

COMMENTARY

On the relevance of qualitative methods for ergonomics

P. A. HANCOCK and J. L. SZALMA*

Department of Psychology and Institute for Simulation and Training,
University of Central Florida

Keywords: Qualitative methods; ergonomics; ethics; human factors; intention; science of purpose.

The application of qualitative methods to ergonomics research and practice offers us a new window on the nature of the interaction between humans and technology. The method discussed by Hignett and Wilson (2004) exemplifies this potential by applying their method to explicate the attitudes of practitioners and academic researchers toward qualitative methodology itself. Their specific findings, however, may be due in part to differences between the institutional structures in which they work as well as the attitudes of the specific individuals surveyed. Here, we offer a commentary on their work and reinforce the importance of qualitative research in ergonomics, while discussing the philosophical empirical, and theoretical issues raised by the introduction of these methods. We conclude that the fundamental problems inherent in qualitative approaches are limitations on quantitative methods also, being inherent to all forms of observation. While supportive of the general thesis proposed and especially appreciative of the authors' focus on purpose, we point to the problem of integrating different orders of knowledge as a significant barrier to future progress towards a comprehensive theory for ergonomics.

1. Introduction

There will always be worries and concerns when we are asked to move beyond our tried and tested approaches and embrace something that has the appearance of novelty. In any profession or academic enterprise there will be those who hold hard to the traditional and disdain the new and, conversely, there will be a group that embraces the new solely because of its innovative character. This leaves the preponderance of individuals cautiously interested but, as yet, unpersuaded. In trying to persuade the undecided, what Hignett and Wilson (2004) offer is the opportunity to embrace a wider vista of investigative procedures but one that is fraught with perceived and real peril since it lies at the very edge of science itself. About a century ago, psychology faced the exact reverse of this problem. Replete with subjectivity, the area seemed primed to divorce itself from all objective observation. Then, it was only through Watson's (1913) draconian dissociation from all inner experience that psychology fought to re-enter the realms of 'science.' Today,

*Author for correspondence. e-mail: jszalma@pegasus.cc.ucf.edu

we in ergonomics should be wary of any absolutes with respect to research procedures and should be more embracing of diverse ways of knowing. Indeed, in dealing with human beings, ergonomics is categorically unable to intrinsically limit itself solely to mathematical and quantitative methodologies. Like ethnology and anthropology, ergonomics must seek diverse strategies to comprehend the complexities of behavior in context. In throwing away the blinders of so-called 'physics envy,' let us now evaluate some such methods which Hignett and Wilson (2004) set before us.

2. Philosophical issues

Hignett and Wilson (2004) argue that the personal philosophy of the practitioner plays a critical role in the choice of method of assessment and approach to ergonomics. We agree with this assertion, as it points to the primacy of intention and purpose of behavior (Hancock 1995). However, we would point out that a sound philosophical position is important in any scientific endeavor, regardless of whether it is qualitative or quantitative in nature.

Hignett and Wilson bolster their argument for using qualitative methodology by appealing to transcendental realism, a position that allows for the existence of physical structures outside the mind but holds that different persons can have distinct but legitimate perceptions of that external world. However, qualitative methodology suffers the same limitation as quantitative methods under this philosophy, because the fundamental problem remains unresolved. That is, how does one establish the 'true condition' (analogous to the 'true score' in classical measurement theory)? Further, given the 'reality' of multiple realities, can such a 'true' condition be said to exist at all? Allowing for multiple realities does not solve this problem because the issue of the existence of an objective universe (i.e. a universe independent of perception and cognition) is not addressed. We do not expect Hignett and Wilson's qualitative methods to address this complicated issue, much less solve such a weighty philosophical conundrum. Nor do we believe that such unresolved problems with their philosophical bases for qualitative research necessarily reduces the immediate utility of the methodology or its relevance. Indeed, we praise them for bringing attention to this kind of research in a field that has historically been steeped in quantitative-based experimental research and expressed largely within an engineering framework. We do however suggest that the philosophical foundation for their efforts needs clarification and strengthening as the hoped for efforts to integrate qualitative findings increase.

