The economic implications of microprocessors on future computer technology and systems

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INTRODUCTION (HOW DID WE GET HERE?)

At the turn of the last decade, 1970, the computer market was well structured. Almost 70 percent of the market was controlled by a single company, IBM, while (25 percent) of the remaining market was primarily controlled by four other companies. These companies produced the systems, software and hardware required for automation systems using second order suppliers to furnish a large proportion of the component parts. The largest second order suppliers were the semiconductor manufacturers who did an annual business of ($348 million/1970) annually producing the logic components for the required computer and peripheral system elements.

As the semiconductor technology developed to permit integration of larger logical functions on a single semiconductor chip, a new low-cost computer industry evolved. This industry, the minicomputer industry, specialized in the production of dedicated computer systems for control applications in price ranges starting under $10,000.

Further developments in this field involved the production of a microcomputer which was partitioned into bit elements of a minicomputer combined with a micromemory capable of sequencing simple microinstructions in order to affect, complex minicomputer instruction performance.

Another development expanded the four bit microcomputer capability to eight bits permitting these devices to efficiently operate for the first time with alphanumeric type codes, such as ASTIA. Thus, application of microcomputers to intelligent terminals and low speed data concentrators began to occur.

WHERE ARE WE NOW?

At the point of this writing, three major semiconductor manufacturers control over ninety percent of the microprocessing market. However, over twenty other manufacturers have announced competitive products in an attempt to penetrate this new market. The next year promises to be one of extreme competition between semiconductor-microprocessor vendors while they attempt to obtain market shares large enough to permit their continuation in this business area. Certainly many competitors will not survive in the keen competition which is about to occur.

In contrast with the initial microprocessor devices which were available, all of which began utilizing the more readily processed PMOS technology, microprocessors are now becoming available utilizing more exotic technologies which permit them to realistically compete with minicomputers in speed, as well as use in rugged environments. Among the technologies recently announced are; NMOS—which yields a factor of three in increased device speed of operation, CMOS—which permits wide temperature range for rugged applications, along with minimum power requirements, and single supply voltage, BIPOLAR TTL—which permits high speed and single power supply
requirement, and INTEGRATED INJECTION LOGIC, which permits reasonably high speed, wide temperature range, and minimum power consumption.

Along with the development of these new technologies in microprocessors, better semiconductor process controls are beginning to permit larger quantities of logic to be placed upon a chip with reasonable yield. This improved process technique is resulting in the design of microprocessors with larger word lengths for applications where more powerful processing functions are required. At this time processors of 12 and 16 bit lengths have been announced by semiconductor manufacturers.

Although many manufacturers are attempting to build truly general purpose microprocessors for use in all applications, certain of the manufacturers have singled out specific applications areas, either based upon their processors design, or by design of chip sets for specific input/output applications. The function of peripheral control has been targeted by Rockwell while RCA is attempting to penetrate the entertainment market with a television add-on processor. Both Motorola and Rockwell are attempting to penetrate the communications market with specially designed microprocessor-modem parts, and Toshiba is attempting to win the automobile microprocessor control market with their wide-word, wide temperature range, 12 bit microprocessor.

In order to penetrate the microprocessor market, semiconductor firms have found that it is necessary to provide potential users with software capabilities almost as sophisticated as that provided by minicomputer firms. Most microprocessor manufacturers now have software assemblers and simulators available from timesharing services, or will provide Fortran decks for users who have their own computer systems.

Most of the microprocessor systems maintain their procedures (program) in read only memories, either fixed or programmable. In order to fix instructions within the ROMs, the user must either prepare data tapes for the semiconductor manufacturer or have available a means of programming their own semiconductor memories. In order to provide this function, and to permit checkout of microprocessor systems several manufacturers have made available low-cost ($2-3,000) hardware simulators which permit test of the system before the program is frozen in ROM or PROM.

At present, except in the case of National Semiconductor, few of the semiconductor microprocessor manufacturers provide assistance in application of their devices to actual function implementation. National is the only manufacturer that has indicated that it is in direct competition with the minicomputer manufacturer for application type business. All other microprocessor manufacturers indicate that they intend to operate as original equipment manufacturers of parts only.

WHERE ARE WE HEADING?

