Bush's Contribution to the Vision of Electronic Information Systems

Sir: In his article, “Emanuel Goldberg, Electronic Document Retrieval, and Vannevar Bush's Memex” Professor Buckland (1992) has performed a signal service in articulating Goldberg's much overlooked contributions and in elucidating the context of Bush's (1945) famous Memex and “As We May Think” article. His article gives us a far broader view of some of the antecedents of post-war information technology development, and a better sense of where we have come from.

However, I would submit that it is not so much that Bush is remembered and honored for the Memex, but that the Memex is remembered, often somewhat inaccurately it appears, as a token of the larger ideas in “As We May Think” and that it is for those larger ideas, also admittedly sometimes inaccurately rendered, that Bush is remembered and honored.

As Linda Smith's (1981) piece points out, a citation content analysis reveals that comparatively few of the citations to Bush's article are to his notion of a personal information system (the memex), still fewer to his notion of the memex as hardware.

What “As We May Think” is remembered for is primarily the combination of high density storage and electronic manipulation of data. Bush spends the bulk of the article, sections one through five, of eight rather conveniently numbered and rather equal sized sections, primarily discussing the capabilities and the advances of electronic technology, before he ever gets to the memex in sections six and seven.

In section one Bush discusses ‘thermionic tubes,’ cathode ray tubes, relays and automatic telephone exchanges, and concludes with “The world has arrived at an age of cheap complex devices of great reliability; and something is bound to come of it.” The bulk of section two, is devoted to electronic recording and transmission, including magnetic wire recording and facsimile transmission, and he makes it clear that he expects substantial improvement. Of facsimile he says “It would be a thermionic tube based devices. He also discusses storage capability and proposes “magnetic dots on a steel sheet.” He finishes by discussing the possibility of being “able to key one sheet of a million before an operator in a second or two with the possibility of then adding notes thereto,” and “One might, for example, speak to a microphone...and thus make his selections.”

The memex when it arrives in section six and seven, and as it is described, is rather something of an anti-climax. Part of the reason for that may lie in the history of the article. As Nyce and Kahn (1989) point out, the first draft of the article was written as early as 1939. Bush had reservations about where it should appear, the war intervened, and it was rewritten before it appeared in the Atlantic Monthly in 1945. One suspects that sections one through five were much expanded, and that expansion incorporated much of what Bush had learned and been involved with during the war, and that sections six and seven remained largely unchanged. Bush's phrase “thermionic tubes capable of controlling potent forces under the guidance of less power than a mosquito uses to vibrate his wings” for example, conjures up and almost certainly derivest from the WWII developments of the VT (variable time) detonated warhead for anti-aircraft shells, and the acoustic torpedo. Another part of the reason, as Bush makes clear, is that in his memex, he is trying to describe a device more or less obtainable within the available technology, and thus make his visions more real and palpable, and his call for physicists to devote their efforts to information technology more persuasive, by describing what comparative marvels could be accomplished with only minor extensions to existing technology.

What Bush is remembered for is the visions he sets out in sections one through five, and again in section eight where he discusses the possibility of communicating information electronically directly to the brain, not so much for the memex of sections six and seven. It is, however, quite likely that in fact those of us who have been perceiving Bush’s importance in that fashion may have been reading too much into his discussion of electronic information technology. “Magnetic dots,” not magnetic spots, for example, sound very much like binary technology. However, Nyce and Kahn (1989) point out that when one analyzes Bush's later writings and correspondence, digital rather than analog electronic devices do not appear to have loomed large upon his horizon.

Nonetheless the following facts are clear:

- “As We May Think” is more about electronic information technology than it is about microform devices in the Goldberg tradition.
- The article contains a number of very compelling visions* of the future of information technology, and most of those visions are electronic:

>“and at least one clunker. In discussing the potential of thermionic tube switching in comparison to mechanical switching he says, “No one would wish to spend the money necessary to make this change in the telephone system, but the general idea is applicable elsewhere.””

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*The Voder, as ‘thermionic tube’, produced speech sounds from key input (the keys represented sounds not letters), and the vocoder, using a microphone as input, reversed the process and produced key movement.

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mass storage both locally and remotely accessible
* rapid high quality facsimile transmission
* voice input to information devices
* flat surface magnetic memory (DASD?)
* direct electrical/electronic communication between brain and information device

The article enjoyed immense visibility, being reprinted (in somewhat reduced form) for Life magazine, whose impact and penetration were enormous in 1945, as well as written up in Time magazine, and subsequently cited, as Smith's (1981) article points out by a galaxy of the major figures in information science.

The article is also remembered for the possible prefiguring of hypertext-like notions by Bush's discussion of "associative indexing," Bush, as Buckland points out, is rather vague and not always well informed in his notions of indexing and retrieval*, and the connection between Bush's associative indexing and hypertext is loose at best, so this aspect does not bear elaboration for the purpose of the theme of this communication.