3. Empirical issues

Ultimately the question of qualitative versus quantitative methods misses the fundamental point, which is the same for both: how can we verify our empirical evidence? This is an old question, regarding how we know that we are asking the correct questions of nature and the criterion for accepting evidence adduced. In other words, given that different people can have different perceptions of the same event, what constitutes valid empirical evidence? It is a problem that one cannot avoid by using any particular methodology, as the issue remains whether one measures physical parameters, physiological indices, performance response, subjective apperceptions, or qualitative interview data. Far from weakening the argu-

ment for adopting qualitative methods, this ambiguity strengthens it. If we cannot know with certainty the veracity of our empirical evidence, then assessing nature in multiple ways provides a better picture than a catholic devotion to a single methodology. With all due respect to Lord Kelvin¹, we argue that empirical evidence does not necessarily have to be quantitative. Any object or event, being constrained by space and time, has at least one characteristic that can be measured quantitatively, but this does not mean that quantitative data are the *only* way to characterize such an object or event. It will have characteristics that can be described qualitatively as well. Hence, a mature investigative philosophy should embrace both forms of assessment. Using the two methods conjunctively can yield a deeper understanding. This is especially true of human behavior and mental processes since they contain esoteric components, which stand in direct contrast to the traditional engineering concerns that deal with inanimate material. While qualitative methods are currently used informally in quantitative experimental research (e.g. in the form of debriefing at the end of experimental sessions), we should, as Hignett and Wilson indicate, consider adopting more formal qualitative procedures to enhance our understanding of human behavior.

In describing qualitative methods, Hignett and Wilson explicitly acknowledge that such research is subjective. Such subjectivity is disturbing to many ergonomists who, eager to reside under the engineering umbrella, are loathe to use methods that may appear 'unscientific' (see also Hancock *et al.* 2002). However, quantitative and 'objective' methods are each hardly independent of the experimenter. The subjectivity of the researcher is an issue regardless of the research method. The care taken to address the issue in qualitative research should therefore be transferred to quantitative research as well. It is interesting that psychologists, qua scientists, profess such an aversion to qualitative methods (Hancock *et al.* 2002). Other disciplines do not express such disdain, as is evident in many of the biological sciences. Chemistry also involves qualitative assessment. For instance, reports of syntheses of new molecules are usually accompanied by descriptions of qualitative characteristics such as color, smell (in the older literature, before the advent of safety procedures), and appearance (e.g. liquid, solid, crystalline, etc). In inorganic chemistry, metals are categorized as 'hard' or 'soft.' If biologists and chemists use descriptive methods when appropriate, why should we shirk from applying these useful methods to psychology and ergonomics? It is not less scientific to do so.

4. Theoretical issues: the importance of purpose

Hignett and Wilson (2004) see ergonomics as a socially situated practice. The social context makes the issue of intention critical as part of theory development and we wholeheartedly agree with the authors' contention that ergonomics must extend its view to include social and emotional factors to address the 'why' in design and behavior generally (see Hancock 2000, Murphy *et al.* 2003). Can qualitative methods aid in revealing intention and describing not only 'what is' but also 'what should

¹William Thomson (Lord Kelvin), who devised the Kelvin (ratio) scale of temperature, asserted that 'when you measure what you are speaking about and express it in numbers, you know something about it, but when you cannot express it in numbers your knowledge about it is of a meager and unsatisfactory kind (D MacHale, Comic Sections)'.

be'? (Hancock and Diaz 2002). If we accept that purpose is essential to ergonomics and sets it apart from other theories of behavior in context (Hancock 1997, Hancock and Diaz 2002), and that ethics is important for ergonomic theory (Shipley, 1998), then promoting the development of such a unique theory requires aggregation of seemingly disparate methods from vastly different disciplines. Qualitative methodology offers one innovative and critical component of this aggregation.

