Seven Research Contributions in HCI

Jacob O. Wobbrock
The Information School | DUB Group
University of Washington
Seattle, WA USA 98195
wobbrock@uw.edu

ABSTRACT
Research in human-computer interaction (HCI) addresses both technological and human-behavioral concerns. It follows that the contributions made in HCI are usually separately familiar to engineering, design, or the social sciences, but rarely brought together under one roof. The seven research contribution types covered here are (1) *empirical*, (2) *artifact*, (3) *methodological*, (4) *theoretical*, (5) *benchmark / dataset*, (6) *survey*, and (7) *opinion*. Of course, some research articles make more than one type of contribution. The goal of this paper is to give researchers insight into the contribution types found in HCI papers, and to provide examples for further reading. I do not claim that the chosen examples are the "best of breed;" rather, they are examples with which I am familiar and that I feel illustrate a given contribution.

Author Keywords
Contributions, methods, research, science, invention.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

1. EMPIRICAL CONTRIBUTIONS

Empirical research contributions consist of new findings based on systematically gathered data. Empirical contributions may be quantitative or qualitative (or mixed), and usually follow from scientific studies of various kinds (*e.g.*, laboratory, field, ethnographic, etc.). In HCI, the purpose of empirical contributions is to reveal formerly unknown insights about human behavior in relation to information or technology. Empirical research methods commonly used in HCI include formal experiments, field experiments, field studies, interviews, focus groups, surveys, usability tests, case studies, diary studies, ethnography, contextual inquiry, experience sampling, and automated data collection (*e.g.*, sensing, logging).

How Empirical Contributions Are Evaluated

Empirical contributions are considered trustworthy when the methods that produce them are executed with rigor and precision. "The devil is in the details" in empirical work. Identifiable confounds and biases must be avoided in studies of all types. If methods are sound and findings important, empirical contributions should be judged favorably.

Examples of Empirical Contributions

Bragdon, A., Nelson, E., Li, Y. and Hinckley, K. (2011). Experimental analysis of touch-screen gesture designs in mobile environments. Proceedings of the ACM Conference in Human Factors in Computing Systems (CHI '11). Vancouver, British Columbia (May 7-12, 2011). New York: ACM Press, 403-412.

Burke, M., Kraut, R. and Williams, D. (2010). Social use of computer-mediated communication by adults on the autism spectrum. Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW '10). Savannah, Georgia (February 6-10, 2010). New York: ACM Press, 425-434.

Casiez, G., Vogel, D., Balakrishnan, R. and Cockburn, A. (2008). The impact of control-display gain on user performance in pointing tasks. Human-Computer Interaction 23 (3), 215-250.

Chilana, P.K., Wobbrock, J.O. and Ko, A.J. (2010). Understanding usability practices in complex domains. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '10). Atlanta, Georgia (April 10-15, 2010). New York: ACM Press, 2337-2346.

Clarkson, E., Clawson, J., Lyons, K. and Starner, T. (2005). An empirical study of typing rates on mini-QWERTY keyboards. Extended Abstracts of the ACM Conference on Human Factors in Computing Systems (CHI '05). Portland, Oregon (April 2-7, 2005). New York: ACM Press, 1288-1291.

Czerwinski, M., Horvitz, E. and Wilhite, S. (2004). A diary study of task switching and interruptions. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '04). Vienna, Austria (April 24-29, 2004). New York: ACM Press, 175-182.

Dawe, M. (2006). Desperately seeking simplicity: How young adults with cognitive disabilities and their families adopt assistive technologies. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '06). Montréal, Québec (April 22-27, 2006). New York: ACM Press, 1143-1152.

Findlater, L., Wobbrock, J.O. and Wigdor, D. (2011). Typing on flat glass: Examining ten-finger expert typing patterns on touch surfaces. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '11). Vancouver, British Columbia (May 7-12, 2011). New York: ACM Press, 2453-2462.

