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BOOKS

Paper and communication without it, elements beyond uranium, the physical capacity of man

by Philip Morrison

PAPER BASICS: FORESTRY, MANUFACTURE, SELECTION, PURCHASING, MATHEMATICS AND METRICS, RECYCLING, by David Saltman. Van Nostrand Reinhold Company ($10.95). TOWARD PAPERLESS INFORMATION SYSTEMS, by F. W. Lancaster. Academic Press ($13.50). Every year enough newsprint is made in the U.S. to paper over the states of the Northeast. As much again is made in all the other forms of that material, which has linked author to reader for many centuries, since its invention by the Chinese during the epoch of the Roman emperors. Today most paper is made from wood fibers; the better grades also contain cotton fibers, not so much from the rags of yesteryear as from cutoffs discarded during the manufacture of new cotton goods. This magazine page is a coated stock, several layers of clay filler and white pigment having been rolled onto the moving web during its passage from a wet slurry to a shippable roll; the paper's wood content is mostly softwood fibers several millimeters long, with some dense, shorter hardwood fibers for filler, all prepared by chemically cooking out the lignin fraction of the wood. Newsprint runs three-fourths or more mechanically ground pulp; the fibers are crushed under a four-foot-wide grinding stone that turns logs into pulp under a deluge of water. The newsprint yield is high, because such pulp contains most of the wood, the lignin as well as the cellulose.

Papermaking has an air of the heroic. Trees are pretty big as raw material, so that cutting and transport has always been a heavy task. Today a tall tree can be seized by the jaws of a hydraulic diesel dinosaur on huge tires, its limbs can be sheared off, its top clipped and its trunk cut to four-foot lengths in a minute or so. Another kind of machine can instead lift and swallow an entire tree and then spew wood chips, bark and all, into a truck waiting at the output end.

The pulp is carefully bleached and prepared until finally it is delivered as a slurry (99 percent or more water) to a big moving wire mesh, the fourdrinier, that vibrates as it carries the steadily draining sheet of pulp along at speeds of up to 30 miles per hour. The dandy roll, with a texture of fine wire mesh, smooths and squeezes the web and may impress a watermark. Up and down around heated drying drums the paper flows in clouds of steam; at the dry end the sheet still contains about 5 percent water; drier paper becomes brittle. Sizings, coatings and smoothing rolls finish the paper and cutters slit the rolls to width. Sheet-cutting and packaging machines may come as a last step. Mills are mass-producers; they like to think of shipments by the carload, a nominal 20-ton minimum. A ton of paper is the yield of a couple of cords of wood, a ton and a half of coal, half a ton of bulk chemicals such as lime, clay and sulfur, and a couple of hundred tons of fresh water.

We all know some of the conventional grades: bond, offset, coated book, newsprint and tablet paper, and thicker stuffs such as bristol and tag, the file-folder material. A campaign for exceedingly lightweight opaque coated papers suited for fast color printing in large-circulation magazines has now gone about to its limit, the weight of the paper having dropped a third below the old standard in the past several years.

About half of *Paper Basics* is a primer of paper technology consisting of such background material; the rest is a knowing guide to the paper market. David Saltman is an old hand in the New York printers' world, and his concern to help the buyer of paper is manifest in detailed accounts of just how to reckon your needs (do not forget an allowance for spoilage) and how to deal with the jobbers who subdivide and pass along those mill-made carloads. Although the book is not always as complete as a reader could wish with respect to production hows and whys, it is nonetheless quick with the common sense of a complicated marketplace. The technically literate have some obligation to understand at least the simple basics of our one hard-copy medium; here is an entry. (Recycling is a real enthusiasm of this author's. Clear-cutting the forest, wherever the slope admits, appeals to him more than the preservation of wilderness, which is plainly all loss to the world of paper.)

Look away from the loggers, the smoking mills, the tense bargaining of Manhattan. In *Toward Paperless Information Systems* there sounds a voice in prophecy, that of a University of Illinois student of information systems in the large. He sets out a forecast: the end of ink on paper, apart from news and entertainment. Why produce, ship and store forever on ten thousand shelves multiplicate acres of symbols when those symbols can be summoned by microwave and cable at any place and at the very moment the reader needs them? The shelves, worldwide, turn into one prodigious central file that is quickly at the disposal of all. What our seer says is not, however, the result of plausible analysis alone, or even of forecasts by extrapolation and analogy.

"In 1972," he writes, "I discovered that the defense-intelligence community in the United States was already moving rather rapidly towards fully electronic systems" for "the dissemination, storage, and retrieval of intelligence information." He challenges our attention "in the role of provocateur," as one who has newly come to see that what the Central Intelligence Agency and its contractors have done points the way to the natural evolution of professional communications in general.

By 1981, after a decade of trial and growth, the full system called SAFE—forget the awkward rationalization of the acronym—should be working at CIA headquarters in Langley, Va. Each of the 2,000 professional production analysts who make up the learned arm of that oracular agency will have a console at hand. Doubled viewing screen and keyboard are the bare essentials; close by will be a printer, and "regionally" there will be a microfilm viewer-printer. The task of an analyst is to contribute to reports—either frequent ones, journalistic in length and timing, or more complete ones on matters of durable interest. The coverage is worldwide and includes economic, military, industrial, political and biographical topics, and more. The emphasis is policy-directed, more on current concerns and the near future than on the past, the eternal or the eventual. Into the agency pour "mes-

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sages," about 6,000 or 8,000 a day. Two-thirds of them arrive by teletype (the "electricals"); the rest come on paper. They include newspaper clippings, the recordings of foreign broadcasts and the cables of diplomatic and military missions overseas.

