Workshop Report:

Split Rock Workshop on Computer Packaging

T. J. Matcovitch
Drexel University

On May 22-24, 1974, the Computer Society's Technical Committee on Packaging held its biannual workshop. Attendance was 55 from an invited list of about 70 consisting of the active members of the Computer Packaging Committee and the invited speaker attendees. Held this year at Split Rock Lodge in Lake Harmony, Pennsylvania, the workshop customarily has five sessions: one at the chip-to-package interface, one aimed at the hybrid circuit interconnection level, one at the computer backplane and cabinet wiring level, one of general interest to the manufacturing technology that cuts across all types of computer manufacturing apparatus, and a fifth that is especially chosen for each conference as an item of importance or special interest that is not covered by any other session.

This year the session on the chip-to-package interface was concerned with life without hermeticity—i.e., the problems of plastic encapsulated packages. The hybrid circuitry level session was concerned with adhesion and the problems in achieving and controlling satisfactory bond of circuits to the substrate. The backplane session was concerned with the achievement of satisfactory transmission properties with higher frequency computer operation, and the general interest session was concerned with new industrial guidelines to manufacturing, including OSHA noise requirements and metrification.

The special session this year was intended to be especially timely because it explored the alternative modes of data transfer within a computer, including frequency and time multiplexing, and microwave data transmission between computer system elements instead of the customary "space" division (i.e., multiple individual leads). Perhaps, in a way, this last session was too timely because there were unexpected difficulties in getting required speaker authorizations to present information. As a result, there were some last minute changes in programs in that area.

Keynote Address:
Buelow of Amdahl Corp. on Packaging Trends and

In addition to the five technology sessions, there is also a keynote speech in which a recognized industry leader in packaging technology is asked to look to the future and the expected changes in computer package technology. This year that speaker was Fred Buelow of the Amdahl Corporation who headed the design team that created the Amdahl 470 large-scale computer. From his very fresh experience in the design of a major new computer, he expressed the belief that the circuit design is the least difficult part of the process and must be held subordinate to the packaging design and the requirements of manufacture. Not only must all steps of the design process be computer aided, but the nature of the computer control of the manufacturing process and of the changes should be established either before design begins or very early in the process. All parameters of the future design should then be put in that data base. Design information is then processed in a way that will be compatible with the future manufacturing management technology.

Buelow did more than underscore these increasingly apparent guidelines for successful design. He pointed out that, on a volumetric basis, the best of today's computer packaging designs require many orders of magnitude more volume for the interconnections of the active elements than the volume required for the active elements itself. For example, all of the integrated circuits of the Amdahl 470 central processor could be made on nine slices of silicon and easily held in the palm of one's hand; yet the cabinet housing the interconnection of those chips is $6' \times 6' \times 2'$ or five orders of magnitude more volume than the semiconductor circuits on silicon wafers. (It could also be pointed out that the active elements on the silicon wafer constitute about 1% of the magnitude for the semiconductor circuits themselves!) Furthermore, the cost of semiconductor devices is rapidly coming down as chip complexity is going up. The semiconductor industry seems easily able to make circuits of twice the element density of each previous year, so that by 1980 one would expect to see circuits of 100,000 or more elements per chip possible, and circuits of 10,000 or more elements per chip very prac-
ticable. If the costs go down below a tenth of a cent per gate, or perhaps even down to two or three hundredths of a cent per gate, it becomes immediately apparent that the principal cost of a major computer system could be the cost of interconnections, not the cost of the devices or circuits. This then is the challenge to the computer packaging designers: to somehow improve their technology at a rate comparable to the rate of improvement of the semiconductor technology.

Zimmerman of Johns Hopkins on Future Developments in Solid-State Devices

In a way, this conference had a second keynote speech: the very worthwhile late addition to the program of the talk by Dan Zimmerman of Johns Hopkins. This talk was invited when it became apparent that the data transfer session might have room for an additional paper. Zimmerman's talk also looked at the future developments in solid state devices and also attempted to assess the impact of the semiconductor technology on future equipment.

