Institution: University of Derby
Unit of Assessment: Psychology, Psychiatry and Neuroscience (UOA 4)
Title of case study: The impact of cognitive ergonomic research on design, industry and policy
1. Summary of the impact (indicative maximum 100 words)

Cognitive ergonomics research helps understanding about how people use information, instructions and guidance about consumer products. Research conducted in the Centre for Psychological Research has enabled real-world improvements in the design and presentation of product information. One strand of research provided the first evidence about the psychology of flat pack self-assembly products, with significant impacts on industry policy and good practice, and on public awareness and understanding. Another strand of research provided evidence about how people use traffic light food labelling systems, enabling consumers to make more informed health-related choices about food products, with significant potential health benefits. The research was included as key evidence in policy statements that led to the introduction of a Health Star Rating food label system in Australia.

2. Underpinning research (indicative maximum 500 words)

Self-assembly task complexity

The researchers produced a method to quantify and predict the complexity of a self-assembly object. The premise was that the characteristics of the assembly object influence the complexity of assembly and the assembly instructions. The research identified how physical attributes of an assembly could be linked to cognitive workload and therefore assembly complexity. The research into assembly task complexity began with a generic task analysis of assembly. The goal of object assembly was divided into identifiable sub-operations that were then linked to aspects of human cognition to hypothesise task variables (assembly characteristics) that could be linked to cognitive load and complexity (Richardson et al., 2004).

In the two experiments reported by Richardson et al. (2006), these physical characteristics of assembly objects, or 'task variables', were systematically varied in a balanced fractional factorial and orthogonal design. Participants were observed carrying out a range of abstract and real-world assembly tasks that varied in task variable levels and involved different materials. To assess the complexity of each assembly, the time participants spent thinking about the assembly was calculated. A relationship between physical characteristics and assembly complexity was found in both experiments, and the regression model from the first experiment was able to predict the complexity of assemblies in the second experiment. The regression model provides a tool to evaluate the complexity of assemblies or assembly steps defined by instructions. This methodology and the predictive models of assembly complexity can be a tool for designers during the design and evaluation process to ensure self-assembly products are not too complicated for consumers. Such a process can be performed before the self-assembly product goes for more expensive user evaluation or to the market place. The methodology can also be used to inform consumers of the likely complexity of a self-assembly product and of an estimated time of assembly.

Nutrition labelling

In a computer based study, participants completed a pre-task questionnaire before making healthiness ratings for two types of nutrition label: standard versus standard plus 'traffic lights'. Upon completion participants completed a post-task questionnaire. The use of traffic light labelling — placing red, yellow, and green circles to signify large, medium, and small amounts respectively of fats, sugars, and salt — increases the frequency with which people can identify healthier products (Jones and Richardson, 2007). This was some of the first evidence worldwide to make

clear how traffic light systems confer significant ergonomic benefits in terms of consumer ability to make more informed choices about food products.

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

1. Jones, G., and Richardson, M. (2007). An objective examination of consumer perception of nutrition information based on healthiness ratings and eye movements. *Public Health Nutrition*, 10, 238-244.
   [This paper, submitted by the University of Derby for RAE 2008 in UOA 44, led to the authors being invited by the Food Standards Agency to discuss the implications of the research. There are 66 citations on Google Scholar as of October 2013, and the paper is in the top 20 of the most cited papers published that year in the journal.]
2. Richardson, M. (2007). Errors, accidents and self-assembly products. In P.D. Bust (Ed.), *Contemporary Ergonomics*. Taylor and Francis.
   [This report, of an Office for National Statistics survey of over 1,200 consumers, provided the first national evidence of problems, injuries and impairment associated with self-assembly products.]
3. Richardson, M., Jones, G., and Torrance, M. (2004). Identifying the task variables that influence perceived object assembly complexity. *Ergonomics,* 47, 945-964.
   [This paper, submitted by the University of Derby for RAE 2008 in UOA 44, presents the first two studies from Richardson's PhD research, where innovative methodologies were used to investigate a previously under-researched issue.]
4. Richardson, M., Jones, G., Torrance, M., and Baguley, T. (2006). Identifying the task variables that predict object assembly difficulty. *Human Factors*, 48, 511-525.
   [This paper, submitted by the University of Derby for RAE 2008 in UOA 44, presents the third and fourth studies from Richardson's PhD research, and led to a great deal of media coverage, industry interest and a book chapter published in 2011.]

