

Submitted by William Marck Stahl-Timmins of the Peninsula Postgraduate Health Institute to the Universities of Exeter and Plymouth as a thesis for the degree of Doctor of Philosophy in the visual presentation of health technology assessment data and information, January 2011.

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Signed:

(Will Stahl-Timmins)

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0.3 Abstract

This thesis addresses the question of the design, production and use of information graphics in health technology assessment (HTA). Drawing on previous research in both information design and health policy, it describes a comprehensive design process for creating new visual presentations that can inform health policy-makers.

The thesis begins by introducing, and functionally defining the terms 'information graphics' and 'health technology assessment' in Chapter 1. It then offers a methodological discussion of how research can be performed at the intersection between these two diverse fields. This discussion forms Chapter 2 of the thesis.

The context of use is surveyed in two studies, which are presented in Chapter 3. These assess the current use of information graphics in HTA, and the information needs of health policy decision-making bodies. This enables a needs-based approach to the design of 10 information graphics, that could be used in HTA. These are shown in Chapter 4.

Finally, two of these information graphics are empirically tested with two further research studies, forming Chapter 5 and Chapter 6.

The thesis is aimed at giving practical advice to those wanting to produce graphical presentations of information in HTA, and to provide the foundation for further original research in information design and HTA. Chapter 7 draws together the research from the rest of the thesis, to make recommendations in light of the combined findings.

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0.4 Thanks

This PhD thesis is not the work of one person, but of many. Without the assistance of the following people, the volume would be much diminished:

