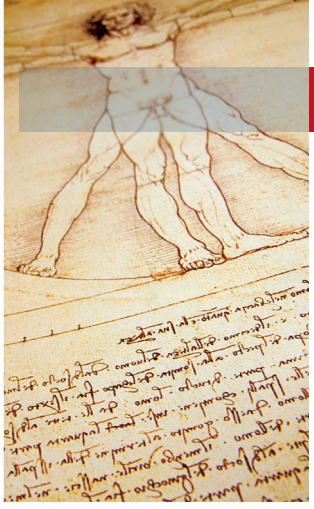

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Keeping Up with Intelligent Technology

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This essay focuses on a fundamental disconnect brought about by the rapid pace of change in intelligent technology. A previous essay in this department referred to this as a critical challenge to human-centered computing[1]: the time frame for experimentation to firmly establish the understandability, usefulness, and usability of intelligent systems (and software, in general) is too long to keep up with the pace of change in the core technology. Robust controlled experimentation takes time, and by the time it has reached its conclusion, the capacities and capabilities afforded by technology will have changed. In this essay, we focus on a derivative disconnect: the time frame for publishing reports on significant results of research and development activities—the time it takes to garner influential publications—is also vastly outstripped by the pace of change in the technology. At a recent government-sponsored workshop on prospects for new technologies, a mantram was: *in a rapidly changing world, the "quickest studies" will win.* This is both arguably true and troubling. This fundamental disconnect has negative consequences for the agenda of human-centered computing HCC, but it also jeopardizes the realization of the promise of intelligent systems. Even more broadly, it calls into question the notion that science is in the driver's seat, that science is cumulative, and that the peer review process is viable.

We start with two stories. Within reason, we try to refer to these examples independent of any specific identification because we want to make clear that these observations are totally unrelated to individuals or any particular deliberations, decisions, or specific journals.

A First Story: Technology Begs for Experimental Evaluation

In the late 1980s, virtual reality (VR) became hot. At the cutting edge of visualization and simulation, VR offered a degree of presence and immersion that was unparalleled and unmatched by the residual and approachingly passé capacities of 2D screens. One of us (P.A.H.) was fortunate enough to secure one of the first commercial "eyephones" (VPL-003) systems. The empirical question for science was of course: is this offered technology a true "quantum leap" forward, or is it just another overhyped technical gizmo? This technology just begged for controlled experimentation to evaluate this proposition, and this was precisely what we proceeded to do. The protocol for the first experiment was really quite simple and represented an extension of the standard "transfer of training" approaches used in classic experimental psychology research. The experiment promised to provide a fair test of VR's utility compared to other methods of training.

We need not recount the results of that experiment here. Suffice it to say that the results were interesting, informative, and to a degree positive: VR did offer some advantages at least in the realm of movement skills training. A report was submitted to a leading relevant journal under a rubric labeled "rapid communications." We were therefore hopeful for prompt publication of the findings. The data were collected in late 1990, the submission was in early 1991, and the accepted revision was accepted some few weeks later. The eventual publication date? 1993! By that time, VR had become just warm. Despite the fact that our results were among the first published in an archival journal, two years was a long time to wait for a "rapid" communication. Like the world, the lead graduate student on the research had by then moved on. It has been gratifying that the work has often been cited, but we still believe it could have had a greater, broader, and more meaningful impact.

Another Story: Drive at Your Own Risk

A recent event has served to recapitulate that VR experience. The technology is Google Glass, and the

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realm is driving. There is little doubt that distracted driving places lives in peril.[2,3] Furthermore, the propensity for drivers to use handheld, carried-in devices in their vehicles is clearly snowballing. This combination threatens to radically increase the number of driving-related injuries and fatalities.[4] As a result, many innovation design and technology firms are looking for ways to reduce such distraction, and this is part of a wider effort in the area of wearable computers. Such is the innovation of Google Glass. Quite rightly, we looked to evaluate the use of Google Glass while driving, and compare it to certain alternative technologies.

In this effort we were not alone, and the race was on to reach the pages of a leading journal first—with the caveat that proper experiments had to be conducted and meaningful and useful results had to accrue. The research of others is just now emerging in the form of conference proceedings. That counts as a publication in deciding which computer science faculty members get tenure, because (so it is argued) proceedings submissions are said to be heavily reviewed. In experimental psychology, only publications in peer-reviewed journals count. One wonders how a five-page paper buried in the morass of unobtainable proceedings from meetings such as the Fourteenth Somewhat International Meeting on Highly Specialized Things for Use in Specific Widgets (FSIMHSTUSW, Timbuktu 2001) will have any profound impact.

By dint of one journal editor's heroic efforts, we managed to get our own results published in what must be close to record time. Although we are more than grateful for this special effort, the fact that it was *special* actually emphasizes our main point about the fundamental disconnect and extraordinary efforts that individuals must undertake in order to keep up.

We wish to make clear these two stories of ours are neither cases of blame nor sour grapes, since both efforts culminated in useful contributions. Currently, the overall process is what it is. But our two stories are tales of responsibility, heroism, and the systemic abrogation of same. The central question is this: must the process of archival publication remain like this, or will such a lag eventually challenge the very foundation of peer-reviewed science by preventing any genuine cumulation of knowledge? It is upon this superordinate issue that we focus.