Grudin, J.T. (1984). Error patterns in skilled and novice transcription typing. In Cognitive Aspects of Skilled Typewriting, W. E. Cooper (ed.). New York: Springer-Verlag, 121-143.

Hwang, F., Keates, S., Langdon, P. and Clarkson, P.J. (2004). Mouse movements of motion-impaired users: A submovement analysis. Proceedings of the ACM SIGACCESS Conference on

Computers and Accessibility (ASSETS '04). Atlanta, Georgia (October 18-20, 2004). New York: ACM Press, 102-109.

Kurtenbach, G. and Buxton, W. (1994). User learning and performance with marking menus. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '94). Boston, Massachusetts (April 24-28, 1994). New York: ACM Press, 258-264.

Lee, S. and Zhai, S. (2009). The performance of touch screen soft buttons. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '09). Boston, (April 4-9, 2009). New York: ACM Press, 309-318.

Patel, K., Fogarty, J., Landay, J.A. and Harrison, B. (2008). Examining difficulties software developers encounter in the adoption of statistical machine learning. Proceedings of the 23rd AAAI Conference on Artificial Intelligence (AAAI '08). Chicago, Illinois (July 13-17, 2008). Menlo Park, California: AAAI Press, 1563-1566.

Poltrock, S.E. and Grudin, J. (1994) Organizational obstacles to interface design and development: Two participant-observer studies. ACM Transactions on Computer-Human Interaction 1 (1), 52-80.

Shinohara, K. and Wobbrock, J.O. (2011). In the shadow of misperception: Assistive technology use and social interactions. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '11). Vancouver, British Columbia (May 9-12, 2011). New York: ACM Press, 705-714.

Wobbrock, J.O. and Gajos, K.Z. (2007). A comparison of area pointing and goal crossing for people with and without motor impairments. Proceedings of the ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '07). Tempe, Arizona (October 15-17, 2007). New York: ACM Press, 3-10.

2. ARTIFACT CONTRIBUTIONS

Artifact contributions in HCI describe inventions, which include new systems, architectures, tools, techniques, or designs that reveal new opportunities, enable new outcomes, facilitate new insights or explorations, or impel us to consider new possible futures. Artifact contributions are, by definition, dependent upon never-before-seen inventions that are instantiated as prototypes, sketches, mockups, demos, or other envisionments, and are often but not always at least partially functional. Artifacts tend to be one of three types: *systems*, *techniques*, or *designs*.

Novel systems, including architectures, tools, and toolkits, provide new knowledge by showing how to accomplish new things formerly impossible, or how to accomplish formerly possible things more easily (*e.g.*, Dixon, Gajos, Greenberg, Myers, Patel, Wobbrock).

Novel interaction techniques provide new ways of inputting information or controlling systems, usually striving to be reusable across myriad platforms or situations (*e.g.*, Baudisch, Grossman, Kristensson).

Novel designs may be prototypes, sketches, mockups, demos, or other envisionments whose purpose is to convey or motivate new possible futures (*e.g.*, Kane, Schwesig, Wigdor). With new designs, form is the priority over function.

How Artifact Contributions Are Evaluated

Artifact contributions are often accompanied by empirical evaluations but they do not have to be. New systems, architectures, tools, and toolkits are often evaluated in a holistic fashion on the basis of what they make possible and how they do so. Interaction techniques, on the other hand, are almost always evaluated precisely and quantitatively, as human performance is central to understanding the merits of most interaction techniques. New desigs, in general, are evaluated according to how compelling, how richly painted, and how informed is their vision. Designs are often presented as results of competing tradeoffs resolved by sound theoretical, conceptual, or empirical means. Designs that are deeply implemented may also be considered systems and evaluated as such.

