Interaction Science SIG: Overcoming Challenges

Andrew Howes
School of Computer Science
University of Birmingham
UK
HowesA@bham.ac.uk

Benjamin R. Cowan
School of Computer Science
University of Birmingham
UK
B.R.Cowan@cs.bham.ac.uk

Christian P. Janssen
The Smith-Kettlewell Eye
Research Institute
San Francisco, USA
cjanssen@ski.org

Anna L. Cox
UCL Interaction Centre
University College London
UK
anna.cox@ucl.ac.uk

Paul Cairns
Dept. of Computer Science
University of York
UK
paul.cairns@york.ac.uk

Anthony J. Hornof
Dept. of Computer and
Information Science
University of Orgeon, USA
hornof@cs.uoregon.edu

Stephen J. Payne
Computer Science
University of Bath
Bath, UK
s.j.payne@bath.ac.uk

Peter Pirolli
Palo Alto Research Center, Inc.
Palo Alto, CA
USA
Peter.Pirolli@parc.com

Abstract
Over the past 30 years science has played a key role in
shaping and advancing research in Human-Computer
Interaction. Informed in part by methods, theories and
findings from the behavioral sciences and from computer
science, scientific contributions to HCI have provided
explanations of how and why people interact through and
with technology. We argue that the contribution of
science to HCI could be enhanced if key challenges are
met. During a SIG meeting we will discuss the challenges
and potential responses and set an agenda for the coming
years.

Author Keywords
science, theory, modeling, scientific method, empirical
method, experiments, data, evidence, analysis, behavioral
sciences, interaction science

ACM Classification Keywords
H.1.0 [General]; H.1.1 [Systems and Information Theory
(E.4)]; H.1.2 [Models and Principles: User/Machine
Systems]:   Human Information Processing

Introduction
Informed in part by methods, theories and findings from
the behavioral sciences and computer science, scientific
approaches to HCI have provided explanations of how and

why people interact with and through technology. Explanations have been offered for a range of individual, social and cultural interaction phenomena and are not limited to any one facet. They include contributions to understanding elementary perceptual and motor interaction [7], of course, but also contributions concerning the use of knowledge to guide search [16], as well as contributions to explaining how people collaborate and share information [17] and how machines limit what interactions are possible [19]. Other work, more peripheral to HCI publication venues, has also offered key insights useful in our field, for example, [12, 18, 2]. Together this body of work forms part of what is becoming known as *interaction science* [6, 1].

A scientific approach offers cumulative theory and empirical rigor. Theories often consist of some systematic representation of individual and or collective interaction that leads to the generation of testable hypotheses. For example, a scientific theory might consist of a computational or mathematical specification of the human information processing mechanisms [11, 4], for others the science is more in the empirical method [8, 18, 20]. Cumulative theory offers explanations across a broad range of contexts and phenomena. Information Foraging Theory, for example, explains how people search for relevant information on a web where there are distal cues as to content and where relevant documents are clustered in distributed patches [16]. It gains its power and generality from a mathematical formalization of foraging and from a computational theory, ACT-R, of the mind. Theories of movement planning describe how long it takes to move a pointer to a button and also variation induced by changes in the cost of error [13, 15]. Theories of team diagnosis, making use of Signal Detection Theory, show the consequences of communication constraints on the

integration of multiple diagnostic decisions [17]. But, however sophisticated the theory, evidence is essential. Controlled experiments are used to test theory. For example, they show how the costs of action imposed by an interface moderate planfulness [14, 10] and they are used to investigate social phenomena, for example to test game theoretic ideas concerning collaboration [2].

Importantly, interaction science has a symbiotic relationship with other activities in HCI. Engineering approaches are closely related but engineering is not synonymous with science. Engineering disciplines can have their own theoretical frameworks and empirical programs. These can inform and be informed by science. Similarly, qualitative approaches to observing interaction and user experience provide descriptions of what designers and practitioners find important for invention and thereby yield guidance as to what phenomena require explanation. In return, scientifically supported theories offer evidence-based explanations that have the potential to contribute to theory cumulation and understanding. They may also provide the underpinning assumptions for engineering methods, though this is not essential. Scientific theories may sometimes inform design immediately, but sometimes may only do so in the long run or may only be useful because they inform HCI education, or inform further scientific investigation of HCI phenomena.

While interaction science has had many successes there are a number of challenges. These include:

1. Despite the strong science contributions to HCI, and ACM CHI, over the past 30 years [7], these contributions sparsely populate an increasingly diverse field.

2. Interaction science methods and theories require years to learn and while a few efforts have been made to provide educational material [5] these efforts are few in number.

3. The imperative for "design implications" can mediate against scientific values and against high risk work on hard problems.

4. A concern with the details of particular interaction instances rather than the statistics of task ecologies [3], central to many researchers experience of HCI, does not always accord with the scientific aim to abstract general principles.