It is possible that using qualitative methods can enhance the development of ergonomic theory promoted by Hancock and Diaz (2002). As an applied field, ergonomics has, at best, generated microtheories, and in many applications empirical work is atheoretical. While Newton's assertion, '*hypothesis non fingo*,' (meaning that description is sufficient to itself and causation is not promulgated) has merit, we believe that theory building and theory testing is critical to ergonomic advancement at this time. By providing a different window to the world, this form of empirical method can provide a unique dataset that permits creation of comprehensive theory of what the human-technology interface *should* be. It can also reveal user intention in a way that can inform the development of design principles. Indeed, if a comprehensive ergonomic theory lies in a theory of intention grounded in linking ecological and information processing views, as suggested by Hancock and Diaz (2002), then qualitative methods have much to offer in specifying the perception of environmental characteristics and quality of information processing. It may help in developing what Hancock and Diaz (2002) called 'mindful technology' rather than the mindless technology that currently is propagated in large volume in the industrialized world.

Hignett and Wilson argued that qualitative methods will take ergonomics to level of their table 1 (spiritual sciences) in which 'universal purpose' is adopted as a central concept. This accords with the arguments of Hancock and Diaz (2002) for ergonomics providing the cornerstone to a science of purpose. It is argued here that qualitative methods are a useful tool for beginning to build this edifice. It is not our intention to challenge the usefulness of quantitative research. Rather, we see the two as complements rather than antagonists, in that they provide different vistas into phenomena of interest. Each provides data on an aspect or set of characteristics of the studied object, and like a gestalt, perhaps a complete picture of the whole only comes from embracing multiple measurement methods. Given the importance of both methods, it may not be advisable to divide different disciplines into qualitative and quantitative, as Hignett and Wilson have done in their figure 2 (e.g. social psychology in the qualitative end and experimental psychology at the quantitative end). While these distinctions may be historically correct, both methods could, in principle, be used by any of the human sciences.

5. Academics versus practitioners

An important question raised by Hignett and Wilson's work is not whether qualitative methods should be employed by ergonomics, but for what applications they should be used. It is not a question of quantitative versus qualitative, but of when a particular tool is appropriate. It is easy to allow this distinction to fall along academic/practitioner lines, but this imposes a categorization that most likely does not describe the many ergonomics professionals who straddle both domains. Some might argue that qualitative methods are more appropriate for the practitioner, for whom case study methods are useful in diagnosing and solving practical problems. However, qualitative methods have the potential to enhance the efforts of academic

researchers as well as practitioners. For instance, a detailed qualitative study of domain experts (e.g. professional drivers, industrial workers, military personnel) can inform the design of more traditional quantitative laboratory studies, thereby enhancing the external validity of such research. Qualitative studies in tandem with the quantitative can thus help address a long standing problem of external validity in basic laboratory research by aiding in the design of ecologically valid laboratory displays and controls. To date, qualitative research in experimental psychology has largely restricted itself to information gathered during the debriefing of participants at the end of an experiment (but see Hutchins 1996). This lack of systematic attention paid to collecting qualitative data is at odds with the tradition of rigorous application of quantitative methodology by experimental psychologists in the design, execution, and analysis of their experiments. It can likely be traced to the behaviorist disdain for studying mental events and the general desire for psychology to be quantitative based on a misguided belief that 'real science' is fundamentally mathematical in nature.

Hignett and Wilson noted that academics and practitioners have different views on the gap between the internal and external environments of ergonomics, in which academics see themselves as filling the gap while practitioners see the gap as reflecting differing views. Each author has a different explanation for why academics and practitioners differ in their viewpoints. One author suggests that it is due to a difference in approach, with academics taking a more traditional quantitative approach, while the other believes that academics feel they need to be jacks-of-all trades. We suggest here that the distinction is due to the behaviorist tradition in academia and the pragmatic considerations of practitioners. To use an analogy, academics and practitioners work in different environments with different affordances and with different goals (intention) which shape their behavior in different directions.

6. Unity and diversity

There was a time when those with a thirst for understanding did not divide the world into component parts for study. All was seen as facets of a unified whole. However, as the world became more complex, logical ways were sought to partition inquiry and derived disciplines subsequently focused on discrete aspects of the world. Art contrasted with science, subjective with objective perspectives and, potentially worst of all, teleology was divorced from technology (see Hancock 1997). This 'divide and study' strategy served well to advance discrete understanding, but now we are realizing that the next step is in integration and cross-fertilization of these divisions in the search for new and integrative knowledge. This coming together or 'consilience' as E. O. Wilson (1998) terms it, is now evident in the world of ergonomics, which stands at the confluence of art and science, of design and technology, and, as Hignett and Wilson (2004) elucidate, qualitative and the quantitative forms of understanding. This process of vergence and emergence is not easily accomplished. It is tantamount to mixing the oil of engineering with the cerebral-spinal fluid of neuroscience. There are many barriers to such a meeting of minds, not the least of which is academic tradition. In general, ergonomics has been a discipline without a home in academic institutions, which are divided traditionally into disciplines represented by distinct 'departments.' Practitioners often evolve from the confluence effects we have noted above, but there are few analogs in the academic world. The structure of