Implications for HCC

The problem of publication priority and relevance has, in a sense, always been with us. From the time of Darwin and Wallace's contemporaneous publication of the ideas of evolution in the organ of the Linnean Society, to the angst expressed by Watson and Crick over the prospect of being beaten to the structure of DNA by Linus Pauling, scientists have always been aware of the importance of time and precedence. But now the intrinsic competition among individual scientists and/or groups has been augmented by the accelerating rate of technological innovation. We all know that technology is cycling at an ever-faster frequency. It is almost an axiomatic cliché of our business that we now illustrate this by referring to a defunct system such as "eight-tracks" or "reel-to-reel" tapes. But the very rate of this replacement has reached such a precipitate level that the cycle time of technology is now faster than the publication cycle of almost any mainstream refereed journal. And here is our professional problem: our primary archival journals cannot now keep pace. By the time that such work appears in our primary archival journals, it is already essentially out of date.

We have heard it said, going back some years now, that the real purpose of journal publications is not to change the "now" but to inform the next generation. Whether science writ large is succeeding at this is open for discussion. It is arguably true that perhaps the most common means by which published work is utilized is in the production of a never-ending stream of literature reviews. This seems to be a mandatory "Task 1" in most grants and contracts. But owing to time and resource constraints, 60 percent of these reviews are too selective to be of much use, and the other 40 percent languish in the proprietary and dust-covered shelving of contractors.

What all this means for a scientific discipline devoted to human-technology interaction is that we stand in danger of being permanently behind the use curve. And what that means—since research is needed to determine that technology is usable, useful, and understandable—is a never-ending stream of user-hostile systems based solely on designer-centered design and weak usability analysis.[5]

Individual researchers or groups of researchers have reacted to this current situation in several ways. One obvious response is to publish work in faster turnaround outlets such as conference proceedings or nonrefereed communications, or even self-publish online in order to get the word out. One can even present results in popular books or via the press that, as the cold-fusion debacle showed, promises to be a rather dysfunctional process for science. But quo vadis science in such situations? Evading time delays by evading peer review might be a pragmatic solution, but eventually such a solution will erode a critical element of the very raison d'être of science. Down this road lies the dissolution of our unique value, to the detriment of all concerned.

So, if we cannot step around the issue, can we shrink the cycle time of refereed journals? Some sort of cycle time metric is the flavor of the week in many discussions of journal editorial policy. Such departments as "rapid communications" propose to circumvent the impasse by shortening the journal's side of the problem, but as we ourselves experienced, this strategy is fighting uphill. Especially vexing is the introduction of software systems to support journal editing and manuscript processing. In our experience, these have the consequence of turning editors into spreadsheet monitors. Indeed, editors often no longer actually edit at all. The upshot is the actual burdens of editing get shifted over to the reviewers, who themselves must feed the beast by placing sanitized, isolated statements into webpage templates and checklists rather than actually digging in and annotating manuscripts.

As Gandhi might say, "perhaps there is a way out of (this) hell," which is contingent upon theory. Here *theory* represents our proactive stance with respect to each generation of technical development and innovation. It is predicated upon our direct understanding of human physical and cognitive capacities, and here we can provide technological pronouncements about what technologies should do (prospective prognostications) as opposed to ever more outdated reactive comments on what designers have already produced (a retrospective cogitation) and then even perhaps discarded. This juxtaposition is reminiscent of the discussions as to whether human factors engineering, as either a science or profession, is doomed to just "clean up after the parade" versus "having its own parade."[6,7] A theme of HCC is that human factors considerations and research should lead the parade.[8]

The empirical embarrassment that we now must face, and must look to resolve, is whether this lag will become necessarily longer than most life cycles of the discrete technologies that we look to assess. Here is the question that culminates all this: can we use intelligent technology itself to address the core challenge? That is, can intelligent systems technologies subserve cycle matching times?

This question brings us to a critical impasse. If HCC and human factors engineering are to lead the parade, they must be based on a "science of technical design." It is salutary to note that, at the present time, design is much more an art than a science (when it should be strongly both), and we have no unequivocal rational, scientific basis upon which is found our "device advice" other than some nebulous "user acceptance."[4,5,9] Whether a true, quantitative ratio-based science of design is a feasible proposition remains a debatable yet critical question. With such a scientific yardstick it could then be possible to deal with ever shorter cycle times by being permanently ahead of the curve—an extension of the "envisioned worlds" approach.[10] Thus in theory and by theory, this could solve the impasse we have noted. However, it leaves the present pragmatic public problem still very much in place.

Founded on the envisioned worlds strategy, we have our own notions as to how we might approach potential solutions.[11] However, we solicit the thoughts of others. If we do not solve the issue and if our archival sources become simply superfluous to the modern technological world, it will not simply affect the revenue stream of our professional societies but rather, promises to undermine the nature of science itself.

It has generally taken a month or two from the time an essay for this department is in final draft, undergoes peer review, and then appears in print. The only software we need is Microsoft Word. HCC essays do not undergo traditional time-consuming peer review, but this is not to say that there is no review. At least one of the HCC department editors is an author on each essay, with the other editors serving as these peers, providing genuine and challenging editorial comments. Indeed, some draft essays have been trash-canned and never saw the light of day. We leave it to others to judge the value and quality of the HCC essays.

The HCC essays present ideas, methods, and principles and are not research reports. Thus, it is an apples-to-oranges contrast with time-to-publication of research in major journals. That being said, we could easily form an essay around a brief report of methods and results of research studies. It's just that such offerings have not appeared (yet).

As the saying goes, if you toot your own horn, it will play a single note. Would that everyone who has reached a certain level of accomplishment had access to rapid publication. Would that anyone at any level of accomplishment could quickly publish hot results and ideas. Would that all of us actually had the time to read all the resulting material.

We welcome your suggestions of topics and possibilities of collaboration on these issues and others in future HCC essays. ▪

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