"Why a LINC"?

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Although I have not been involved directly with the LINC now for some time, I was nonetheless there when the idea first germinated and helped to bring it into being. So it seems appropriate by way of introduction for me to spend a few minutes reviewing the early history and some of the original objectives of the LINC. I'm particularly interested in hearing people's reactions to the changes represented by the PDP-12, and later I'll give you some of my own impressions.

It all began somewhere in 1960, and, although many people contributed to the final product, the LINC was primarily Wes Clark's invention. At that time, we were part of the Digital Computer Group at M.I.T.'s Lincoln Laboratory. We had come together originally through the hope that our work in computer development might be directed to the needs of the medical community. Several people in the group were involved in neurophysiological research, and this provided the background for some of the decisions which had to be made about the machine.

During the Spring of 1961, Wesley filled several notebooks with developing ideas for the machine, and by the Fall, these ideas were being discussed and criticized. The fundamental concept survived this pretty much intact, although many details changed as the picture of the machine began to crystallize. We eventually produced a prototype early in 1962, a binocular version of today's cyclops with the two scopes mounted side by side. Early on, Wesley had referred to the machine as the LINC, and most of us assumed that this had something to do with our presence within Lincoln Laboratory. It was only when the group was about to leave Lincoln that Wes announced casually that LINC really stood for Laboratory Instrument Computer. We clearly still had much to learn.

Back in those days, the large machines were beginning to enter their heyday. The computer center could surely serve everyone if the computer was only big enough. Claustrophobia of the core,

stemming from having been shut up in small early memories, had permanently affected the mind. The idea that other features could be of overriding importance was not taken seriously. And yet, a large part of the scientific community, the experimental as opposed to the actuarial, was being poorly serviced. The inaccessibility of the large computer-center facilities made debugging of programs a chore. If rewriting and reshaping of programs (as an experiment developed) was a continual rather than a one-time effort, matters were even worse. If, in addition, one needed to connect laboratory apparatus to the computer, then the case became virtually hopeless. The computer was remote from the laboratory and most likely accepted only punched cards. And even if it took your data in, without a scope you might never know what had become of it.

These, then, constituted the physical inaccessibilities. There were also the psychological ones having to do with the size, cost, and general impressiveness of the computer. Experimental scientists generally thought in terms of intermediaries who would write programs to solve differential equations, compute standard deviations, etc. No one really thought of the computer as a tool to be utilized directly in the course of an experiment. The computer therefore had very little impact on the kinds of research that were undertaken.¹

Accessibility was thus a key consideration throughout the design of the LINC. Separation of the logic/power supply cabinet from the user's units was an attempt to increase convenience in settings where, for space or environmental reasons, only the minimum of equipment was permissible in the laboratory. The scope was included so that one could observe results in real time rather than somewhere in the midst of a 4-in.-thick printout. The A/D conversion system accepted signals that could come, in most cases, directly from lab apparatus or, at most, via simple amplifiers. The console is perhaps the only one I have ever seen that, with its debugging features and speed control, is a pleasure rather than a frustration to use. The knobs permitted one to control parameters of all kinds in the most natural way. The I/O system had to be extremely flexible, and we preferred to arrange matters so that devices could be connected

with minimal hardware combined with clever programming.

I think the interfaces for the Calcomp plotter, the Teletype, and even the more elaborate tape transports speak for themselves. Pointing out the desirability of the LINC tapes seems unnecessary at this stage, although we should pause to consider how handicapped the machine would be without them. The ability to walk up to a cold machine (with no bootstrap program in memory) and load a program from any block of tape into the memory with one simple action is enormously convenient.

Despite these added features, the price was to be kept down, and the machine had to be small enough and reliable enough to be portable. These conflicting requirements of course meant some compromises. The (expensive) memory had to be kept small, not only in number of words, but also in word length. This complicated the instruction format, although, by way of compensation, I feel we ended up with a powerful repertoire. Speed was sacrificed for savings; we convinced ourselves that 8 bits of accuracy was sufficient for most analog measurements, etc.

The advances that have taken place in reducing the cost and size of logic and speeding up memories have permitted some of the improvements represented by the PDP-12 (although, of course, prices are always disappointing). The faster and larger memory is welcome, as is the overlapped tape-transfer logic. The larger scope would be more impressive if the precision had been increased.

Combining the parts of the machine into a single larger cabinet certainly gets rid of the cables, which are something of a nuisance. However, it clearly violates the original goal of trying to keep the bulky and uninteresting part of the machine out of the way. The addition of the Teletype, grim device that it is, is a concession to reality that we also were ultimately forced to make.

All in all, I feel ambivalent toward the changes that have taken place from the classical LINC. There are some clear gains, but I think there may prove to have been some losses as well.

NOTE

1. We are no doubt still suffering from the scientific equivalent of the "first-sports-car" syndrome. If we don't outgrow it, the computer is hardly to blame.