5. Laboratory studies, which are often dismissed as irrelevant to the "real world", are essential to science's, including social science's, capacity to acquire causal knowledge through controlled variation [9].

6. Interaction science has overlapping goals with other fields – including economics, social science, and psychology – and as a consequence its nascent focus needs nurturing.

7. As with other science and engineering disciplines, interaction science suffers from limited diversity in its community of researchers.

Objectives
The SIG has the following objectives.

1. *Develop a diverse community of interest* - There are many researchers in a range of scientific disciplines who conduct work that is relevant to CHI. By providing a focal point for the science of Human-Computer Interaction we will provide an opportunity for these people to engage more fully with CHI researchers and research problems. In

the long term we will actively seek collaborations with key individuals and journals to promote interdisciplinary work. The SIG is intended to complement efforts by others to educate and promote in this area [5, 6, 1, 20].

2. *Discuss how to innovate content types and grow the area* - Innovation is required in part because of the changing landscape of publication models including the move toward open-access and, in some scientific disciplines, toward free-to-publish/free-to-read and a broader use of open peer review. Registered publication of empirical studies also provides an opportunity. Innovation is also required because of the differing value that disciplines perceive in conference versus journal publication.

3. *Discuss the 7 challenges listed above.*

References
[1] Bahr, G. S., Heron, M., Hanson, V. L., Ricketts, I., Harrison, R., Flood, D., and Duce, D. Editorial: Journal of Interaction Science. *Journal of Interaction Science 1*, 1 (2013), 3.

[2] Bolton, G., Katok, E., and Ockenfels, A. How effective are electronic reputation mechanisms? An experimental investigation. *Management Science 50*, 11 (2004), 1587–1602.

[3] Brunswik, E. Representative design and probabilistic theory in a functional psychology. *Psychological Review 62*, 3 (1955), 193.

[4] Byrne, M. D. ACT-R/PM and menu selection: Applying a cognitive architecture to HCI. *International Journal of Human-Computer Studies 55*, 1 (2001), 41–84.

[5] Cairns, P., and Cox, A. *Research Methods for Human-Computer Interaction*. Cambridge Univ Press, 2008.

[6] Card, S. Interaction Science in the Age of Makers and Instructables. In *ACM SIGCHI* (2012).

[7] Card, S. K., Moran, T. P., and Newell, A. The Psychology of Human-Computer Interaction Lawrence Erlbaum Associates. *Hillsdale, NJ* (1983).

[8] Ellison, N. B., Steinfield, C., and Lampe, C. The benefits of Facebook friends: social capital and college students use of online social network sites. *Journal of Computer-Mediated Communication 12*, 4 (2007), 1143–1168.

[9] Falk, A., and Heckman, J. Lab experiments are a major source of knowledge in the social sciences. *Science 326*, 5952 (2009), 535–538.

[10] Fu, W.-T., and Gray, W. D. Resolving the paradox of the active user : stable suboptimal performance in interactive tasks. *Cognitive Science 28* (2004), 901–935.

[11] Halverson, T., and Hornof, A. J. A computational model of active vision for visual search in human–computer interaction. *Human–Computer Interaction 26*, 4 (2012), 285–314.

[12] Huberman, B. A., Pirolli, P. L. T., Pitkow, J. E., and Lukose, R. M. Strong regularities in world wide web surfing. *Science 280*, 5360 (1998), 95–97.

[13] MacKenzie, I. S. Fitts' law as a research and design tool in human-computer interaction. *Human-computer interaction 7*, 1 (1992), 91–139.

[14] O'Hara, K. P., and Payne, S. J. The effects of operator implementation cost on planfulness of problem solving and learning. *Cognitive psychology 35*, 1 (1998), 34–70.

[15] Payne, S. J., and Howes, A. Adaptive Interaction: A Utility Maximization Approach to Understanding Human Interaction with Technology. *Synthesis Lectures on Human-Centered Informatics 6*, 1 (2013), 1–111.

[16] Pirolli, P. *Information foraging theory: Adaptive interaction with information*, vol. 2. Oxford University Press, USA, 2007.

[17] Sorkin, R. D., and Woods, D. D. Systems with human monitors: A signal detection analysis. *Human-Computer Interaction 1*, 1 (1985), 49–75.

[18] Sparrow, B., Liu, J., and Wegner, D. M. Google effects on memory: Cognitive consequences of having information at our fingertips. *Science 333*, 6043 (2011), 776–778.

[19] Thimbleby, H. *Press On — Principles of Interaction Programming*. MIT Press, 2010.

[20] Wilson, M., Resnick, P., Coyle, D., and Chi, E. ReplicCHI - The Workshop. In *CHI'13 ACM SIGCHI Conference on Human Factors in Computer Systems Extended Abstracts*. (2013).