Once SAFE comes, the analyst will begin the day with a "mail scan." Following his standing orders, or "interest profile," the screen will bring to his attention messages that have been computer-screened by key-word combinations, with these tentative computer assignments overseen by human decisions. Half of the messages are standard items that are always sent to the appropriate people, and almost 40 percent more are distributed ad hoc by the computer-human combination. The message text need be stored only once. The 28 million paper copies now sent around each year will drop greatly in number; each analyst will call up what he wants, examine either extracts of the document or the whole of it, cancel his address from the item or reroute it. He can search a mail file for recent items; that is, for a few days he can search the very text itself. Later on the message is downgraded to a text file that can be searched by various indexing schemes, but not by every word. Finally the analyst can use the microforms. These will offer not only the nonelectrical messages but also the older and more general materials. The microform store can be called up automatically by its indicators and can be displayed nearby for his use.

All of this is mail and library, so to speak, but every analyst can also build his own files. Into these he puts any item, indexed as he chooses, with standard information already included (date, source and so on). His tags will be his own, accessible to no one else and as varied as he wishes. He can mark key words with a light pen for inclusion in his index; he can add comments, which will come up with the document whenever he calls for it, both of them being displayed on the divided screen simultaneously. All searches are interactive; some files will be kept by groups or by offices rather than by individuals. Through special terminals where expert help is available the analyst can gain access to external digital files of information such as that of *The New York Times* and various medical and legal data bases. (What he will not have is access to any high-quality images. For quite some time these digital systems will not work for photography or for color.) He can compute, edit and release his work to add to the message stream directed to those he seeks to reach. With that action the system closes on itself.

Secrecy and resilience against breakdowns (by redundancy of equipment and by distribution of many functions among minicomputers throughout the network) appear to be attainable. The system promises to save money (a handy sum in paper shredders alone, one imagines) and above all to produce a "more thoroughly and swiftly informed intelligence community."

A paperless world for all scientific and technical communication is presented in scenario form in the last chapters of this book. Based on the recent literature and on the CIA experience and plans, the picture includes the economic rationale, the technical and special problems of implementation and the role of the future library, all as of the millennial year 2000. Every research worker her terminal, certainly (and perhaps another one at home), keyboard, screen and so on. There she can write and send letters, reports and preprints, and also receive them. "Virtual journals" will come regularly, edited, refereed, with familiar names and standards, but all by way of the screen. The researcher can skim or read carefully. A personal file will include an electronic notebook for recording research in progress as informally as the user chooses. Editing programs will facilitate the preparation of more formal reports at every level up to full publication. Drafts might be sent out for the comments of friends.

Of course, the on-line capabilities would include all kinds of reference books, bibliographies, indexes and similar tools. Just as journals will become virtual, so libraries will be without walls. Familiar colleagues—the "invisible colleges" of science—will be easy to reach by message or even in conversation. Billing for all of this would be on a pay-as-you-go basis, for items actually used or services examined. A search could widen from simple and local files to unique national sources according to need and expense. Personal files would accumulate from all of this, holding or disposing of whatever the user chose. Any portion of such informal stores could be available to particular users or to entire groups. The network foreseen is flexible, widespread and even worldwide. Its architecture might somewhat resemble the CIA example. All that CIA urgency seems less than a good model for much of science, which has a far longer attention span.

Is it feasible? The memory needed for all world journals is about 10^{13} bits of on-line storage each year, a couple of million dollars' worth a year with laser memories (it says here). An estimate (made by an English author in 1977) suggests that an investment of $2 billion would place a world electronic journal system in full operation, with a cost per year equal to the present cost of journals, mainly for the mass provision of workable terminals, of course.

Will we enter the paperless world? The roles of publishers, journals and research libraries would all change, and capital demands would be heavy. Can research workers themselves adapt? The author thinks so, the more since the CIA professionals were won over by the benefits demonstrated for their system. And it is not we old fogies who must be served but the new generation. They are used to screens.

Certainly paper will not vanish. Books are marvels of easy access, and notebooks even more so. (One would like to know the results of an inventory of the paper actually on hand at Langley in 1984.) There is opened a vision of terrible homogeneity and overload. Advertisements, letters from dear friends with good news, first-rate papers, nonsense, long catalogues of data to be used only years after receipt—all pour in, all look just the same, with no cues to memory save the digital labels themselves. No familiar bulk or cover would mark the journal, the book or the long-expected reprint. Will textual memory work well enough? The graphic arts have practical value; visual aesthetics is not separate from thought. A notebook without graphs and sketches may suit a historian, but it would not suit a scientist. Computer output today is ugly stuff, hardly readable. Better graphics is essential, and something more than a keyboard input. Will those mass-production terminals be good enough? Visual images of quality will be seriously limited. We see how television brings us its murder and merriment, hard data and sheer fantasy, all of it in one tiny size in the same place in the same room, flat, miscolored and flickering—unreal images.

Alan Turing was surely right in principle: the digit maps all knowledge. The human brain has not evolved so, however. It enjoys many channels of input, and cross-correlation is a sovereign mental technique. Sensory dilution is a real danger; so is the extreme centralization of stores. Multiplicity has always offered protection; a single store will not save knowledge in the long pull.

Still, some of all of this will surely come to pass. The economics of symbols ensures it. Once long ago the learned must have complained: What, write down those verses? A book is far too thin a version of Homer's verse; the living bard is individual, his song a beauty. And yet for millenniums we have been able to take joy from mere ink on paper. So all things flow.

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