Examples of Artifact Contributions

Baudisch, P., Sinclair, M. and Wilson, A. (2006). Soap: A pointing device that works in mid-air. Proceedings of the ACM Symposium on User Interface Software and Technology (UIST '06). Montreux, Switzerland (October 15-18, 2006). New York: ACM Press, 43-46.

Dixon, M. and Fogarty, J.A. (2010). Prefab: Implementing advanced behaviors using pixel-based reverse engineering of interface structure. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '10). Atlanta, Georgia (April 10-15, 2010). New York: ACM Press, 1525-1534.

Gajos, K.Z., Weld, D.S. and Wobbrock, J.O. (2010). Automatically generating personalized user interfaces with SUPPLE. Artificial Intelligence 174 (12-13), 910-950.

Greenberg, S. and Fitchett, C. (2001). Phidgets: Easy development of physical interfaces through physical widgets. Proceedings of the ACM Symposium on User Interface Software and Technology (UIST '01). Orlando, Florida (November 11-14, 2001). New York: ACM Press, 209-218.

Grossman, T. and Balakrishnan, R. (2005). The Bubble Cursor: Enhancing target acquisition by dynamic resizing of the cursor's activation area. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '05). Portland, Oregon (April 2-7, 2005). New York: ACM Press, 281-290.

Kane, S.K., Avrahami, D., Wobbrock, J.O., Harrison, B., Rea, A., Philipose, M. and LaMarca, A. (2009). Bonfire: A nomadic system for hybrid laptop-tabletop interaction. Proceedings of the ACM Symposium on User Interface Software and Technology (UIST '09). Victoria, British Columbia (October 4-7, 2009). New York: ACM Press, 129-138.

Kristensson, P.-O. and Zhai, S. (2004). SHARK2: A large vocabulary shorthand writing system for pen-based computers. Proceedings of the ACM Symposium on User Interface Software and Technology (UIST '04). Santa Fe, New Mexico (October 24-27, 2004). New York: ACM Press, 43-52.

Myers, B.A., McDaniel, R.G., Miller, R.C., Ferrency, A.S., Faulring, A., Kyle, B.D., Mickish, A., Klimovitski, A. and Doane, P. (1997). The Amulet environment: New models for effective user interface software development. IEEE Transactions on Software Engineering 23 (6), 347-365.

Patel, S.N., Gupta, S. and Reynolds, M.S. (2010). The design and evaluation of an end-user-deployable, whole house, contactless power consumption sensor. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '10). Atlanta, Georgia (April 10-15, 2010).New York: ACM Press, 2471-2480.

Schwesig, C., Poupyrev, I. and Mori, E. (2004). Gummi: A bendable computer. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '04). Vienna, Austria (April 24-29, 2004). New York: ACM Press, 263-270.

Wigdor, D., Forlines, C., Baudisch, P., Barnwell, J. and Shen, C. (2007). LucidTouch: A see-through mobile device. Proceedings of the ACM Symposium on User Interface Software and Technology (UIST '07). Newport, Rhode Island (October 7-10, 2007). New York: ACM Press, 269-278.

Wobbrock, J.O., Wilson, A.D. and Li, Y. (2007). Gestures without libraries, toolkits or training: A $1 recognizer for user interface prototypes. Proceedings of the ACM Symposium on User Interface Software and Technology (UIST '07). Newport, Rhode Island (October 7-10, 2007). New York: ACM Press, 159-168.

3. METHODOLOGICAL CONTRIBUTIONS

Methodological research contributions add to or refine the methods by which researchers or practitioners carry out their work. Research methods enable scientists to make new discoveries. Practitioner methods enable designers and engineers to apply their skills to greater effect. Entirely new methods of either sort are infrequent; method variations are more common.

