A Tribute to the Foresight of Joshua Lederberg

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My theme is foresight. Investors, politicians, and generals want it, and Joshua Lederberg had it. I want to honor Josh by sharing some of his foresight in his own words. I could share examples of his foresight about bacteria or about the moon, but I would like to share especially happy examples that almost everyone today can appreciate.

The 18 examples are about email and the internet. They come from Josh's essay "Digital Communications and the Conduct of Science: The New Literacy," (Proceedings of the IEEE, Vol. 66, No. 11, November 1978). Nobel-prize winning geneticist Lederberg is identified simply as a Senior Member of the Institute of Electrical and Electronics Engineers. Received 9 January 1978, the essay reports on a project named SUMEX (Stanford University Medical EXperiment) initiated in 1974 with Edward Feigenbaum to explore applications of artificial intelligence to medical research.

Before quoting Josh, I should mention that the prefix "eu-" in Greek means good, happy, or pleasing. Josh's term EUGRAM is what we have come to call an email.

1. Josh begins:
Abstract—This essay is a personal perspective on the emergence of a new form of communication, optimistically called the "EUGRAM". This new form is based on the convergence of economical digital communications with computer-aided facilities for file management, and protocols to facilitate the interconnection of users separated both in time and space. The EUGRAM is contrasted with the telephone, with the latter's demands on instant availability and the subjugation of the user to an almost uninterrupted stream of data…

2. In the body of the paper he notes:
The economical integration of the user, file, processor, and distance-indifferent communication link is the novel capacity of what I shall call a EUGRAM system. EUGRAPHY thus embraces not only electronic dispatch of mail but also a panoply of computer-augmented text-handling tools and protocols…

3. For the diffusion of the system, Josh notes a cause now keenly felt but largely unnoticed in 1978:
…[I]it will probably be the cost-explosion of print media for scientific publications that proves to be a more immediately compelling motive for fundamental reexamination of our methods of scientific documentation and communication.

4. He notes the surprising local effects of computer networking:
Our experience EUGRAPHY at [Stanford] has been extraordinarily good. Individual users, of course, rely upon it routinely for access to computer processing. More surprising was the utility of EUGRAPHY for research management, involving the exchange of texts even over relatively short distances—offices down the corridor or in nearby buildings. This phenomenon has provoked introspections about EUGRAPHY as a qualitatively different method of interpersonal communication from conversation, the telephone, the handwritten memo, the dictated letter, or the published report, and some speculations about the further evolution of EUGRAM's as part of scientific communication.
5. He observes the virtues of asynchronous communication:
When telephone usage is limited to a few calls per day, and the connecting parties are reliably locatable, the telephone may indeed fulfill its image of instant, spontaneous communication. In current practice, beleaguered by time zone shifts, lunch hours, conferences, and competing calls, the reality of phone usage is exemplified by the employment of secretaries to make and receive the calls. The very instantaneity of the phone connection generates a queuing problem that defeats the basic motive. In due course, the two-way conversation may disappear, to be replaced by messages stored on tape recorders. The information density of speech may be viewed as very low, or very high, depending on how much of the burden is carried by the text, how much by inflection, phrasing, and other personal qualities. It may be only with respect to communications that have high affective content that audio channels can compete with digital channels.

6. He observes what now go under rubrics such as sort, search, and copy:
The EUGRAM has all the advantages of digital storage and accessibility to archiving, sorting and searching mechanisms that are far easier to implement, and require far less bandwidth than do voice messages. The EUGRAM itself can be composed quickly with a text-editor on the user display, where it is readily rehearsed, corrected and reedited before being transmitted. The same EUGRAM can be fanned out simultaneously to a large number of recipients, or it can be revised and perfected through several versions with similar broadcast, or with selective distribution. From the receiver's perspective, he has the advantage of a literate spatially oriented medium. In contrast to the time-fluent telephone, radio, or TV, he has the option of perusing his mail at his own pace, of interruption, backtracing, and cross-checking the text, even of marking it for reexamination and further rumination. He retains mastery of the use of his own time, and can coordinate attention to a coherently chosen set of tasks. He is liberated from the tyranny of synchronizing his own mental processes to those of the external actor.

7. Josh appreciates what we now call threads as well as spellcheck and other desktop features:
In framing responses, entire messages or selected extracts together with added comments can be forwarded to others, or returned to the sender-lending focus to a 'discussion' and providing unambiguous texts for the development of a consensus. EUGRAM's can be filed and retrieved efficiently, or transcribed into hard copy as required. Text editors may be embellished with elaborate formatting aids, spelling correctors, even an on-line thesaurus to aid in composition. When quantitative calculations are in question, numbers can me mechanically copied directly from program outputs, avoiding pestiferous typographical errors. The same computer is likely to be the user's research tool and give access to shared data-bases: the EUGRAM's can then refer

to common files by names that are themselves machinable. The user will also have access to other conveniences, such as desk-calculator-like programs for the checking of figures.