Nonetheless, it is evident at this time that the microprocessor is headed for competition in two basic areas. First, it will penetrate the low end and eventually take over the minicomputer market, secondly, it will generate many new high volume applications in areas previously unreachable by the computer industry due to the previously high cost of processor hardware.

There is no question that we shall see a marked change in the semiconductor business as a result of the evolutionary development of the microprocessor. For the first time the semiconductor manufacturer will have volume (end product) markets in automation application areas. Areas of business which could provide new markets for microprocessors directly to the semiconductor houses without intervention of computer manufacturers are shown in Table I below.

Several market projections have been made during recent months. A summary of these market projections in dollar volume is given in Figures 1 and 2. As indicated in Figure 1, market projections vary between $180 million in 1978 to $107 million in 1982. It is interesting to note that given an estimated demand of 3 million chip sets in the end projected year, the cost of chip sets by semiconductor manufacturers shows a cost varying between $36 and $90 per chip set.

Actual microprocessor system costs, projected in Figure 2 include memory and input/output units, in addition to the basic microprocessors. Average costs of these units vary from $167 to $564 in 1982 and 1978 respectively. One can only regard the large variation in these figures as an indication that the emerging microprocessor market is not
yet well defined. No projection yet indicates the effect of the automobile market, estimated to begin using microprocessor product in 1980, and only one projection indicates the in-house capability that will be developed by the present computer industry leaders in order to maintain value added in their peripheral and processor products.

One thing is patently apparent, and this is that there will be a fall-out of vendors of microprocessor products. No one winner will be evident, but rather several manufacturers concentrating on specific functional products will survive the shakeout, along with, perhaps, several general purpose device producers.

The effect on microprocessor users, such as numerical control manufacturers, and peripheral manufacturers will be the development of de facto interface standards that are enforced by the availability of only a few dominant types of microprocessor types to implement their device control. It is appealing to project that the survivor, and thus the interface definition will be determined by the best, most economical design available from the several semiconductor microprocessor producers. However, as already apparent in the industry, the surviving de facto standard is not always the best possible design, but rather an indication of the economic, marketing, and political elements existing at the time of the technology shakeout.

Projections of eventual costs of devices by semiconductor manufacturers indicate that piece parts of $10 per unit are possible for product volumes of 10,000 units or greater. Simple availability of such devices will force computer design engineers of larger systems to use these devices whenever possible because of economics. Thus the availability of microprocessors will affect even the architectures of larger machines in areas where speed is not of extreme importance.

Undoubtedly, because of cost advantage there will be a trend toward partitioning of those problems which will admit such decomposition into a series of serial processes which can be implemented by means of microprocessors with little sharing of the problem data base. (An example of such a partition for a radar processing function is given in Figure 3.) Some modification to current microprocessor architecture will undoubtedly occur to more readily permit sharing of certain memory banks by multiple microprocessors.

Certainly in the near future there will cease to be any non-intelligent peripherals. The economics of the microprocessor dictates that all symbiont routines, previously held in the central processor for peripheral unit control, will gravitate to the microprocessor within each peripheral which controls its function and permits modification to affect various control disciplines.

Nevertheless, there will continue the need for the high performance general purpose processors of high complexity manufactured by the leaders of the processing industry. These processors will continue to be used for network control and as data base handlers, because the economics of the central data base will force this form of network organization.

**SUMMARY**

In summary, the microprocessor evolution will work great changes on the computer-automation field. Anticipated events within the next five years will include:

1. Growth of intelligent peripherals with microprocessing control, including even the simplest data entry device. Implementation of present software 1/O symbionts into the fixed programs contained within the processors/manipulating peripherals.

2. A renewed attempt to partition complex problems with little data base overlap so that a pipeline of microprocessors may be used to effect a more economic implementation of such problems.

3. Minimization of the actual control of processes by large scale processors, and a specialization of central
processor facility to provide network control and data base handling.

4. A fallout of microprocessor manufacturers with several specialized architectures and suppliers remaining to service different functions. (i.e., communications, entertainment, machine (auto) control, general purpose.)

5. As a result of the fallout, a de facto standard of devices and device interface which will force the large scale computer manufacturer to design to the needs of the microprocessor interface.

REFERENCES