How Methodological Contributions Are Evaluated

Methodological contributions are evaluated largely on the basis of the utility of the new or improved method. Demonstrating the utility of a method often requires empirical validation. Such validation may be formal in nature (*e.g.*, an experiment in which one of two groups uses the new method, while the other group uses an extant *de facto* method), or a case study (*e.g.*, where the method is applied in a particular setting and outcomes are analyzed and reported). The goal of validating a methodological contribution is to convince readers that the new method or method improvement is useful, valid, and reliable for its intended purpose. As the method is to be used by others, it must be described well enough to be employed by researchers or practitioners, including with warnings of its pitfalls and shortcomings.

Examples of Methodological Contributions

Blomberg, J., Giacomi, J., Mosher, A. and Swenton-Wall, P. (1993). Ethnographic field methods and their relation to design. In Participatory Design: Principles and Practices, D. Schuler and A. Namioka (eds.). Hillsdale, New Jersey: Lawrence Erlbaum, 123-155.

Consolvo, S. and Walker, M. (2003). Using the Experience Sampling method to evaluate ubicomp applications. IEEE Pervasive Computing 2 (2), 24-31.

Holtzblatt, K. and Jones, S. (1993). Contextual Inquiry: A participatory technique for system design. In Participatory Design: Principles and Practices, D. Schuler and A. Namioka (eds.). Hillsdale, New Jersey: Lawrence Erlbaum, 177-210.

Kjeldskov, J. and Stage, J. (2004). New techniques for usability evaluation of mobile systems. International Journal of Human-Computer Studies 60 (5-6), 599-620.

Guiard, Y. (2009). The problem of consistency in the design of Fitts' law experiments: Consider either target distance and width or movement form and scale. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '09). Boston, Massachusetts (April 04-09, 2009). New York: ACM Press, 1809-1818.

Palen, L. and Salzman, M. (2002). Voice-mail diary studies for naturalistic data capture under mobile conditions. Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW '02). New Orleans, Louisiana (November 16-20, 2002). New York: ACM Press, 87-95.

Price, K.J. and Sears, A. (2009). The development and evaluation of performance-based functional assessment: A methodology for the measurement of physical capabilities. ACM Transactions on Accessible Computing 2 (2), 10:1-10:31.

Soukoreff, R.W. and MacKenzie, I.S. (2003). Metrics for text entry research: An evaluation of MSD and KSPC, and a new unified error metric. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '03). Ft. Lauderdale, Florida (April 5-10, 2003). New York: ACM Press, 113-120.

Soukoreff, R.W. and MacKenzie, I.S. (2004). Towards a standard for pointing device evaluation, perspectives on 27 years of Fitts' law research in HCI. International Journal of Human-Computer Studies 61 (6), 751-789.

Wobbrock, J.O., Aung, H.H., Rothrock, B. and Myers, B.A. (2005). Maximizing the guessability of symbolic input. Extended Abstracts of the ACM Conference on Human Factors in Computing Systems (CHI '05). Portland, Oregon (April 2-7, 2005). New York: ACM Press, 1869-1872.

Wobbrock, J.O., Morris, M.R. and Wilson, A.D. (2009). User-defined gestures for surface computing. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '09). Boston, Massachusetts (April 4-9, 2009). New York: ACM Press, 1083-1092.

Wobbrock, J.O., Findlater, L., Gergle, D. and Higgins, J.J. (2011). The Aligned Rank Transform for nonparametric factorial analyses using only ANOVA procedures. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '11). Vancouver, British Columbia (May 7-12, 2011). New York: ACM Press, 143-146.

4. THEORETICAL CONTRIBUTIONS

Theoretical contributions consist of new or improved concepts, definitions, models, principles, or frameworks. These thought-vehicles may be quantitative or qualitative in nature, and structured so as to be useful in the pursuit of future knowledge. Theories are built over time, and in some fields (*e.g.*, psychology, physics), after repeated validation, theories may attain the status of laws. Theories are both descriptive and predictive in nature; that is, they reveal the essential features of *what is* (descriptive) while accurately foretelling *what will be* (predictive). Theories must be explanatory in nature. They must not only state *that* a relationship holds, but why it holds the way it does. Scientific theories must also be falsifiable; they must assert something

that may or may *not* be true. If a theory cannot be falsified even in principle, it is not a scientific theory. Theoretical contributions significantly advance our understanding of phenomena by providing inherently reusable constructs and ways of thinking about phenomena of interest.

