

Institution: University of Gloucestershire		
Unit of Assessment: UoA 04, Psychology, Psychiatry and Neuroscience		
Title of case study: Quantitative analysis of situation awareness (QASA).		
Period when the underpinning research was undertaken: 1999 - present		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Graham K. Edgar	Professor of Psychology and Applied Neuroscience	2002 – present
Steven Baker	Academic Course Leader – Psychology	2016 – present
Dianne Catherwood	Emeritus Professor of Psychology	2000 – 2015
David Brookes	Technician – Psychology	1998 – present
Period when the claimed impact occurred: 2005 - present		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact		
<p>Research undertaken by Professor Graham Edgar and co-researchers has led to the development of a world-leading approach to the measurement of situation awareness (SA). Good SA underpins effective human performance in almost any context. The measurement methodology incorporates unique, theoretically robust, measures and is referred to as QASA (Quantitative Analysis of Situation Awareness) or (formerly) QUASA. QASA has been applied across multiple domains, and has been adopted by users worldwide, particularly in the domain of firefighting, where QASA has been developed into a training tool referred to as Firemind and, as such, has been incorporated into firefighter training in the UK and Netherlands.</p>		
2. Underpinning research		
<p>Situation awareness is widely regarded as one of the key issues for human factors, and one of the world's leading researchers in the field (Mica Endsley) was, until recently, chief scientific adviser to the US Chief of Staff. Failures of SA are often identified as a key factor underlying major errors and catastrophic accidents that carry enormous human and financial cost. Situation awareness is fundamental to good performance and decision-making in any context.</p> <p>There have been many techniques developed for the measurement of SA, that measure either actual situation awareness (knowledge of a situation compared to the, 'ground truth') or perceived situation awareness (how good or bad an individual <i>believes</i> their SA to be). The QASA approach⁶, originally developed by Edgar within the military domain while employed by BAe Systems, measures both actual and perceived situation awareness, together with another measure that is unique to the QASA tool and provides a measure of information use (bias) – a key component of the process of building SA.</p> <p>The underpinning research for QASA spans a wide range, from fundamental neuroscience³ through cognitive psychology⁶ to applied research^{1,2,4,5}.</p> <p>QASA, originally developed in the military domain, has been refined and applied in areas including health, education, driving, and fire and rescue. A strength of the QASA approach is the strong theoretical underpinning; something that is relatively under-developed in many SA measures. The tool is underpinned by research in the new area of 'neuroergonomics' funded by</p>		

a grant won from the Ministry of Defence's 'Competition of Ideas.' This has led to the publication of one of the first ever papers linking SA to the underpinning neuroscience³.

The QASA approach was tested initially within a military command and control simulation⁷, providing an explanation for the cognitive processes that may underpin, 'friendly fire', and was then successfully applied in highly realistic army brigade-level simulations and international tri-service disaster relief simulations (findings unpublished due to security considerations). The unique bias measure within QASA gave insights (that there are individual differences in information use when building SA) that would not have been obtainable with any other current measure.

A finding that information is used selectively when building SA drove the application of the QASA approach in the health domain⁵, where missing key information can lead to poor patient outcome, particularly in the domain investigated (obstetrics). This research was funded by a grant from Great Western Research and United Bristol Healthcare. A key finding of this research was, again, that individuals use available information in different ways when building SA and also that interruptions are a key factor in lapses in SA.

The application of QASA in the domain of firefighting has been supported by two Erasmus+ grants generating a body of research^{1,2,4,G} on individual and cultural differences in situation awareness and an [online training tool](#) has now been implemented to allow firefighters and trainers to access the tool remotely and to use it to either self-test or incorporate into formal training sessions. A paper describing the approach, produced in collaboration with stakeholders across Europe, has been published in premier international professional publications for firefighters^{1,4}.

