

<p>Institution: Aston University</p>
<p>Unit of Assessment 11: Computer Science and Informatics</p>
<p>Title of case study: The GRiST computer decision support system: a new tool for assessing and managing risks associated with mental-health problems.</p>
<p>1. Summary of the impact The Galatean Risk and Safety Tool (GRiST) is a clinical decision support system (CDSS) conceived and developed by computer scientists at Aston University from 2000 onwards, where it is being delivered as a cloud-computing service. It is used every day by mental-health practitioners in the NHS, charities, and private hospitals to assess and manage risks associated with mental-health problems. Between 1/1/2011 and 31/7/2013, clinicians provided 285,426 completed patient risk assessments using GRiST. It has changed organisational and clinical processes by its systematic collection of risk information, explicitly linking data to clinical risk judgements, and showing how those judgments are derived. Increasing international awareness has come through presentations to mental-health practitioners in Europe, America, and Australia.</p>
<p>2. Underpinning research Mental-health problems are experienced by one in four people every year and are associated with risks of suicide, self-harm, harm to others, neglect, and vulnerability. In Europe, fourteen people per 100,000 take their own lives despite 40% having seen their GP within the previous month. Detecting risks is difficult because it requires specialist training and risk communication is hampered by assessment tools currently recording unstructured data that is not easy to process or share by machines. GRiST addresses these problems by using validated mental-health expertise to produce a web-based system that helps people with or without mental-health training to collect data systematically, evaluate risks, and provide appropriate advice.</p> <p>The key innovation of GRiST software is its psychological model of classification for representing human expertise within an intelligent knowledge-based system. This “Galatean” model was developed by Christopher Buckingham, who has a first degree in psychology and joined Aston University in 2000 as a Lecturer in Computer Science. At Aston, he specified how the Galatean psychological model can build CDSSs [3.1] and conducted parallel research building on interpreting clinical decision making as three linked, iterative classification tasks: diagnosing, assessing potential outcomes, and making intervention decisions. Buckingham developed a coding scheme (2001-04) to encapsulate underlying elements of these classification tasks that was applied to analysing differences between US and UK primary-care practitioners’ decision-making behaviours [3.2, 3.3]. Together, these two research avenues lie at the core of GRiST by providing the theory and framework for capturing risk assessments as a classification process.</p> <p>The GRiST CDSS development began in 2003 in collaboration with researchers at Warwick Medical School, who provided the bridge to clinical expertise. The psychological underpinnings of GRiST helped derive knowledge engineering techniques [3.4] that elicited expertise in a format that end users could fully understand. The result is a unique formal model or “ontology” of the knowledge used in mental-health risk assessments [3.5]. This ontology enables GRiST to exploit semantic-web technologies so that evolving human expertise and varying contexts of CDSS deployment can be flexibly accommodated with minimal additional programming requirements [3.4]. It increased uptake of the GRiST CDSS in the NHS, private sector, and third-sector (non-profit organisations) [5.1, sponsors] so that impact and research continued in tandem, with three NHS trusts directly funding it through EPSRC CASE PhD studentships [3, grants 7].</p> <p>GRiST is the only mental-health risk-assessment approach that explicitly combines clinical judgements with empirical evidence, as recommended by the Department of Health [5.2]. It does this using its psychological model of structured clinical judgement linked to and validated by sophisticated probabilistic and statistical analyses of the patient database. GRiST’s web-based system helps clinicians: (i) collect and record relevant risk data for particular patients and assessment circumstances; (ii) see how data contribute to risk evaluations; and (iii) identify where patients need help. It motivated additional research funding [3, grants 1, 2, 3] that ensured GRiST incorporates variable end-user requirements [3.4], integrates risk assessment data [3.6], and optimises risk evaluations. International funding [3, grants 4, 5, 6] is using GRiST for investigating suicide causes (March, 2013-15), analysing health inequalities (2010-2015), and exploiting the generic nature of its technologies by applying it to logistics (2010-2013).</p>

3. References to the research (the three most significant ones are marked by an asterisk)

Most papers are jointly authored with Adams from the University of Warwick, who was the main clinical collaborator on GRiST. The software impact is entirely the responsibility of Aston University and Warwick is not putting in any impact case study using GRiST [5.3].