How Theoretical Contributions Are Evaluated

Theoretical contributions are evaluated based on their novelty, importance, descriptive power, and predictive power. A theory that accounts well for observed data from a specific situation but has no ability to generalize to a new situation is inherently limited. Such a theory may be "over-fit" to the observed data. Conversely, a theory that is so broad it can account for anything probably does not contain any real descriptive power. It lacks specifics and is "under-fit." For these and other reasons, theory validation is almost always accompanied by empirical work, although such work occasionally precedes and give rise to theory.

Examples of Theoretical Contributions

Bellotti, V., Back, M., Edwards, W.K., Grinter, R.E., Henderson, A. and Lopes, C. (2002). Making sense of sensing systems: Five questions for designers and researchers. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '02). Minneapolis, Minnesota. New York: ACM Press, 415-422.

Buxton, W. (1990). A three-state model of graphical input. Proceedings of the IFIP TC13 Third Int'l Conference on Human-Computer Interaction (INTERACT '90). Cambridge, England (August 27-31, 1990). Amsterdam, The Netherlands: North-Holland, 449-456.

Cao, X. and Zhai, S. (2007). Modeling human performance of pen stroke gestures. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '07). San Jose, California (April 28-May 3, 2007). New York: ACM Press, 1495-1504.

Card, S.K., Mackinlay, J.D. and Robertson, G. (1990). The design space of input devices. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '90). Seattle, Washington (April 1-5, 1990). New York: ACM Press, 117-124.

Guiard, Y. (1987). Asymmetric division of labor in human skilled bimanual action: The kinematic chain as a model. Journal of Motor Behavior 19 (4), 486-517.

MacKenzie, I.S. (1992). Fitts' law as a research and design tool in human-computer interaction. Human-Computer Interaction 7 (1), 91-139.

Schön, D.A. (1992). Designing as reflective conversation with the materials of a design situation. Knowledge-Based Systems 5 (1), 3-14.

Wobbrock, J.O., Cutrell, E., Harada, S. and MacKenzie, I.S. (2008). An error model for pointing based on Fitts' law. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '08). Florence, Italy (April 5-10, 2008). New York: ACM Press, 1613-1622.

Zhai, S., Kong, J. and Ren, X. (2004). Speed-accuracy tradeoff in Fitts' law tasks—on the equivalency of actual and nominal pointing precision. International Journal of Human-Computer Studies 61 (6), 823-856.

5. BENCHMARK / DATASET CONTRIBUTIONS

Benchmarks or datasets are infrequent contributions in HCI, but they do occur. A benchmark or dataset contribution provides a new and useful corpus, often accompanied by an analysis of its characteristics, for the benefit of the research community. Benchmarks are offered along with standard tests to facilitate cross-project comparisons. Datasets enable evaluations of common data repositories by new algorithms, systems, or methods. Benchmark or dataset contributions are more common in the artificial intelligence, algorithms, operating systems, and database communities, to name a few.

How Benchmark / Dataset Contributions Are Evaluated

A benchmark or dataset contribution is judged favorably the extent to which it supplies the research community with a much-needed corpus against which to test future innovations. Also, benchmarks or datasets should be accompanied by explanations of how the benchmark was created or how the data was gathered, in what ways it is (or is not) representative, and common procedures to employ with it. Often, benchmarks or datasets are published with new tools that enable researchers to work with the new corpus. Where new methods or tools are released with new data, benchmark or dataset contributions may be part of methodological or artifact contributions as well.