ssistan	ce of the following people,	the volume would be much diminished:	1	Introduction
Supervisory team	Martin Pitt Rob Anderson Ken Stein	I am immensely grateful that you have recognised the potential of visual communication of scientific data. Your patient support and guidance through the last three years and more has enabled me to produce this work. If I have got science, it is thanks to you. I look forward to working with you in the future.	1 1.1 1.2 1.3 1.4 1.5 2 2.1 2.2 3	Introduction Information graphics HTA Potential functions Problem domain Research question Methodology Discussion Process model Context
Peninsula College of Medicine and Dentistry	Stuart Logan	Thank you for your valuable feedback through my transfer and Annual Research Events, Your astute critiques	3.1 3.2 4 4.1 4.2 4.3 5 5.1 5.1 5.2	Current use Information needs Design
	Nicky Britten PenTAG	of the project have focussed it greatly. You have made me feel like one of the		Elements Specification Development
	Technology Assessment Group)	are a strong group, and I will miss your questioning minds and sharp wits enor- mously. (And all the cake, of course)		Prototype test 1 (GOfER) Introduction Methods
	Gabriel Rogers	Thanks for sharing your information communication challenges with me, which ultimately enabled me to base my designs on actual needs rather than ones I imagined in the bathtub.	5.4 5.5	Qualitative results Conclusions
	Mary Bond Tiffany Moxham		6 6.1 6.2	Prototype test 2 (soc) Introduction Methods
	Ruth Garside	For being there to bounce ideas off, and advising me throughout my studies. Your deep knowledge of your fields never ceases to amaze me.	6.3 6.4 6.5	Qualitative results Conclusions
	Roy Powell		7.1 7.2 7.3	Summary Conclusions Future research
	Jaime Peters		8 A	Appendices Methodological study
	Jenny Lowe	For putting up with my endless binding and printing demands, you have my thanks. Also, for booking my accommodation and travel around Europe, and generally looking after me (and keeping the tea and biscuits flowing).	B C D	NICE interview data GOfER graphic GOfER test script
	Jo Perry		Е F G	GOFER test transcript GOFER test data SOC graphic
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	Bernice Wilmshurst	For patiently keeping me on course	0.3	Abstract
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nued)	Katie Hill	requirements of postgraduate study in		Definitions
		the School.	0.7	Abbreviations
nti			1	Introduction
ပ္ပ	Pam Rosenthall	For keeping my unconventional IT needs	1.1	Information graphics
Δ		letting me get on with the bits I could	1.2	HTA
Ň	Paul Field	do myself. And for providing an	1.3	Potential functions
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	Darren Russell	on my latest gadgets to.	1.5	Research question
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	Rupert Frankum		2.1	Discussion
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		at the end of a long journey. I won't say	3.2	Information needs
	John Vines	we are unscathed, but we have survived	4	Design
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	Vicki Goodwin	as appropriate.	4.2	Specification
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	Becky Rose		5	Prototype test 1 (GOfER)
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ndi	Chris Fox		5.2	Methods
Ţ.	Sarah Danfard		5.3	Quantitative results
¥ہ کہ	Saran Denford		5.4	Qualitative results
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	Mike Timmins	Vvvvan-Jones, etc. I will always owe	6.2	Methods
		everything to you.	6.3	Quantitative results
	Lynda Stahl		6.4	Qualitative results
	Allison McFarland	For putting up with the huge demands on my time that this PhD has required, and distracting me when I needed it most. If I have any shred of sanity	6.5	Conclusions
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		remaining now, it is thanks to you.	7.3	Future research
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	Eric Kindel	and the others at Reading University's Department of Typography and Graphic Communication, especially the Otto and Marie Neurath Isotype Collection. You	0.3 0.4 0.5 0.6	Abstract Thanks Author's declaration Definitions
External contacts		guard the traditions of our field, and do so with great sensitivity and openness.	0.7	Abbreviations Introduction
	Peter Jones	and the other staff and students at Plymouth's BA (Hons) Graphic Communication with Typography course, for giving me a platform to begin to develop my teaching skills. I found even a small quantity of teaching support exhausting but enormously rewarding. I was very pleased to be able to play a tiny part in the creative development of such engaging and interesting young minds.	1.1 1.2 1.3 1.4 1.5 2 2.1 2.2 3 3	Information graphics HTA Potential functions Problem domain Research question Methodology Discussion Process model Context Current use
	The participants in my studies:	I wish that I could name you all without breaching the terms of my ethical research permission from the university. Without your input, I would have no research on which to base this PhD. Thank you for offering your time, insight, encouragement, suggestions and expertise.	3.1 3.2 4 4.1 4.2	Information needs Design Elements Specification
	advisors The researchers at PenTAG and ScHARR		<mark>4.3</mark> 5 5.1 5.2	Development Prototype test 1 (GOfER) Introduction Methods
	The hundreds that took part in the online study		5.3 5.4 5.5 6	Quantitative results Qualitative results Conclusions Prototype test 2 (soc)
	HTA researchers worldwide	You do challenging, sometimes misunderstood, but greatly important work. I feel privileged to have come to understand a little about your field.	6.1 6.2 6.3 6.4 6.5	Introduction Methods Quantitative results Qualitative results Conclusions
	Information designers	Lastly on this list, but in no way last in my mind, I would like to thank those that have taken it upon themselves to inform and explain using visual communication. Thank you for helping to make my life colourful, fascinating, and full of beautiful information graphics.	7 7.1 7.2 7.3 8	Discussion Summary Conclusions Future research Appendices
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0.5 Author's declaration

The six original research studies presented this thesis, in Chapters 3.1, 3.2, 4, 5 6, and Appendix A, are all my own work. Two studies have been published as joint works, which require a statement of my involvement in the research:

Pitt, M., Stahl-Timmins, W., Anderson, R., & Stein, K. 2009, *Using information graphics in health technology assessment: Toward a structured approach,* International Journal of Technology Assessment in Health Care, vol. 25, no. 04, pp. 555–563.

The content analysis research for this study was performed by myself at an early stage of my PhD. All data collection, analysis and visual presentation of data were performed by me. The idea for the study was, however, that of my Director of Studies, Dr Martin Pitt. He also produced the original draft of the paper, using sections from a report on the study written by myself. The other two authors and myself each made comments on the draft before submission.

Stahl-Timmins, W., Pitt, M., Peters, J., Stein, K. & Anderson, R. 2010, *Graphical presentation of data for health policy decisions: An exploratory online decision task experiment to measure effectiveness,* Information Design Journal, vol. 18, no. 3.

