Impact case study (REF3b)

Institution: University of Bath

Unit of Assessment: B11 Computer Science and Informatics

Title of case study: Collaboration research influencing Defence and Security Policy, Strategy and Stabilisation Operations

1. Summary of the impact (indicative maximum 100 words)

Peter Johnson's research on collaboration and autonomous systems has been adopted by the MoD Defence Science and Technology Laboratory, through both collaborative research and his appointment to advisory roles. This has led to impact on defence and security policy and strategy, with a primary focus on "Humans in Systems". Specific points of impact are:

a) In **Cyber Influence & Stabilization**, Johnson's Life-Story research provided a conceptual framework for collecting and organizing information on people and groups to support stabilization efforts in unstable regions;

b) In **Human Capability Science & Technology**, Johnson's Autonomous Systems and Human-Computer Interaction research influenced the strategic direction, requirements setting and allocation of resources on the £11.6M Human Capability Research Programme;

c) In the organisation of **DSTL's engagement with research**, Johnson's advice and involvement resulted in the development of, and commitment of resources to, a formal Visiting Scientist scheme.

2. Underpinning research (indicative maximum 500 words)

The research underpinning this case study was led by Peter Johnson (Professor at Bath since 2000) from 2004 onwards. Johnson's work concerns understanding and supporting *HCI in Complex Systems* including where collaboration occurs between groups of people and between people and autonomous systems, with continued support from BAe Systems and EPSRC.

Johnson and Coughlan, his research student and later PDRA at Bath from 2006, investigated technology support for creative groups through the development of models of *collaborative creativity* [1,2,3]. This work argued that creative interaction can be usefully viewed in terms of i) Productive Interaction: focused engagement on the development of a creative outcome, ii) Structural Interaction: the development of the structures in which production occurs, and iii) Longitudinal Interaction: the long-term development of resources and relationships that increase creative potential. These perspectives were used as a basis for the design of tools to support such interactions. A prototype tool for supporting collaborative creativity grew out of this work and formed the beginning of the "Life Stories" approach in the impact described below.

Johnson and his colleagues also investigated human-automated systems where failures have occurred that have often been attributed to human error or poor display design. On investigation, Johnson was not satisfied with the explanations and assumed causes. Previous analyses had largely considered the human as the operator or controller of the automation. However the automation technology had advanced faster than the human-factors understanding, such that the technology was not merely carrying out tasks but making decisions and invoking actions. For example, modern aircraft comprise complex collaborative systems of humans and automated agents working together to fly the aircraft. Johnson's work systematically investigated this new paradigm for human/automation interaction, developing original insights into human-system behaviours, novel design solutions and improved human-system performance. For example, [4] showed how errors previously thought of as display mode errors, resulting in fatal air disasters, are better and more fully explained and mitigated by understanding awareness of the context of decisions by the auto-pilot and the human pilot. Novel design features that increased the human pilots' awareness of the decisions that had been made, their contexts and intended consequences were shown to reduce errors significantly.

Johnson and his team went on to develop a framework for collaboration that links models of the different structures of the collaborating teams, roles, tasks, and resources, providing a basis for the design, support and management of complex collaborative systems that can be applied and tested in various real world settings. In [5] they developed the concepts of "collaborative flow" and

"working as one" as descriptive expressions of what good collaborative teamwork can be in such scenarios, and demonstrated the utility of their framework in modelling and supporting collaboration in complex system structures.

3. References to the research (indicative maximum of six references)

[1] * Hourizi R. & Johnson P. (2004) Designing to support awareness: a predictive, composite model. ACM CHI Conf. Human Factors in Computing Systems,159-166. [DOI:10.1145/985692.985713]

[2] Johnson P, Hourizi R, Carrigan N & Forbes N, (2010) A Framework to Manage the Complex Organisation of Collaborating: Its Application to Autonomous Systems, EPTCS, vol 16: Proc. Second Workshop on Formal Aspects of Virtual Organisations. [DOI:10.4204/EPTCS.16.5]

[3] * Coughlan, T. & Johnson, P. (2006) Interaction in creative tasks: ideation, representation and evaluation in composition. ACM CHI Conf. Human Factors in Computing Systems, 531-540.[DOI:10.1145/1124772.1124854]