1. * Buckingham, C.D. (2002). Psychological cue use and implications for a clinical decision support system. *Medical Informatics and the Internet in Medicine*, 27(4), 237-251. DOI: 10.1080/1463923031000063342. *An important paper for presenting the theory underpinning the GRiST clinical decision support system. It has 16 citations, with international authors using the work to inform their decision making research including Canada (book chapter on Clinical Decision Support Systems), America (book on Advanced Practice Nursing), Serbia (paper on cardiology), and New Zealand (paper on a tool investigating clinical decision making).*
2. Ann Adams, Christopher D. Buckingham, Sara Arber, John B. McKinlay, Lisa Marceau and Carol Link (2006). The influence of patient's age on clinical decision-making about coronary heart disease in the USA and the UK, *Ageing and Society*, 26(02), 303-321. DOI: 10.1017/S0144686X05004265. *The first paper applying the coding scheme from linked classification models to interpret clinical decision making. It has 16 citations and is jointly authored with Surrey and Warwick Universities in England and the New England Research Institute, Boston, America.*
3. * A.E. Adams, C. D. Buckingham, A. Lindenmeyer, John B. McKinlay, Carol Link, Lisa Marceau, & Sara Arber (2008). The influence of patient and doctor gender on diagnosing coronary heart disease. *Sociology of Health & Illness*, 30(1), 1-18. DOI: 10.1111/j.1467-9566.2007.01025.x. *International research with Surrey and Warwick Universities in England and the New England Research Institute, Boston, America. It also applies the classification model coding scheme but in a more developed form. It has 33 citations.*
4. Buckingham, C.D., Ahmed, A., & Adams, A.E. (2007). Using XML and XSLT for flexible elicitation of mental-health risk knowledge. *Informatics for Health and Social Care*, Vol.32 (1), pp. 65-81. DOI: 10.1080/14639230601097895. *10 citations but mainly a paper used as a marker for the method we used, so often self-cited. Co-author Ahmed is a postdoctoral research associate at Aston University having obtained his PhD on the GRiST project.*
5. * Buckingham, C. D., Adams, A.E. & Mace, C. (2008). Cues and knowledge structures used by mental-health professionals when making risk assessments. *Journal of Mental Health*, 17 (3): 299-314. DOI: 10.1080/09638230701498374. *Prestigious Institute of Psychiatry journal with 14 citations. The paper is important for validating the clinical expertise within GRiST and is co-authored with the University of Warwick.*
6. Gilbert E., Adams A.E. and Buckingham C.D. (2012). "Examining the relationship between risk assessment and risk management in mental health". *Journal of Psychiatric and Mental Health Nursing*, 18(10), 862-868. DOI: 10.1111/j.1365-2850.2011.01737.x. *Official journal of HORATIO, the organisation for European Psychiatric Nurses with 2 international citations from Holland and Italy on assessing mental-health risk. Co-authored with the University of Warwick.*

Peer-reviewed grants providing evidence of research quality

(Buckingham was Principal or Co-investigator on all grants)

1. New and Emerging Applications of Technology (2003-2006), *A decision support system for mental-health risk screening and assessment*. Aston (£198,371) and Warwick (£75,305) Universities
2. Burdett Trust for Nursing (2008-09), *Extending the GRiST for use with adolescents and older people*. Aston (£46,241) and Warwick (£43,542) Universities.
3. Judi Meadows Memorial Fund, *Implementing GRiST within primary care and the community* (2011-2012): Aston (£48,967) and Warwick (£44,246) Universities.
4. American Foundation for Suicide Prevention, *Improving Clinical Evaluations of Suicide Risk and their Relationship to Care Planning* (2013-2015, awarded 2012): Aston (£31,903) and Warwick (£13,632) Universities.
5. European Commission FP7-ICT-2009-5 (2010-13), *ADVANCE: Advanced predictive-analysis-based decision-support engine for logistics*: Aston University (£480,518) and multiple European

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organisations (£1,191,071).