The research study was designed, programmed and analysed entirely by myself. Statistical work and graphical presentation of results were also carried out by me. I also drafted the paper, which the other authors were kind enough to comment on and edit. Dr Peters checked the statistical work, but did not make any major revisions.

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0.6 Definitions

Appraisal Committee (NICE) – The meeting at which guidance on the use of a health technology in the UK's national health service is discussed.

Arm – This term is used both in relation to mathematical modelling and clinical trials. The arms of a Markov model are different simulations which are run so that they can be compared with each other. The arms of a clinical trial relate to different groups of participants, who would usually be given different interventions, so that they can be compared.

Confounder – A factor that influences the results of a trial, and potentially introduces bias, such as having flawed randomisation.

Confidence interval – A statistical measure, giving a range of values and a stated degree of certainty. Commonly, this range represents an area within which there is 95% probability that the true population mean may be found, as estimated from a sample of this population (Field, 2005).

Cycle – The unit of time into which a Markov model is separated, commonly a week or a month in HTA.

Discrete event simulation – A way of producing a mathematical model, in which simulated patients are represented individually.

EVPI (expected value of perfect information) analysis – A calculation of the amount you would be willing to pay for perfect information (if that were possible).

Forest plot – A graphical presentation specifically developed for presenting meta-analyses. These charts give a summary of the weight and direction of scientific evidence (see Chapter 4.2.8.1).

Hazard ratio – A statistical measure of the hazard, or risk of an event, with reference to an explanatory variable – such as the risk of death with reference to which of two interventions was received.

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Health technology – "The drugs, devices, and medical and surgical procedures used in medical care, and the organizational and supportive systems within which such care is provided." (Office of Technology Assessment 1978)

Intervention – A health intervention can be a drug, device, surgical procedure, screening programme, public health campaign or organisational change.

Markov model – A mathematical modelling technique commonly used in HTA. In this technique, cohorts of people are simulated, allowing transitions between health states to be represented by flows between states.

Model (modelling, modeller) – In HTA, a mathematical model is a simulation of a cohort of imagined people, used to extend the length of trials.

Parallel coordinates – A way of showing data with many attributes on a single set of axes. See Chapter 4.2.3: Graphic 3 – Parallel coordinates for probabilistic sensitivity analysis.

Scalability – In information visualisation literature, this term refers to whether a visual presentation would be suitable for a much larger or more complex data set than the example with which it is presented.

State – A state in a Markov model is a grouping of units that fulfil particular criteria. In HTA, simulated people commonly move between states when experiencing different health events, such as undergoing surgery, disease progression or death.

Systematic review – A way of giving an overview of an area of research, by systematically searching databases of published scientific evidence. See Chapter 1.2.1 – A brief history of HTA.

Technology (as in context of 'health technology assessment') – See *Health technology*.

Vector-based files – Vector-based files, such as PDFs, can be enlarged and resized, as they are recorded as a series of mathematical functions, rather than on a pixel-by-pixel basis, as in bitmap (or raster) file formats such as JPEG and TIFF).

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0 1 Overview

0.7 Abbreviations

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GOFER – Graphical Overview for Evidence Reviews	1	l
HTA – Health technology assessment	1.1	
in a freuth technology assessment	1.2	. '
INAHTA – International Network of Agencies for Health Technology	1.3	, F
Assessment	1.4	F
ISPOR - International Society for Pharmacoeconomics and Outcomes	2	
Descent	2 21	Г
Kesearch	2.1	' F
MCV – Multiple Coordinated View (a method of linking interactive displays	2.2	
together and presenting them on the same screen)	ა 21	0
Nutional Harlth Commiss (com)	3.2	i li
NHS – National Health Service (UK)	1	
NICE – National Institute for Health and Clinical Excellence (UK)	4	F
TAR Technology assessment report (UK UTA)	4.2	. 5
TAR - Technology assessment report (OK HTA)	43	
OTA – Office of Technology Assessment (USA)	5	F
PSA – Probabilistic Sensitivity Analysis	5.1	- h
	5.2	. N
soc – State Occupancy Chart	5.3	C
υκ – United Kingdom (of Great Britain and Northern Ireland)	5.4	. (
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