Examples of Benchmark / Dataset Contributions

Hse, H. and Newton, A.R. (2003). Sketched Symbol Recognition using Zernike Moments. Technical Memorandum UCB/ERL M03/49, Electronics Research Lab, Department of EECS, University of California, Berkeley.

Llorens, D., Prat, F., Marzal, A., Vilar, J.M., Castro, M.J., Amengual, J.C., Barrachina, S., Castellanos, A., España, S., Gómez, J.A., Gorbe, J., Gordo, A., Palazón, V., Peris, G., Ramos-Garijo, R. and F. Zamora. (2008). The UJIpenchars database: A pen-based database of isolated handwritten characters. Proceedings of the Sixth International Conference on Language Resources and Evaluation (LREC '08). Marrakech, Morocco (May 28-30, 2008). Paris, France: European Language Resources Association, 2647-2651.

MacKenzie, I.S. and Soukoreff, R.W. (2003). Phrase sets for evaluating text entry techniques. Extended Abstracts of the ACM Conference on Human Factors in Computing Systems (CHI '03). Ft. Lauderdale, Florida (April 5-10, 2003). New York: ACM Press, 754-755.

Myers, B. et al. (1997). Using benchmarks to teach and evaluate user interface tools. Available at http://www.cs.cmu.edu/~amulet/papers/benchmarks.pdf

Paek, T. and Hsu, B.-J.P. (2011). Sampling representative phrase sets for text entry experiments: A procedure and public resource. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '11). Vancouver, British Columbia (May 7-12, 2011). New York: ACM Press, 2477-2480.

Plaisant,C., Fekete, J.-D. and Grinstein, G. (2008). Promoting insight-based evaluation of visualizations: From contest to benchmark repository. IEEE Transactions on Visualization and Computer Graphics 14 (1), 120-134.

Willems, D., Niels, R., van Gerven, M. and Vuurpijl, L. (2009). Iconic and multi-stroke gesture recognition. Pattern Recognition 42 (12), 3303-3312.

6. SURVEY CONTRIBUTIONS

Survey contributions are attempts to review and synthesize work done in a research field with the goal of exposing trends, themes, and gaps. Survey contributions take a step back (and often a step up), organizing the literature on a particular topic and reflecting on what it means. Often, survey contributions are conducted after a topic has reached a certain level of maturity. It is not uncommon for surveys to be over fifty pages in length, with references numbering in the hundreds. The journal *ACM Computing Surveys* is exclusively devoted to publishing survey contributions in computing. In HCI, the journal *Foundations and Trends in HCI* regularly publishes survey contributions.

How Survey Contributions Are Evaluated

To be effective, survey contributions must not be mere laundry lists of prior work. Rather, they must review and synthesize this work, extracting emergent themes and trends, identifying gaps where new opportunities lie. Surveys are judged on their completeness, depth, organization, maturity, synthesis, and fairness. Surveys are also judged favorably the extent to which they uncover promising new areas for future work.

As an example, consider the stated scope of *ACM Computing Surveys*: "[To] present new specialties and help practitioners and researchers stay abreast of all areas in the rapidly evolving field of computing. Computing Surveys focuses on integrating and adding understanding to the existing literature. [It] does not publish 'new' research. Instead, [it] focuses on integrat[ing] the existing literature and put[ting] its results in context. [S]urveys … must develop a framework or overall view of an area that integrates the existing literature. Frequently, such a framework exposes topics that need additional research. Basically, a [survey] article answers the questions, 'What is currently known about this area, and what does it mean to researchers and practitioners?' It should supply the basic knowledge to enable new researchers to enter the area, current researchers to continue developments, and practitioners to apply the results."

Examples of Survey Contributions

Balakrishnan, R. (2004). "Beating" Fitts' law: Virtual enhancements for pointing facilitation. International Journal of Human-Computer Studies 61 (6), 857-874.

Holden, M.K. (2005). Virtual Environments for Motor Rehabilitation: Review. CyberPsychology and Behavior 8 (3), 187-211.