6. Joint US National Institutes of Health (NIH-USA) and UK ESRC, *Understanding Social Contributions to Disparities in Depression Care: US and UK* (2010-2015): Johns Hopkins (£370,000), Warwick (£254,000), and Aston Universities (£52,400).
7. EPSRC CASE PhD studentships at Aston University related to GRiST: Birmingham and Solihull Mental Health Foundation Trust, 2007-10, £80,000; Humber Mental Health Foundation NHS Trust, 2010-13, £85,000; Birmingham Children's Hospital, 2011-14, £66,000.

4. Details of the impact

Impact is integrally linked to the research process because involvement of clinicians and service users was written into all grants. GRiST's evolution in collaboration with end users, both prior to and post implementation of the CDSS, provided a direct and immediate route for research into practice.

GRiST helps mental health practitioners, service users, and carers detect and explain risks associated with mental-health problems to reduce suicides, self-harming, neglect, and violence. It has changed practice by replacing paper risk tools and word-processed electronic documents that do not structure information or analyse the results. It formalises data collection, provides visual cues for where risks originate, analyses and displays graphs of risks over time, enables customised risk reports generated automatically from the data, and compares individual risk judgements with expert consensus to improve accuracy and alert assessors to potential errors. Economic impact has come from GRiST licences and training. Clinical education impact comes from GRiST's risk explanations during use and through workshops attended by healthcare professionals.

Health impact

1. **Use by healthcare providers in the period from 1/1/2011 to 31/7/2013:** 2,152 mental-health practitioners have used GRiST on 52,334 patients and completed 285,426 individual risk assessments [5.1, sponsors]. GRiST is used in *secondary care* (mental-health hospitals) in the NHS (Humber NHS Foundation Trust, Cumbria Partnership Trust, Birmingham Children's Hospital) and private sector (Raphael Healthcare, Craegmoor Hospital group, Barchester Healthcare). In *primary care and the community*, GRiST is being used in the NHS Improving Access for Psychological Therapies (IAPT) services in Cumbria Partnership Trust, Lincoln Partnership Foundation Trust, Coventry and Warwickshire Partnership Trust, East Riding Psychological Wellbeing Service, and the Hull IAPT service. Mental-health charities (Mental Health Matters, mcch, Imagine Mental Health, Welmede Housing Association) have over 200 practitioners using GRiST for mental-health provision.
2. **Use by service users for self-assessments (1/1/2012 to 31/7/2013):** The self-assessment version of GRiST, myGRiST, has been trialled by mcch and Imagine charities, Lincoln IAPT, and two GP practices (190 service users in the time period). Positive feedback has been received from GPs ("it gave me a very detailed picture of how he is feeling and helped me empathise with him. It led to a useful consultation", 2012, [5.3]) and service users ("I found myGRiST a helpful way to explore my own vulnerability ... I would have benefitted from using this tool when I first started to suffer from suicidal ideation", 2012, [5.1, testimonials; 5.3]).
3. **Continuous improvement of clinical practice (1/1/2011 to 31/7/2013):** GRiST is being delivered to mental-health organisations as a cloud-computing service from Aston University. The database enables analysis of how mental-health clinicians make risk judgements. Results feed directly back into practice through the GRiST CDSS and have generated international interest for collaboration [5.4, 5.5]. The American Foundation for Suicide Prevention [5.6] said the research "has potential for exceptional impact from the perspective of clinical care, patient outcomes, and public health" (2012). Practitioners and organisations have confirmed how much GRiST helps their clinical practice [5.1, testimonials; 5.3, 5.7].
4. **Raising awareness and understanding among healthcare professionals (1/1/2008 to 31/7/2013):** GRiST has been presented at international workshops attended by mental-health practitioners and service users in Boston, USA [5.4], the US Department of Veterans Affairs [invited speaker, 5.4], Orange, Bathurst (Kenote speaker, "Rural and Remote" mental-health conference [5.5]), Moree, Newcastle, and Dubbo in Australia [5.5], and more than 30 venues