academic institutions, as currently configured, does not provide a receptive scaffolding on which ergonomics can be supported. Indeed, we argue that despite the polemics of many administrators, the traditional discipline-based divisions of academic institutions act to discourage inter-disciplinary work which is at the heart of ergonomic science. We suggest that the results that Hignett and Wilson (2004) report in regard to practitioner vs. academic attitudes may, in part, reflect these structural institutional differences.

7. Conclusion

Hignett and Wilson (2004) describe a useful and innovative approach for analyzing data from human-machine systems research. As such, it is an excellent addition to the toolbox of both researchers and practitioners. Its application to the issue of attitudes of academics and practitioners toward these methods, however, misses important differences between the contexts in which these two groups work. This underscores the importance of developing qualitative research questions in an iterative manner, as well as the necessity to consider the context in which the behaviors of interest evolve. In sum, Hignett and Wilson (2004) are asking us to learn new languages and embrace wider vistas. They have disturbed the comfortable, but we are comfortable with having been disturbed.

Acknowledgements

This research was facilitated by a Multidisciplinary University Research Initiative (MURI) program grant from the Army Research Office, Dr. Elmar Schmeisser, Technical Monitor (Grant # DAAD19-01-1-0621). The research was also facilitated by grants from the Army Research Laboratory, Mr. John Lockett, Dr. Michael Barnes, and Dr. Jessie Chen, Technical Monitors (Grant # DAAD 19-01-C-0065), and from a DARPA-funded program under Grant NBCH1030012, CMDR Dylan Schmorrow, Technical Monitor. The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Army, Department of Defense, or the US Government.

References

- DEMPSEY, P. G., WOGALTER, M. S. and HANCOCK, P. A. 2000, What's in a name? Using terms from definitions to examine the fundamental foundation of human factors and ergonomics science, *Theoretical Issues in Ergonomic Science*, **1**(3), 3–10.
- HANCOCK, P. A. 1995, Teleology for technology, in R. Parasuraman and M. Mouloua (eds), *Automation and Human Performance: Theory and Applications* (Hillsdale, NJ: Erlbaum), 461–497.
- HANCOCK, P. A. 1997, Men without machines, in P. A. Hancock (ed.), *Essays on the Future of Human-Machine Systems* (Bunta: Eden Prairie, MN), 137–142.
- HANCOCK, P. A. 2000, A stranger in paradigms. Keynote Paper. In *Proceedings of the 14th Triennial Congress of the International Ergonomics Association and the 44th Annual Meeting of The Human Factors and Ergonomics Society*, San Diego, California, USA. July 29–August 4, 2000. (Santa Monica: The Human Factors and Ergonomics Society).
- HANCOCK, P. A. and DIAZ, D. D. 2002, Ergonomics as a foundation for a science of purpose. *Theoretical Issues in Ergonomic Science*, **3**, 115–123.

- HANCOCK, P. A., WEAVER, J. L. and PARASURAMAN, R. 2002, Sans Subjectivity – Ergonomics is Engineering, *Ergonomics*, **45**, 991–994.
- HIGNETT, S. and WILSON, J. R. 2004, The role for qualitative methodology in ergonomics: a case study to explore theoretical issues. *Theoretical Issues in Ergonomics Science*, **5**, 473–493.
- HUTCHINS, E. 1996, *Cognition in the wild* (Cambridge, MA: MIT Press).
- MURPHY, L., STANNEY, K. and HANCOCK, P. A. 2003, The effect of affect: the hedonic evaluation of human–computer interaction, *Proceedings of the Human Factors and Ergonomics Society*, **47**, 764–768.
- SHIPLEY, P. 1998, The ethical turn and the workplace. The Ergonomics Society Lecture, *Ergonomics*, **41**(1), 1–19.
- WATSON, J. 1913, Psychology as a behaviorist views it, *Psychological Review*, **20**, 158–177.
- WILSON, E. O. 1998, *Consilience the unity of knowledge* (New York: Knopf).