Johnson, G., Gross, M.D., Hong, J. and Do, E.Y.-L. (2009). Computational support for sketching in design: A review. Foundations and Trends in Human-Computer Interaction 2 (1), 1-93.

MacKenzie, I.S. and Soukoreff, R.W. (2002). Text entry for mobile computing: Models and methods, theory and practice. Human-Computer Interaction 17 (2), 147-198.

Plamondon, R. and Srihari, S.N. (2000). On-line and off-line handwriting recognition: A comprehensive survey. IEEE Transactions on Pattern Analysis and Machine Intelligence 22 (1), 63-84.

Sawilowsky, S.S. (1990). Nonparametric tests of interaction in experimental design. Review of Educational Research 60 (1), 91-126.

Shaer, O. and Hornecker, E. (2009). Tangible user interfaces: Past, present and future directions. Foundations and Trends in Human-Computer Interaction 3 (1-2), 1-137.

Welford, A.T. (1960). The measurement of sensory-motor performance: Survey and reappraisal of twelve years' progress. Ergonomics 3 (3), 189-230.

7. OPINION CONTRIBUTIONS

Papers making opinion contributions seek to change the minds of readers through persuasion. Although the term "opinion" might suggest a less-than-scientific effort, in fact, opinion contributions, to be persuasive, must draw upon many of the above contribution types to advance their case, especially empirical results. Opinion contributions are considered a separate contribution type not because they lack scientific bases, but because of their goal, which is to persuade rather than to just inform. Along with persuasion, the goal of opinion contributions is to compel discussion, reflection, and even dissention or a change of course for the field. Opinion articles advance a specific point of view more overtly than articles from other contribution types.

How Opinion Contributions Are Evaluated

Opinion contributions are evaluated on the credibility and use of their supporting evidence and examples, on their fair consideration of alternate perspectives, and on the strength of their articulated position. Opinion contributions should focus on topics of interest to a broad community, and should therefore have widespread appeal. Often opinion contributions appear in semi-scholarly venues such as *ACM Interactions* to reach a wide audience.

Examples of Opinion Contributions

Bannon, L. (2011). Reimagining HCI: Toward a more human-centered perspective. Interactions 18 (4), 50-57.

Bernstein, M.S., Ackerman, M.S., Chi, E.H. and Miller, R.C. (2011). The trouble with social computing systems research. Extended Abstracts of the ACM Conference on Human Factors in Computing Systems (CHI'11). Vancouver, British Columbia (May 7-12, 2011). New York: ACM Press, 389-398.

Dourish, P. (2006). Implications for design. Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '06). Montréal, Québec (April 22-27, 2006). New York: ACM Press, 541-550.

Greenberg, S. and Buxton, B. (2008). Usability evaluation considered harmful (some of the time). Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI '08). Florence, Italy (April 5-10, 2008). New York: ACM Press, 111-120.

Harper, S. (2007). Is there design for all? Universal Access in the Information Society 6 (1), 111-113.

Newell, A. and Card, S.K. (1985). The prospects for psychological science in human-computer interaction. Human-Computer Interaction 1 (3), 209-242.

Norman, D.A. (1999). Affordance, conventions, and design. Interactions 6 (3), 38-43.

Norman, D.A. (2006). Logic versus usage: The case for activity-centered design. Interactions 13 (6), 45, 63.

Olsen, D. (2007). Evaluating user interface systems research. Proceedings of the ACM Symposium on User Interface Software and Technology (UIST '07). Newport, Rhode Island (October 7-10, 2007). New York: ACM Press, 251-258.

Shneiderman, B. (2000). Universal usability. Communications of the ACM 43 (5), 84-91.

Taylor, A. (2015). After interaction. Interactions 22 (5), 48-53.

ACKNOWLEDGEMENTS

I thank Scott E. Hudson for our numerous discussions of “activities of discovery” and “activities of invention.”