3. References to the research

- ¹Arendtsen, B., Baker, S., Bertels, M., Brookes, D., Catherwood, D., Christiansen, K., Cuypers, W., **Edgar, G.**, Krawczynska, S., Maes, V., Sallis, G., Stegienko, K., Van Craybex, G., Vastmans, J., Vorenkamp, F., Weewer, R., & Wenarski, G. (2016, November). Firemind: Trialling a new tool for training fire and rescue service decision-making. *International Fire Professional*, 14-17. [Note – author-order is alphabetical].
- ²Catherwood, D., **Edgar, G. K.**, Sallis, G., Medley, A., & Brookes, D. (2012). Fire Alarm or False Alarm?! Decision-making "Bias" of Firefighters in Training Exercises. *International Journal Emergency Services*, 1(2), 135-158.
- ³Catherwood, D., **Edgar, G. K.**, Nikolla, D., Alford, C., Brookes, D., Baker, S., & White, S. (2014). Mapping brain activity during loss of situation awareness: an EEG investigation of a basis for top-down influence on perception. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 56(8), 1428-1452.
- ⁴Catherwood, D., et al. (2011). "Understanding fireground 'situation awareness'." *Fire* **103**(1333): 27-29.
- ⁵Davis, S., **Edgar, G. K.**, Strachan, B., Bahl, R., & Catherwood, D. (2015). *Loss of Situation Awareness Linked to Interruptions during Cardiotocograph Monitoring in a Day Assessment Unit*. Paper presented at the British Maternal and Fetal Medicine Society 17th Annual Conference, London.
- ⁶**Edgar, G. K.**, Catherwood, D., Baker, S., Sallis, G., Bertels, M., Edgar, H. E., Nikolla, D., Buckle, S., Goodwin, C., & Whelan, A. (2018). Quantitative Analysis of Situation Awareness (QASA): Modelling and Measuring Situation Awareness using Signal Detection Theory. *Ergonomics*, 61(6), 762-777. doi:10.1080/00140139.2017.1420238

⁷Edgar, G. K., & Edgar, H. E. (2007). Using Signal Detection Theory to Measure Situation Awareness: The Technique, The Tool (QUASA), the TEST, the Way Forward. In M. Cook, J. Noyes, & Y. Masakowski (Eds.), *Decision making in complex environments* (pp. 373-385). Aldershot, UK: Ashgate.

4. Details of the impact

The QASA approach was first developed in the military domain and it is here that it has been adopted by others to look at a range of real-world issues such as:

- Improving SA in single-ship naval anti-air warfare and also measuring SA in anti-submarine warfare helicopter crew (ASW) where the approach was well accepted ^E.
- The impact of collaborative work support systems in a large-scale military experiment with Canadian Forces officers ^I.
- Performance in a digital warfighting exercise ^H.
- Situation awareness within the context of a realistic command-and-control scenario ^F.

The QASA approach has also been used by other workers in non-military scenarios such as:

- Improving CCTV security surveillance ^J.
- Developing effective human-robot interaction in teleoperated systems ^B.

The QASA approach has been widely adopted by other researchers and, to quote a paper in the area ^F,

'QUASA, as developed by Edgar et al. (2000, see also Edgar et al. 2003) is, currently, one of the most frequently used method of collecting and analysing data on SA.'

The QASA approach has now been developed into a tool designed for use in firefighter training. The development of this tool was supported by an EU grant under the EU Erasmus+ scheme and the tool is referred to as, '[Firemind](#).' Firemind research has been accepted for publication in professional fire and rescue publications^{1,4}. Papers have been published in International Fire Professional (IFP), the Journal of the Institution of Fire Engineers - a global organisation for fire professionals established in 1918 and also in 'Fire' magazine (established in 1908), the leading magazine for firefighters, distributed to fire services nationally and internationally.

The Firemind approach was presented at the Annual Conference on Fire-related Research and Development, UK, where it was awarded the Research Excellence Award (best paper) sponsored jointly by Gore Associates (a large, multinational company) and Fire magazine^G. A publication² in the International Journal Emergency Services was an Outstanding Paper Award Winner.

