (2) participants' had worse automation failure detection in the high workload condition and (3) participant automation failure detection remained mostly static across reliability. The eye tracking data revealed that participants spread their attention relatively equally across all three of the automated displays for the duration of the experiment. Together, these data support a system-wide trust approach as the default position of an individual monitoring multiple automated displays. **Practitioner Summary:** Given the rapid growth of automation throughout the workforce, there is an immediate need to better understand how humans monitor multiple automated displays concurrently. The data in this experiment support a system-wide trust approach as the default position of an individual monitoring multiple automated displays.

- **Keywords:** Automation, automation failures, human-automation interaction, supervisory control, attention allocation, system-wide trust, eye-tracking

John Taverniers & Joel Suss. *A user-centred assessment of a less-lethal launcher: the case of the FN 303® in a high-pressure setting*. Pages: 1162-1174.

The present study explored the usability of a less-lethal launcher from the end-user's perspective. A within-subjects field experiment (N = 16) tested the FN 303® in a lab condition, enabling optimal firing conditions and in a high-pressure simulated operational condition (SOC). Results showed that the high-pressure SOC, which was both psychologically and physiologically challenging, provoked significantly more subjective workload and substantial increases in cortisol biomarker secretion. Importantly, the SOC had a deleterious effect on participants' shooting accuracy at a static target at 30 m. Moreover, as might be expected, accuracy was affected, notably in the hazardous vertical y-axis. Finally, the SOC significantly influenced participants' perception of the overall usability of the FN 303®. These findings, combined with reduced accuracy, could become

critical factors during real-life crowd control operations. To the authors' knowledge, no empirical work has tested less-lethal launchers from an end-user's perspective. Recommendations are made with regard to the selection, training, skill maintenance, and design. A less-lethal launcher was tested under two conditions (lab vs. simulated operational condition). Workload, salivary cortisol as a biomarker, shooting accuracy, and the weapon's perceived usability were measured. Increased workload led to reduced vertical accuracy, even at 30 m distance. Also, the reported usability of the less-lethal launcher was significantly lower in the simulated operational condition.

- **Keywords:** Cortisol, crowd control, less-lethal launcher, usability, workload

Errol R. Hoffmann & Colin G. Drury. *Models of the effect of teleoperation transmission delay on robot movement time.* Pages: 1175-1180.

Recent research of [Scholcover and Gillan (2018)] has shown experimentally that system transmission delay has a linear effect on the time taken to perform a complex tracking task with a simple teleoperated robot. This note shows that, for the case of moving a robot through a straight path, this relationship is predicted. The result is a simple modification of Drury's law to take into account the system delay. This work extends the model for performance under intermittent illumination of Drury to the effects of fixed delays in task performance, occurring with teleoperated robots. In all cases, there was empirical evidence for the predicted linear relationship. **Practitioner summary:** When there is a delay in system response for robotic teleoperation between a control input and system output, movement time (MT) is increased and the increased times are linearly related to the system delay. This is true for zero and first-order control and for delays occurring before and after the control action.

- **Keywords:** Teleoperation, robots, Drury's law

Nicola C. D. Armstrong, Amanda Ward, Mitch Lomax, Michael J. Tipton & James R. House. *Wearing body armour and backpack loads increase the likelihood of expiratory flow limitation and respiratory muscle fatigue during marching.* Pages: 1181-1192.

The effect of load carriage on pulmonary function was investigated during a treadmill march of increasing intensity. 24 male infantry soldiers marched on six occasions wearing either: no load, 15 kg, 30 kg, 40 kg or 50 kg. Each loaded configuration included body armour which was worn as battle-fit or loose-fit (40 kg only). FVC and FEV1 were reduced by 6 to 15% with load. Maximal mouth pressures were reduced post load carriage by up to 11% (inspiratory) and 17% (expiratory). Increased ventilatory demands associated with carrying increased mass were met by increases in breathing frequency (from 3 to 26 breaths·min⁻¹) with minimal changes to tidal volume. 72% of participants experienced expiratory flow limitation whilst wearing the heaviest load. Loosening the armour had minimal effects on pulmonary function. It was concluded that as mass and exercise intensity are increased, the degree of expiratory flow limitation also increases. **Practitioner Summary:** This study investigated the effect of soldier load carriage on pulmonary function, to inform the trade-off between protection and burden. Load carriage caused an inefficient breathing pattern, respiratory muscle fatigue and expiratory flow limitation during marching. These effects were exacerbated by increases in mass carried and march intensity.

- **Keywords:** Load carriage, pulmonary function, operating lung volumes, fit

Michelle Nicole Brown, Rachel Michelle Mei Ling Char, Shawn O. Henry, Jenna Tanigawa & Shelyce Yasui. *The effect of firefighter personal protective equipment on static and dynamic balance.* Pages: 1193-1201.

Firefighters work in unpredictable conditions, necessitating the use of personal protective equipment (PPE). However, the additional weight from the PPE and self-contained breathing apparatus (SCBA) alters their centre of mass (COM), restricts movement and limits vision (face mask) contributing to a firefighters' challenge of maintaining balance. Thus, the purpose of this study was to quantify the effects of firefighter PPE on static and dynamic balance. Participants performed two sets of three functional balance tests: (1) Static Single Leg (SSL); (2) Dynamic Single Leg (DSL); (3) Limits of Stability (LOS). The balance tests were performed under one control and three randomised PPE conditions: (1) athletic clothing; (2) turnouts; (3) turnouts + SCBA; (4) turnouts + SCBA + face mask. Our study found turnouts + SCBA both with and without the face mask negatively affected dynamic balance. These findings identify factors in fall-related injuries and strategies to reduce occupational risk. **Practitioner summary:** Slips, trips and falls are the most common cause of injury in firefighters. Our study investigated the effects of firefighter personal protective equipment (PPE) on static and dynamic balance utilising a computerised balance instrument. We found that turnouts with a self-contained breathing apparatus (SCBA) with or without face mask negatively affected balance.