8. A year before the first Atari home computer and four years before the Commodore 64 computer would enter the market, Josh anticipates the era of the laptop, on-line address books, and merge functions:
EUGRAM's to groups are sent in real time supported by conveniences like group labels. Stored in the receiver's file areas, EUGRAM's are exchanged among an active community within a few hours, often within minutes. Users also remain in ready communication with each other, via their respective EUGRAM files, even when either or both have travelled away from their customary homes. Lightweight portable terminals give any user full access to the system from any point which connects to the global telephone and other communications networks. Some facilities offer a fair amount of directory assistance, in locating and identifying the EUGRAM addresses of users; files may also be used to contain blocks of addresses that can be addressed by group names.

9. He also called by name "Bulletin Boards" and "junk mail":
At [Stanford], publicly accessible bulletin boards are also available for broadcasting information or posting queries, without obstruction, to a large audience. No doubt, 'junk mail' will become a problem in this medium, as it may in any other. However, the recipient has as powerful a technology for filtering unwanted messages as the broadcaster has for disseminating them.

10. He appreciated the importance of fidelity in sharing computer code:
Consider how often we have to ask simple names to be spelled out and numbers repeated in phone discourse. Imagine then communicating a computer program of more than ten instructions over the telephone! Indeed, it is precisely for the sharing of such program source texts that EUGRAM's have been most manifestly indispensable for groups like the ARPANET and SUMEX communities. These program texts, which may reach hundreds of thousands of instructions, are among the most complex records of human logical effort.

11. Josh foresaw behavioral tendencies in word-processing, including "cut-and-paste":
The ease of its alteration saves some kinship of the EUGRAM to the oral tradition, with perhaps less social discipline but more effective tools to ensure the authenticity of the text. In fact, so much 'writing' is produced these days by dictation, with the most meager and clumsy postediting, that these tools may help bring the author closer to the well-tempered text he intends. Most tools are two-edged: the ease of inserting clichés and of conforming to system-defined formats may also hinder creativity. But this is like agonizing whether desk calculators will frustrate arithmetic skills. Some authors will balk at learning to type—even with all the facility of error correction afforded by every editor program.

12. He worried about privacy, flaring, and the inability to delete from memory:
Not every communication will or should be reduced to an unerasable EUGRAM. Lovers will not be deterred, no more than they are by the mails; but other intimate communications—particularly some of the angrier ones—are better left to media where

expletives can be deleted in hindsight. Even in scientific communication, there may be a place for a potential refuge: "I never said that?" This opportunity may be vitiated by the relentless accuracy of the EUGRAM, supported by new methods of encoding "signatures."

13. He called for software for "tracking", anticipating "track changes":
EUGRAPHY has been indispensible for the division of labor in drafting and criticizing complicated research proposals: 20 people may be closely involved in a product of 250 print pages. We have not secured a good system for tracking and interleaving successive versions, reducing a hairy tree of separate modifications to a coherent final form. Most nearly fatal is a cleanup reformatting that frustrates any simple line-by-line text comparison of deviant versions! Confusions of this kind in communal refinement of encyclopedic texts can perhaps be ameliorated with further software for documentation control.

14. Josh foresaw the business of Google and other search firms:
Near-zero-cost entry into the archives of a EUGRAM system will aggravate that problem, but has the compensation of an easy technology for selective retrieval. The role of the trustees will be shifted from controlling what enters the archives to that of organized consultation about what is worth perusing.

15. He anticipated the change of scale as millions of minds would contribute knowledge and also the problems of information control:
The same technology can also be used to broaden the participatory base, and to reduce the grievous time lags and enhance the limited information flow that now characterizes research proposals used for the allocation of budgetary resources. The pros and cons of a wider base of 'voting' on one's colleagues' efforts can be roughly anticipated: in some sense more equitable distributions on the one hand; on the other, the factionalization of decision-making, political alliances, and the tyranny of the majority even in the most creative of individual activities. These dilemmas face us today; the new technologies will introduce a change of scale not of principle in the social monitoring of private thought. It is not just Big Brother we may need to fear, but the whole brood of our competing siblings. The enemy may also be within ourselves.

16. He worried about the end of literacy and a shift to voice technology and cartoons - and also anticipated YouTube:
The social innovations will doubtless evolve in response to microscopic pressures rather than as part of a system design, and their functionality will probably be tested on a time scale slower than continued technological inputs. Some of the needs and inventions can be foreseen; their main effect may be to facilitate another wave of illiteracy by the recruitment of still more elaborate devices for the human-bit interface. Reading and pecking are slow, and beneath the dignity of some professionals; voice response is even cheaper than the visual EUGRAM, and the technology for voice entry is on the way. Graphics already are an indispensable aid; there is no technological barrier to the integration of multimodal cable-TV (e.g., animated cartoons) with EUGRAPHY.

17. Josh looked forward to font and color control:

The literate tradition can still be enhanced with improved designs of orthographic display, a wider menu of formats including color, perhaps even new alphabets and languages.

18. He realized the icons were on the way:
A 26-character alphabet certainly bears no relationship to any system that would be systematically designed to enhance the speed and reliability of human communications.

These thoughts matured in the context of a computer facility consisting of a dual DEC Model KI-10 CPU running under a locally developed dual processor TENEX operating system. It had 256K words (36-bit) of high-speed memory, 1.6M words of swapping storage, 70M words of disk storage, two 9-track 800 bits/in industry-compatible tape units, a dual DEC-tape unit, a line printer, and communications-network interfaces providing user terminal access.
Let us celebrate the foresight of Joshua Lederberg.

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