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Dear Ed:

I wonder if you noticed a piece by Richard Feynman in the Saturday Review for April 2. This had to do with a proposal for Art to emulate Nature in storing information on a minute scale. I think we had actually discussed some speculations along the same line at our luncheon meeting. At any rate, it would be a great trick if we could use a linear information program like the sequences of purines and pyrimidines in the DNA of chromosomes as the memory for a computer, but... we haven't begun to think of how we could read out this information, though I think it may be feasible when the biochemistry has gone a bit further.

You did ask me to alert you if I could visualize any new directions for contributions from Varian for biological research. Apart from the rather trite suggestions I made before (particle counting devices) I haven't run into anything very promising. But I suggest that you do give some thought to the possibilities of developments in the direction of microstorage of information. Since the bits have to be discriminated from one another, some sort of microscope is presumably required; eventually some kind of chemical amplification (e.g. self-replication of the sequence) might come in too. I had not noticed that microscopes play any important role in information technique until now, except for the use of rather limited optical magnification in, e.g., the microfilm reader. There are, I think, 3 kinds of microscope that are likely to be useful -- the standard light microscope, resolutions to about 1 micron; the electron microscope, useful resolution to about .001 micron, and the electron-field microscope which might go to an angstrom. (The last item, by the way, might well warrant attention as an instrument that is technically rather tricky now, but might have tremendous application if suitably developed.) Once you think of using a microscope, the ways of using it become fairly obvious. For example, Ultra-violet light beams of 1 micron diameter are not too difficult to produce, and even smaller particle beams are available. A high intensity beam can be modulated to write a message on a microtape dyed with a bleachable stain, which can then be read out by microscopy at innocuous light intensities. Even erasure and reimprint can be provided for by using some reversible reactions. Micromanipulators are already available that should be able to handle specimens to the same 1 micron resolution; they could be improved by incorporating positional information on the tapes and feeding this back to the controls. As you will have calculated, a grid 1 cm^2 could accomodate 10^8 bits (without overstraining present day technique). ((Erasing and correcting a single bit in such an array may be somewhat optimistic -- I have in mind some chemical analogues to biological photoreversal of UV effects -- and it might be easier at first to correct by recopying to fresh tape.))

The chief limitation to using higher resolutions may be some mechanical problems of registration; I would have to ask what the relative angular resolution of a flying spot can be held to. In connection with his work on X-ray microscopy, reading the latent images in the electron microscope, Howard Pattee may have some useful background.

Yrs. cordially,
Joshua Lederberg

Ed: I'm sure some of this is "old hat" (perhaps not all. It would be a contribution to theoretical biology as well as to engineering if chemical microstorage of information could be exploited. Call me at your convenience if there is anything I can do to facilitate matters.
J.