About the authors

Peter A. Hancock is Provost Distinguished Research Professor in the Department of Psychology, the Institute for Simulation and Training, and at the Department of Civil and Environmental Engineering at the University of Central Florida. He is currently the Director of the Minds in Technology, Machines in Thought Laboratory at UCF. In his previous appointment, he founded and was the Director of the Human Factors Research Laboratory at the University of Minnesota. At Minnesota he held appointments as Full Professor in the Departments of Computer Science and Electrical Engineering, Mechanical Engineering, Psychology, and Kinesiology as well as at the Cognitive Science Center and the Center on Aging Research. He currently holds a courtesy appointment as a Research Scientist at the Massachusetts Institute of Technology (MIT) and as an Adjunct Senior Research Scientist at the Transportation Institute of the University of Michigan. Professor Hancock is the author of over four hundred refereed scientific articles and publications as well as editing numerous books including: Human Performance and Ergonomics in the Handbook of Perception and Cognition series, published by Academic Press in 1999 and Stress, Workload, and Fatigue, published in 2001 by Lawrence Erlbaum. He is the author of the 1997 book, Essays on the Future of Human-Machine Systems. He has been continuously funded by extramural sources for every year of his professional career, including support from NASA, NIH, NIA, FAA, FHWA, the US Navy and the US Army as well as numerous State and Industrial agencies. He is the Principal Investigator on the recently awarded Multi-Disciplinary University Research Initiative, in which he will oversee \$5 Million of funded research on stress, workload, and performance. In 1999 he was the Arnold Small Lecturer of the Human Factors and Ergonomics Society and in 2000 he was awarded the Sir Frederic Bartlett Medal of the Ergonomics Society of Great Britain for lifetime achievement. He was the Keynote Speaker for the International Ergonomics Association and the Human Factors and Ergonomics Society at the 2000 combined meeting in San Diego. In 2001 he won the Franklin V. Taylor Award of the American Psychological Association as well as the Liberty Mutual Prize for Occupational Safety and Ergonomics from the International Ergonomics Association. In association with his colleagues Raja Parasuraman and Anthony Masalonis, he was the winner of the Jerome Hirsch Ely Award of the Human Factors and Ergonomics Society for 2001, the same year in which he was elected a Fellow of the International Ergonomics Association. He was awarded a Doctor of Science (D.Sc.) degree from Loughborough University in December, 2001. In 2002, he was awarded the Jastrzebowski Medal of the Polish Ergonomics Society for contributions to world ergonomics and in the same year was named a Fellow of the Ergonomics Society of Great Britain. He has recently been elected to a three-year term as a Member of the National Research Council's Committee on Human Factors and which will run concurrently with his membership of the Executive Council of the Human Factors and Ergonomic Society. His current experimental work concerns the evaluation of behavioral response to high-stress conditions. His theoretical works concerns human relations with technology and the possible futures of this symbiosis. He is a Fellow of and past President of the Human Factors and Ergonomics Society. He collects and studies antique maps and is a committed Ricardian.

James L. Szalma is a Senior Research Scientist in the Minds in Technology, Machines in Thought Laboratory at the University of Central Florida. His previous appointment was assistant professor in the psychology department at SUNY Farmingdale. He received his Ph.D. in 1999 from the University of Cincinnati, where he investigated the performance, workload, and stress of monitoring tasks, and the use of feedback in training for vigilance performance. In addition to vigilance, his current research efforts are aimed at testing theoretical models of stress and performance. As part of this work, he is investigating the individual differences related to stress and coping strategies. he is also conducting studies to empirically test a novel modification of Signal Detection Theory, Fuzzy Signal Detection Theory.

Hancock, P.A., & Szalma, J.L. (2004). On the relevance of qualitative methods for ergonomics. *Theoretical Issues in Ergonomic Science*, 5 (6), 499-506.