[4] * Coughlan, T & Johnson P. (2009) Understanding productive, structural and longitudinal interactions in the design of tools for creative activities. ACM CHI Conf. Creativity and Cognition, 155-164.[DOI:10.1145/1640233.1640258]

[5] Middup, C., Coughlan, T. & Johnson P. (2010) How Creative Groups Structure Tasks Through Negotiating Resources. Proc. ECOOP 2010 9th International Conference on the Design of Cooperative Systems, 203-221.
http://coop.wineme.fb5.uni-siegen.de/proceedings2010/12_cMiddup_et_al_203_222.pdf

* marks the outputs best indicative of the quality of underpinning research

4. Details of the impact (indicative maximum 750 words)

Since 2009, Johnson has been working with the Ministry of Defence (MoD), the Defence Scientific Advisory Council (DSAC), and the Defence Science and Technology Laboratory (DSTL), transferring the findings of his research to inform defence and security policy, strategy and practice. He has:

a. developed and delivered a software tool that repurposes his research on collaborative creativity [1,2,3] to provide support to stabilization efforts

b. influenced the strategic direction and allocation of resources within the Human Capability Research Programme to reflect his work on collaboration between people and systems [4,5]

c. demonstrated the value to DSTL of direct engagement with academics and other external establishments, resulting in the development of the DSTL Visiting Scientist scheme and other commitments of resources.

a) Cyber Influence & Stabilisation: the LifeStories environment and tool
The Government's National Security Strategy (NSS) highlights the risk to UK security due to instability: "Fragile, failing and failed states around the world provide the environment for terrorists to operate as they look to exploit ungoverned or ill-governed space". As part of the responses to the threat from unstable countries, the NSS states that the UK will "help resolve conflicts and contribute to stability". To this end the NSS identifies eight National Security tasks, of which one is "Tackle at root the causes of instability". This concern is emphasized in the Strategic Defence and Security Review, which details the threats associated with instability, and notes that the cost of military intervention is far greater than that of tackling instability before it flares up into violence.

The Ministry of Defence became interested in Johnson's work in 2009 when he was invited to attend a two-day invitation only workshop in Whitehall ("Counter Terrorism Attack The System") on novel approaches to counter terrorism. He outlined how his research in understanding and supporting collaboration could be relevant to understanding tribal structures and relationships in unstable countries. He was subsequently asked to provide a more detailed report and presentation

to MoD in February 2010. In this report he developed the ideas from [1,2] to suggest how they could be used to build and share life-stories of people and groups in other cultures.

The ongoing operation in Afghanistan and the International Stabilisation Response Team in Libya identified challenges with the current way in which UK stabilisation practitioners operate. Given the large amount of data gathered and the speed with which practitioners operate it is critical to gather, assess and exploit information rapidly. In addition, being able quickly to review previously gathered information linked to an individual, location or situation both increases the impact of the personnel and enables them to understand incidents or actions more rapidly and accurately. As demonstrated in Afghanistan and Libya, stabilisation is a multi-agency activity, employing both military and civilian personnel, so the ability to work across organisation boundaries and share information rapidly is essential. Currently this is done using paper notebooks. This quickly becomes unwieldy and it is difficult to search for pertinent information or to make new links in a timely manner.

Johnson's report to the MoD in February 2010 detailed how re-purposing his work on the Digital Scrapbook developed in [1,2] could assist with this facet of stabilisation operations. In February 2011 DSTL awarded funding to develop a prototype of the proposed tool. This work produced a prototype digital scrapbook, a user manual and training guide, delivered in May 2011. In June 2011 Johnson ran a short training course for DSTL on how to use the scrapbook to develop life stories of people, villages, and their activities and contexts.

The MoD have since used the ideas taken from the life-story modelling tool in the Cyber Influence and Stabilisation part of the DSTL Cyber and Influence Science and Technology Centre (https://www.dstl.gov.uk/cyberandinfluence) to develop awareness and understanding of people, villages and activities in different cultures, for use as a "get you in" pack for military personnel on stabilization operations. The scrapbook ideas showed how to improve information collection and availability to the military, increasing the links between different pieces of information and providing a more accessible, readily intelligible, portable and effective source of information. This enhances the stabilization efforts. Further work by DSTL resulted in a range of tools being evaluated during "Exercise Civil Bridge" carried out for one month in 2012 in Uganda involving military and civil personnel. Johnson's life-story concepts were used as the benchmark on this exercise.