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

Self-Assembly task complexity

Self-assembly, or ready-to-assemble (RTA), products are very common and a survey of UK consumers by the Office for National Statistics showed that they can lead to frustration and injury for consumers and product return costs for industry (Richardson, 2007). Dr Miles Richardson is the leading expert in research on the complexity of self-assembly tasks, and his research is timely because there are several international policy developments to improve product standards using research evidence. This includes a major current European effort by CEN and CENELEC (the European standards organisations) to improve the way that research informs the development of standards (http://www.cencenelec.eu/research). The Council of the International Standards Organisation (ISO) oversees the work of a consumer policy committee (ISO-COPOLCO). In the UK, the British Standards Institution (BSI) is the gateway to European and international committee work on standardisation.

Dr Richardson's formal role in the international policy-making process began when BSI's Consumer and Public Interest Manager, External Policy, was approached by the Product Safety Working Group of ISO-COPOLCO. This group were aware of Dr Richardson's research and wished to obtain research-based evidence to inform a proposal to produce standards and guidance for self-assembly instructions, in order to help make self-assembly products safer, easier to use, and more reliable. For business, the standards and guidance will be strategic tools which reduce costs by minimizing waste and errors and increasing productivity. They will help companies to access new markets, level the playing field for developing countries, and facilitate free and fair global trade.

As a result of the recognition of Dr Richardson's research and its potential impact, Dr Richardson was invited in 2012 to become one of just six members of ISO-COPOLCO (PSWG subgroup - Inadequacies of Instructions for Assembly and Maintenance in the IEC 82079), and as a result, Dr

Richardson is now a Background Technical Expert in the BSI's Consumer and Public Involvement Network (CPIN).

The Project Manager at DIN (the German Institute for Standardisation), who leads the Task Group developing the proposal, commented: "Several problems consumers have with self-assembly products are well documented thanks to Dr Richardson's research. This helps to raise the problem on a European and global level where the problem has been discussed with experts representing consumers' interests on an international level. His research contributes also to draw conclusions and work out solutions which are discussed in the standardisation work."

Dr Richardson has also been approached by LEGO, a major manufacturer of children's toys involving self-assembly, who had accessed his research on self-assembly complexity and wished to learn from him "how to make the building experience of LEGO models even better, but also how building with LEGO can help children develop in maths and science."

Dr Richardson published an invited chapter on assembly complexity and the design of self-assembly products for the 2011 book *Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques*. This chapter explains to designers and other users how to incorporate human factors and ergonomics principles and knowledge into the design of consumer products in a variety of self-assembly applications. With contributions from a team of researchers from 21 countries, the book covers the current state of methods and techniques of product ergonomics. It provides an increased knowledge of how to apply human factors and ergonomic principles to obtain improved product design.

Dr Richardson's research on self-assembly has already received considerable media attention (e.g. The Independent, 2010), which takes the impact of the research to the wider public, and Dr Richardson is approached for expert advice by those working on issues related to self-assembly. For example, he was consulted in August 2012 for a BBC business documentary dealing with the flat pack furniture market.

Nutrition Labelling

Research by Jones and Richardson is often cited as key evidence to support policies for mandatory front-of-pack (FOP) 'traffic light' nutrition labels. For example, the research was included in a major review of evidence prepared for the US Department of Health and Human Services to "help guide the Food and Drug Administration in its future policy decisions regarding FOP labelling" (Anater et al., 2012, p. ES-7; see also Hersey et al., 2011). In June 2012 and July 2013, the research was used as key evidence in public notices by the Assistant Commissioner for Policy, US Food and Drug Administration, of proposals for laboratory and in-store studies of how consumers view and process label information, and how label information and components influence purchasing decisions (Kux, 2012; Kux 2013).