He not only reaffirmed the expected increase in circuit density per chip and consequent reduction in cost that Buelow assumed, but pointed out that the military's impact on the semiconductor business has decreased rapidly from some 23% of semiconductor device purchases a few years ago, to 2% in 1973, to probably only a few tenths of a percent in 1975 and thereafter. Even with greatly increased spending on the part of the government, it is no longer possible for such purchases of semiconductor devices to be of any real market importance or impact. The fallout developments to the technology from the very broad base of semiconductor manufacture for calculators and other consumer products will probably result in more innovation and improved capability than could ever be achieved by government funding stimulation.

The capability in future years to do almost anything on the chip will mean that the differences between systems will largely be concerned with innovation between the chips or semiconductor circuits. The astute management of these interfaces will be of more economic and technological importance and will ultimately be the principal determiner of manufacturability and economic design worth.

In particular, Zimmerman raised some questions with the group about the continued use of gold contact interfaces and hardwired signal interfaces of any kind. He suggested that the combination of light emitting diodes, photodiodes and surface light pipes could serve to entirely eliminate the chip interconnection wiring. (In some ways this was reminiscent of the implication at an earlier session this year in which the possibility of chomerics type conductive rubber sheeting could similarly obviate the need for hardwired contacts between chips.) Presumably the only requirement would be that there be sufficient registration between the light emitting spot and the receiver pad to avoid cross connection to the next circuit. The choice between surface light pipes on surface metalization connections would be based on whatever signal processing needs might be served in the transmission means.

Other Session Highlights

Highlights of some of the other sessions included endorsement of Novolac or other improved epoxies for plastic encapsulation. Considerable useful data on the sources of difficulties in adhesion on hybrid ceramics was presented, as well as some of the capabilities of laminated ceramic materials. The backplane session had a discussion of the advantages of mechanical simulation at four to ten times the size with four to ten times the propagation delay so that a system can be debugged at this larger size and then translated to small size later. Such a transformation sees each printed circuit board become a semiconductor chip and each dual inline individual pack become a zone on that IC chip, each cabinet having four small field-replaceable units instead of four mother-daughter board assemblies.

There was continued interest in the use of microwave data transmission within a computer and a first opportunity to look at some of the hardware that was generated using that approach. The new manufacturing guidelines session indicated the need for better understanding on the part of the computer manufacturers to not only understand the OSHA guidelines but to set internal company standards that are commensurate with the ways in which those guidelines will be interpreted in the future.

One particularly controversial item emerged in the hybrid technology session when the members of this committee learned for the first time that the American Vacuum Society has decided to arbitrarily define the difference between a thick and thin film at 50,000 Angstroms, thus making a thickness criterion that could only seem rational to the technologically naive. All of the workers in the thick and thin film field that were at this conference were amazed and appalled to find that, at this late date, the distinctions between thick and thin films are not universally understood to be technology distinctions that are almost independent of the resultant film dimensions. Certainly there is a job to be done so that the distinctions between thin and thick remain a distinction between two types of elements. One type are films of primarily metallic character whose characteristics are strongly influenced by surface phenomena and whose means of deposition include chemical deposition and evaporation, sputtering and like processes; the other type are the more volume-dependent films, including cermets and inks, whose generation may include firing or other heat processes but which are basically mechanically printed or screen deposited under normal temperatures and pressures. Each conference attendee who was in any position to influence the thin-thick film technology indicated a strong interest in rescinding that decision and urged the return to the more sensible one which has become industry standard over the years.

The Computer Society’s Packaging Committee, which normally holds its regular meetings in New York at IEEE headquarters every other month, seeks a national membership. IEEE members routinely attend from places as far as Illinois, Minnesota, Virginia, and Massachusetts, but interested computer packaging workers who are more remote are kept on the mailing list so that they may at least attend the semiannual workshop and perhaps an occasional, particularly pertinent bi-monthly meeting.

Address inquiries and correspondence to T. J. Matcovitch, Professor of Electrical Engineering, Drexel University, 32nd and Chestnut Streets, Philadelphia, Pennsylvania 19104.

February 1975