A principal scientist from the DSTL Cyber and Influence centre confirms that "*this tool was also shared with military stabilisation practitioners and utilised for contingency training. The concept of displaying and linking information in easy to view schemas is becoming more widely utilised across the military and Prof Johnson's research has provided some of the underpinning foundations for this.*" [S1]

b) Advisory work influencing *Human Capability Science & Technology* investment
Johnson's work has had a direct influence on the direction and allocation of resources within DSTL's Human Capability Research Programme (http://www.defencehumancapability.com/). This programme represents a significant contribution to defence research in human capability, with a budget of £11.6M in 2012/13, coordinated by BAe Systems. The programme currently represents 225 research contracts awarded to 190 research suppliers across SMEs, large businesses and academia. Johnson's advisory work has taken place as part of his 20% secondment to DSTL [S2].

Johnson was the academic member of the Technical Assessment Panel "*helping to review and select a bidder for the provision of MoD's future Human Sciences research*" [S3]. He went on to "*shape and influence the governance of the programme through his engagement in the Programme Governance Board, working with MoD and the supply chain to evaluate the successes and issues with the programme*" [S3].

Johnson's research has played a key role in the specification, award and assessment of the contracts within the programme. He has established the need to focus on Humans in Systems from a broader behavioural and social perspective. For example, he has drawn on the findings of [4] to influence the programme in favour of work that treats humans not as operators but as collaborators with autonomous systems (AS). His autonomous systems work [5] has been used to advise DSTL in the focus of their programme away from one-person:one-AS ways of working, towards one-person:many-AS and mixed teams of people:AS. The framework, model and recommendations in [5] provided a reference point to focus DSTL on issues of command, reporting and information sharing between these mixed and one:many teams to achieve greater awareness and reduce

human cognitive load. [S4] states that Johnson's work and influence have *"ensured that the confluence of cyber and traditional infrastructure engineering was considered in a social and sociotechnical context. This raised the value of the work significantly as critical infrastructures exist to provide a service to humans and it is not clear that this would have been captured by the other participants."*

[S3] states that *"Peter has provided valuable input to a the Human Capability Steering Group, helping our military stakeholders understand where research may play a role in solving their problems, but also by signposting where there is already work available to support an appropriate intervention – or where research would not be appropriate. He has helped to push the thinking of this community away from their 'here and now' perspective to a longer term view which will facilitate longer term research programmes with more stable requirements. He plays a key role in the assessment and down-selection of technical programmes of work within the new external delivery mechanisms, and provides a valuable insight into work ongoing within academic Departments MoD would otherwise not be sighted on."*

[S1] confirms that *"Prof Johnson has been instrumental in supporting the Influence and Stabilisation programme at DSTL. This includes providing independent expert scientific advice to help challenge suppliers of research to DSTL – including the likes of QinetiQ. This ensures that the technical standard of work supplied to the military is rigorous and robust. […] This means that maximum value is achieved from both research council funding (which is exploited) and for the military, who can take output from researchers and apply it to real world problems in defence and security. Input from Prof Johnson has already been applied to ongoing military stabilisation activities overseas – directly supporting HMG objectives."*

c) DSTL Distinguished Visiting Scientist

In his DSTL Distinguished Visiting Scientist role Johnson has influenced DSTL policy towards a Centre of Excellence in the Social and Behavioural Sciences by helping establish the need and defining its relationship to external organisations including academia. Johnson has also influenced DSTL's broader engagement with academia, advising DSTL on their activities with research councils and their national PhD scheme launched in 2011, and developing with DSTL staff the DSTL Visiting Scientist scheme. [S4] thanks Johnson for his work to *"create a more formalised, rational, visiting scientist scheme."*

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

S1. Statement from Principal Scientist, Cyber and Influence Programme, DSTL Porton Down.

S2. Secondment - Counter Terrorism, Cyberinfluence, Information Management and Innovations; £68153 awarded to P. Johnson from DSTL since January 2012.

S3. Statement from Domain Leader, Human Dimension and Medical Sciences, DSTL Porton Down.

S4. Statement from Senior Principal, DSTL Porton Down.