Firemind, was developed initially with the UK Fire and Rescue service.^{2,G}. The introduction of the world-leading methodology into the training of incident commanders generated transformational changes for the end-users. UK incident commanders that took part in the

training reported changes in their day-to-day practice of incident command^G. Firemind has now been further developed across six other countries (Belgium, Denmark, Estonia, The Netherlands, Spain and Poland). The Firemind tool has revealed differences in information processing across the firefighters in the different countries¹. As a result of the Firemind research two members of the unit (Edgar and Baker) were invited to attend an EU-funded Exchange of Experts on the topic of mental strength, and to present a paper to a symposium on SA, hosted by the Institute for Safety (IFV) that is responsible for developing and implementing the training of firefighters in the Netherlands.

Firemind has been used by IFV Netherlands in a longitudinal study of firefighter SA^A and has been incorporated into the training of Firefighters in the Netherlands^{C,D}.

Members of the UoA (Edgar & Baker) have again successfully bid into the EU Erasmus+ scheme to fund a development of the Firemind tool ([Firefront](#)) that expands the tool to measure situation *understanding*, as well as situation *awareness*. Firefront involves two of the original Firemind partners (Belgium and the Netherlands) together with 4 new partners (two new partners from Denmark, Estonia and Spain). All of the EU partners are actively involved in the training of firefighters.

The Firefront training scenario has now been migrated to an [online platform](#) and is available as a self-contained package that can be used by firefighters and trainers worldwide, either to self-test (the package gives detailed and individualised feedback on performance) or to incorporate into formal training.

5. Sources to corroborate the impact (indicative maximum of 10 references)

^A Bomhof, L. (2017). *Experience says it all! Or not..?: Situation awareness on the fire ground*. MPsy, University of Twente.

^B Gatsoulis, Y., Virk, G. S., & Dehghani-Sanij, A. A. (2010). On the measurement of situation awareness for effective human-robot interaction in teleoperated systems. *Journal of Cognitive Engineering and Decision Making*, 4(1), 69-98. doi:10.1518/155534310X495591

^C Hazebroek, J. C. Senior researcher/project manager, Institute for Safety (IFV), Netherlands. *Letter of support*.

^D Hazebroek, J. C., et al. (2015). "Situational incident command in the Fire Service." *Instituut Fysieke Veiligheid, Brandweeracademie*.

^E Lamoureux, T. Senior Consultant – Human-Systems Integration/Human Factors Engineering Defence & Security CAE Inc., Kanata, Canada. *Emails on use and impact of QASA*.

^F Rousseau, R., Tremblay, S., Banbury, S., Breton, R., & Guitouni, A. (2010). The role of metacognition in the relationship between objective and subjective measures of situation awareness. *Theoretical Issues in Ergonomics Science*, 11(1/2), 119-130.

^G Sallis research: Sallis, G. (2015). How does bias/scope influence the operational outcome of pressurised incident command decisions and can it be countered? PhD, *University of Gloucestershire*. Associated paper in professional publication: Sallis, G., Catherwood, D., Edgar, G., Brookes, D., & Medley, A. (2013). The human brain in fireground decision-making: trustworthy firefighting equipment? *International Fire Professional*(5), 21-24.

^HThomas, J. A. (2008). *Network Science: Observations from the Omni Fusion 2007 Digital Warfighter Exercise Simulation Experiment*. Paper presented at the 13th International Command and Control Research and Technology Symposia (ICCRTS 2008), 13th International Command and Control Research and Technology Symposia (ICCRTS 2008).

^ITremblay, S., Breton, R., Vachon, F., & Allen, D. (2012). *Support of collaborative work in battlespace management: Shared (loss) of situation awareness*. Paper presented at the Cognitive Methods in Situation Awareness and Decision Support (CogSIMA).

^JVachon, F., Vallières, B. R., Suss, J., Thériault, J.-D., & Tremblay, S. (2016). *The CSSS Microworld: A Gateway to Understanding and Improving CCTV Security Surveillance*. Paper presented at the Human Factors and Ergonomics Society 2016 Annual Meeting.