Impact case study (REF3b)

around Europe [5.1, timeline], including a conference (May, 2013) hosted by GRiST at Aston for mental-health service providers and commissioners [5.1, timeline]. International outcomes include GRiST being used in America by the North Carolina, Department of Health and Human Services in a mental-health clinical decision making study (2009, [5.8]) and plans are underway for piloting myGRiST for self-assessments in New South Wales, Australia [5.5]. GRiST is an example of a tool following best practice given in guidance by the Department of Health (2007, but updated in 2009 and still followed by UK Trusts [5.2]) and the Irish Health Service Executive [2009, 5.2].

Economic impact

5. **Improving market potential for patient-record companies:** Mayden [5.9] is a company providing patient record software, IAPTus, for two thirds of the English NHS IAPT services, which offer psychological support as part of primary care. IAPTus had no validated risk tool until GRiST was linked to it in 2012, which has improved IAPTus functionality. Three IAPT services already use GRiST via IAPTus (July 2012 to July 2013) and negotiations are underway for 5 more, with the licence fee shared between GRiST and Mayden.
6. **Improving market potential for private health companies:** GRiST is being used by 7 private hospitals and care homes (one in Ireland), increasing potential for patient referrals because they can point to a validated risk tool, which they did not previously possess [5.1, GRiST sponsors].
7. **Training:** All the charities using GRiST and Cumbria NHS Trust have paid for external GRiST training (1/1/2010-31/7/2013, [5.10]).

5. Sources to corroborate the impact

1. GRiST website at www.egrlist.org. Access the following links: *testimonials*, *timeline*, and *sponsors*, as indicated by the references within square brackets in the impact text.
2. Department of Health (2007/09) "Best Practice in Managing Risk" (p. 35). London, HMSO. <http://www.nmhdh.org.uk/silo/files/managing-risk-best-practice.pdf>
Irish Health Service Executive (2009, p. 35). "Risk Management in Mental Health" <http://www.hse.ie/eng/services/Publications/services/Mentalhealth/RiskManagementinMentalHealth.pdf>
3. Principal Research Fellow, Warwick Medical School, University of Warwick.
4. Assistant Professor, Department of Health Policy and Management, Boston University School of Public Health, Research Health Scientist, Center for Health Quality, Outcomes and Economic Research, Department of Veterans Affairs, 200 Spring Road (152), Bedford, MA 01730, 781.687.2861
5. Director of the Centre for Rural and Remote Mental Health, a joint initiative of NSW Ministry of Health and University of Newcastle Faculty of Health, New South Wales, Australia. www.crrmh.com.au
6. American Foundation for Suicide Prevention. <https://www.afsp.org/research/our-researchers/all-grants/christopher-buckingham-ph.d>
7. GRiST change manager, governance, and trainer at Humber Mental Health NHS Foundation Trust during the impact period.
8. North Carolina, Department of Health and Human Services, Division of Mental Health (2009, pages 5, 9-13). <http://www.ncdhhs.gov/mhddsas/statspublications/Reports/reports-generalassembly/generalreports/revisedfirstcommitmentevaluationreport.pdf>
9. IAPTus patient record system: Mayden www.mayden.co.uk/what-we-do/patient-management/iaptus/ and <http://www.mayden.co.uk/2013/06/event-information-technology-tools-for-iapt-services-12-july-london/>
10. Independent GRiST trainer, <http://www.selfmotiv8.co.uk/>.