- **Keywords:** Postural stability, turnout gear, protective clothing, falls, Biodex Balance System

Katie A. Goggins, Marco Tarabini, W. Brent Lievers & Tammy R. Eger. *Standing centre of pressure alters the vibration transmissibility response of the foot.* Pages: 1202-1213.

Vibration-white foot as an occupational disease has underscored the need to better understand the vibration response of the foot. While vibration transmissibility data exist for a natural standing position, it is anticipated that weight distribution will affect the response. The purpose of this study was to determine the effects of changes in centre of pressure (COP) on the foot's biomechanical response. Twenty-one participants were exposed to vertical vibration of 30 mm/s, with a sine sweep from 10–200 Hz. Z-axis (vertical) vibration was measured at 24 locations on the right foot, with the COP shifted forward or toward the heel. A mixed model analysis at each location revealed significant differences ($p < .001$) in the transmissibility response when the COP was altered to the forefoot and rearfoot. In general, the peak frequency of the average vibration response increased for a region of the foot when the COP was shifted toward that region. **Practitioner Summary:** Altering the centre of pressure location resulted in changes in the transmission of vibration through the foot. The forward lean position was associated with the greatest amplitude of vibration transmissibility at the toes. This information is relevant for clinicians studying vibration-induced white-foot and engineers designing protective equipment.

- **Keywords:** Foot-transmitted vibration, resonant frequency, centre of pressure

Samantha E. Pritchard, Calvin T. F. Tse, Alison C. McDonald & Peter J. Keir. *Postural and muscular adaptations to repetitive simulated work.* Pages: 1214-1226.

Complex repetitive tasks are common in the workplace and have been associated with upper extremity disorders. The purpose of this study was to examine the progressive effects of highly repetitive work on joint kinematics and muscle activity of the trunk and upper extremity. Fifteen healthy men performed 60 one-minute cycles of 4 simulated automotive-related tasks. Electromyography of eight muscles and kinematics of the trunk and right upper extremity were collected. Data were analysed at 12-min intervals and divided into a complete work cycle. The time to complete the work cycle decreased by 6.3 s over the trials. Peak shoulder flexion decreased and peak elbow flexion increased during the work cycle. Muscle activity magnitude and variability was influenced by time during the repetitive tasks. This study found adaptations to highly repetitive but light

work in only 1 h; redistributing muscle demands within the shoulder over time may reduce muscle fatigue development. **Practitioner Summary:** While the work was not strenuous, we were able to demonstrate muscular and postural adaptations in a single hour of simulated work. By evaluating both the whole work cycle and the sub-tasks, we aim to develop new methods for evaluating the risk of complex tasks in prolonged repetitive work.

- **Keywords:** Repetitive movement, posture, upper extremity, surface electromyography

Ronald L. Snarr, Emily L. Langford, Greg A. Ryan & Sydni Wilhoite. *Cardiovascular and metabolic responses of active sitting while performing work-related tasks.* Pages: 1227-1233.

Stability balls and active-balance sitting chairs have recently emerged as a way to reduce sedentary behaviours in office settings. The purpose of this study was to determine differences in caloric expenditure and heart rate between a standard chair (SC), stability ball (SB) and active balanced sitting chair (ST) while performing work-related tasks. Participants (n = 20) performed a 10-minute randomised reading and typing task while sitting on the SC, SB and ST. For both the reading and typing tasks, heart rate (HR), caloric expenditure per minute and metabolic equivalents were all significantly greater (i.e. 6–13%; 19–40%; 18–39%, respectively) while using the ST when compared to the SC and SB. No significant differences were observed between the SB and SC for any of the comparisons. The ST produced a greater HR response and caloric expenditure than the SC or SB, indicating that active balanced sitting may be a feasible way to increase energy expenditure in an office setting. **Practitioner summary:** The purpose of this study was to determine differences in cardiovascular and metabolic responses to various forms of office chairs. The key finding was that active sitting on a balance chair significantly increased heart rate and caloric expenditure as compared to a stability ball and standard chair.

- **Keywords:** Stability ball, active workstation, standing desk, energy expenditure

Diane Gyi, Annabel Masson & Sue Hignett. *Plus size and obese workers: anthropometry estimates to promote inclusive design.* Pages: 1234-1242.

A significant proportion of the adult population globally is overweight, obese or classed as 'plus size'. This has led to variability in size and shape across the working population and exclusion in the workplace. A new dataset of the anthropometry of plus size people has been created. Length dimensions were similar to other data, but breadth, circumference, and depth measurements were substantially larger. The hip breadth and abdominal depth were important for predicting largeness in this population. These data help explain the high exclusion rates from design and the number of fit, reach, posture and clearance issues reported by participants with a high BMI: generally, the higher the BMI the greater prevalence of problems. It is hoped that a better understanding of the anthropometric characteristics of the plus size worker will inform the design of safe, productive work environments to promote inclusion for a wider range of people. **Practitioner Summary:** A new anthropometry dataset of plus size people has been created. The higher the BMI the greater the problems with design in the workplace for fit, reach, posture and clearance. To ensure inclusion and reduce stigma it is important to understand more about the size and shape of this population.

- **Keywords:** Anthropometry, workplace design, obesity, overweight, architectural design