My concern with Professor Buckland's otherwise excellent and very commendable article is the implication that Bush's contribution has been much overstated. Buckland commences with: "The memex is usually viewed, unhistorically, in relation to subsequent development using digital computers" (p. 284). And he concludes with: "The evidence found indicates that the generally accepted view needs substantial revision" (p. 291).

The first statement is eminently correct. The second is quite true as long as its antecedent (which context the article does not make clear) is strictly to the forebears of Bush's notions concerning the application of microform technology.

What is of concern is that Buckland places the statements above in a context that more than implies that the microform based memex was all there was to Bush's article. Buckland, in fact, states baldly that "the paper... had nothing to do with either digital computers which were only then beginning to be invented, or the analog machines on which Bush himself had worked" (p. 284). That statement is quite incorrect. Although the word "computer" is not used nor is any example mentioned (this may be a function of not yet relaxed wartime security injunctions), the article is replete with mention of thermionic tubes, relays, magnetic storage—all the components of a computer. But, most importantly, much of section three, all of section four, and a fair chunk of section five, roughly 20–25% of the entire article, is devoted to the development of devices which are quite unambiguously computers. These devices are admittedly primarily special rather than general purpose computers, though there are tantalizing hints about "equation transformers" as opposed to mere "equation solvers" (a good descriptive phrase for the typical special purpose computer such as a naval gunfire control computer), and "a machine which will manipulate premises in accord with formal logic." But whether special or general purpose, it is clear that such an extended treatment of computers as prelude to the memex (sections six and seven) is in the context of, if not the first generation memex, then of subsequent generation memexes.

In summary what Buckland's article does not point out is that the microform/memex component of "As We May Think" is, in fact, not the major component of the article. The major theme of "As We May Think" is for physicists to now reorient their efforts to work on information systems. The major technical thrust of the article is the combination of mass storage with electronic information technology, and it is for this that it is principally remembered and cited. Without discussion, if only in passing, of the totality of Bush's article, Buckland's statements impair inappropriately that a substantial revision of the article's reputation is due.

If we have inflated the importance of "As We May Think," it is not because we have overlooked the contributions of Goldberg and other predecessors of Bush, but because we have read too much into the electronic information technology half of Bush's article. This we may indeed have done to a degree, but there still remains a compellingly visionary and original core to that component of "As We May Think" that will continue to ensure its position as a seminal document in our field.

References


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Sir:

Dean Koenig (n.d.) is, of course, correct that much of “As we may think” is a review of technology. Dean Koenig emphasizes the extent to which it can be seen as primarily discussing the capabilities and advances of electronic technology. I do not know what sources and precedents for “associative trails” there may have been, but, in re-reading “As we may think,” I myself am struck by the extent to which Bush is reviewing techniques that were already widely known at the time: photocells, microfilm, dry photography, positional coding, miniature camera, thermionic tubes, magnetic recording, electric circuits for sorting, and so on. Dean Koenig may be right in suggesting that too much has been read into the article.

Bush’s claim to originality needs to be seen in relation to his context. Whether Bush knew it or not, the features now associated with the “electronic library” of the twenty-first century—compact storage, ease of reproduction, personal workstations, remote access to full text using electronic telecommunications, hypertext, equipment capable of sophisticated searching in complex retrieval systems—had all been identified and discussed in print by those whose field this was by 1935, a decade before “As we may think” appeared (Buckland, 1992, pp. 9-17). Buck in 1931, for example, the well-known Dutch documentalist Fritz Donker Duyvis wrote that punched card equipment was simply inadequate for telephone systems was a more promising line of development for the sheer complexity of the Boolean and faceted techniques developed for retrieval from the 1890s onwards by Paul Otlet and others (Donker Duyvis, 1931, p. 53). In adopting microfilm selector technology, Bush was reinventing (and improving) in ignorance of the state of the art, as I suspect, he knew of the prior work of Goldberg and others but chose not to acknowledge it. Research may clarify these issues. None of this in any way diminishes the rich legacy of inspiration of others that Bush’s well-written article has achieved, nor Bush’s achievements in other fields for which he has, perhaps, received less credit than he deserves.

In the meanwhile, more material is becoming available. Nyce and Kahn (1991) have edited a volume on Bush and the Memex. Publication of detailed historical research by Professor Colin Burke is in preparation: An article entitled “The other Memex” is forthcoming in this journal (Burke, 1993; forthcoming 1992 ASIS Annual Meeting will include papers on Bush, on the development of hypertext before Bush, and on innovation in the handling of technical reports plundered from Germany at the end of World War II.

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References