The research was included as key evidence in policy statements in Australia and New Zealand. These include a policy position statement by the Royal Australasian College of Physicians. Based on the evidence reviewed, which included research by Jones and Richardson, this recommended that "Federal regulations be put in place in Australia and New Zealand to provide for mandatory 'Traffic Light' labelling on the front-of-packaging of food and beverages sold in these countries" (Royal Australasian College of Physicians, undated, p. 1). Also, the research was included in a review of evidence about food labelling produced by the New Zealand Agencies for Nutrition Action, which made recommendations to inform policy for more standard food labelling in New Zealand (Lyon, 2012). This has resulted in policy change, with representatives from these organisations being included in a Project Committee established by the Australian government's Food Regulation Standing Committee (FRSC) to develop the front of pack labelling (FoPL) system. Final recommendations for a FoPL scheme were made February 2013 and on Friday 14 June 2013 the Commonwealth and state and territory food and health ministers announced that a Health Star Rating system would be introduced on food labels to help shoppers make healthier choices (Australian Government Department of Health, 2013).

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

Self-Assembly Task Complexity

1. Personal correspondence from the Consumer and Public Interest Manager, External Policy, British Standards Institution (BSI), and the German Institute for Standardisation (DIN), about the contribution that the research has made to ISO's work to develop international standards for self-assembly instructions.
2. The Consumer Insight and Experience Innovation department at LEGO have contacted Dr Richardson to obtain further information about the self-assembly research.
3. Recent national media coverage includes:
   - The Daily Mail, June 2010: http://www.dailymail.co.uk/sciencetech/article-1288177/Why-flat-pack-furniture-mentally-challenging-adults-Lego-children.html#ixzz1IGYf5jce
   - The Independent, August 2010: http://www.independent.co.uk/property/house-and-home/leaders-of-the-flatpack-selfassembly-furniture-is-reinventing-itself-as-clever-sustainable-and-stylish-2063284.html
4. Several publications have followed from the underpinning research, helping to increase the impact of the original work. For example:
   Richardson, M. (2011). Assembly complexity and the design of self-assembly products. In W. Karwowski, M. Soares, and N.A. Stanton (Eds.), *Handbook of Human Factors and Ergonomics in Consumer Product Design: Methods and Techniques* (pp. 187 -200). CRC Press. ISBN 978-1-42004628-1.
   [This chapter provides designers with research based guidelines to reduce assembly complexity and a novel method to evaluate and predict assembly complexity. The work therefore contributes to the reduction or prevention of difficulty, harm and return costs.]

Nutrition Labelling

5. Anater, A.S., Wohlgenant, K., Cates, S., Hersey, J., Muth, M.K., Zaccaro, D., and Zhen, C. (2012). *Evaluation Planning and Tools for Front of Package Nutrition Labeling: Final Report* (RTI Project Number 0212050.020.000.001). Prepared for the Department of Health and Human Services, Office of the Assistant Secretary for Planning and Evaluation, Office of Science and Data Policy, Washington DC.
6. Australian Government Department of Health (2013).*'Front-of-pack labelling' update*. http://www.health.gov.au/internet/main/publishing.nsf/Content/foodsecretariat-front-of-pack-labelling-1
7. Hersey, J.E., Wohlgenant, K.C., Kosa, K.M., Arsenault, J.E., and Muth, M.K (2011). Policy Research for Front of Package Nutrition Labeling: Environmental Scan and Literature Review: Final report (Contract No. HHSP23320095651WC). Prepared for the Department of Health and Human Services, Office of Assistant Secretary for Planning and Evaluation, Office of Science and Data Policy, Washington DC.
   http://aspe.hhs.gov/sp/reports/2011/fopnutritionlabelinglitrev/index.shtml or http://aspe.hhs.gov/sp/reports/2011/FOPNutritionLabelingLitRev/
8. Kux, L. (2012). Eye-tracking experimental studies to explore consumer use of food labelling information and consumer response to online surveys. *Federal Register* 77, 116 (June 15, 2012), 35983-35985.
9. Kux, L. (2013). Eye-tracking experimental studies to explore consumer use of food labelling information and consumer response to online surveys. *Federal Register* 78, 128 (July 3, 2013), 40153-40156.
10. Lyon, J. (2012). *Evidence Snapshot: Food labelling*. Agencies for Nutrition Action. http://www.ana.org.nz/)
11. Royal Australasian College of Physicians (undated but since 2009*). Mandatory Front–of-Pack "Traffic Light Labelling" on Food and Beverages A Policy Position Statement by the Royal Australasian College of Physicians*. Royal Australasian College of Physicians. (http://www.foodlabellingreview.gov.au/internet/foodlabelling/submissions.nsf/lookupSubmissionAttachments/1ATAN-85JVSB20100518094116DMLO/$FILE/448a.pdf)