EVOLUTION OF
MECHANIZED DESIGN, AUTOMATED DESIGN, COMPUTER-AIDED DESIGN AT ERA, REMINGTON RAND, UNIVAC, AND SPERRY
from the early-1950s to late 1980s – as compiled by Earl M. Vraa

Contibutors: John Alton, James R. Andrews, Keith Behnke, Curt Bute, John Esch; W. Burt Horsted; John J. Travalent, and Earl M. Vraa. Editing and formatting by Lowell A. Benson

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Synopsis: Computer Aided Design, etc. by Earl Vraa - 14 March 2008

What was/is Mechanized Design?
The application of "computers to help design computers" at Sperry, and one might say within the industry, evolved over a long period of time beginning with the initial application by the "computing machine" pioneers, Seymour Cray, R. Kisch, et al. in the mid to late 40s at Engineering Research Associates (ERA). If one looks back, the application of computers for that process was very similar to what one sees today in the "application of computers'. It was to simplify the repetitive and increasingly complex processes. In effect, it was the elimination of associated errors to reduce labor costs and time. The complexity of today's designs would be impossible without design automation processes.

What was/is unique about Mechanized Design?
One might step back and look at the Industrial Revolution of the 1800s to grasp the methodology and significance of computer design automation. The Industrial Revolution harnessed steam, water, and carbon based resources to increase the productivity of mankind. Likewise, the invention of the transistor and subsequent electronic technology led to harnessing the electron for similar leverage.

Was anyone else doing it, and if so what were we doing that was different/better?

It is possible that other companies, universities, and/or individuals were working to apply computers in the "computer design" process but it is highly unlikely that they took the aggressive approaches taken by the early "pioneers". Cray and Kisch presented a paper at an IEEE Conference in the mid-50s that described their efforts. This paper in all likelihood provided the emphasis for the interest in the discipline. But, computers were not readily available for applying the discipline. The question was, "What came first, the chicken or the egg?"

Cray, et al. had the advantage of classified government contracts that gave them access to computers and most important, "King Cash". This Remington Rand/Univac association with a classified customer over at least twenty years [thirty years if you count some component replacement activities] made for an enviable business opportunity. Needless to say, when several employees, left in 1957 to form Control Data Corporation (CDC), they took knowledge with them but not the base from which to build. Remington Rand had the experience, contract base, and remaining engineers and programmers to continue on the path of development.

Looking back, I doubt if many of the employees understood or had the foresight to believe what was to be accomplished over the next thirty years. I know that I surely did not. Management supported and encouraged the application and new development of design automation while the design engineers and design automation employees took the initiative to expand the capabilities.

How did Mechanized Design impact the rest of the industry as well as our ability to get product to market? For example how did it improve, and by how much, over the previous methods?

Computer Aided Design (CAD) was but one of the disciplines that made Univac a major player in the defense industry. One cannot say that CAD was more important than any of the other disciplines; it was the cohesion of these that made the company successful in its support of government needs and requirements. Each contributed in their own way. CAD probably contributed most by developing programs and procedures to reduce design errors early in the cycle, reducing first pass and turnaround times of design drafting, reducing cost of documentation, reducing time and cost of test verification, providing the initiative for automated manufacturing, etc.

These disciplines kept UNIVAC competitive in industry with long term contracts in many cases. It was difficult for competitors to compete in our niche markets. The Navy contracts for the AN/UYK-43, AN/UYK-44, and the Wild Weasel computer were good examples.

Who were the principal contributors to Mechanized Design and what were their contributions?

It would be difficult to identify the major contributors to the CAD process without forgetting someone that did some significant task. One would have to go back to the early years of Seymour Cray and those that followed over the years. Curt Bute, manager of the facility, along with his "merry band of engineers" challenged the mechanized design programmers in the late 50s and early 60s. Some that I remember were John Alton, Wayne Olson, Joe Kimlinger, Leland

'Lee' Granberg, and Wally Eidal. Jerry Neese and Burt Horsted were deeply involved in expanding the Mechanized Design capability. Burt, was especially involved in the numerical control of the Gardner-Denver Wire-Wrap machine; early numerical control (NC). When the commercial division spun off to Roseville, Burt became their manager of the Automated Design.

If I remember correctly, Jerry Neese remained manager of the Defense Systems Automated Design for a few years and then was followed by Wayne Leverkuhn when Jerry moved to the UNIVAC Salt Lake City operations. This was during the mid-60s when the design automation programs were transitioned to run on the CP-667.

During mid-60s, a couple of "unique system" developments were accomplished. The first was the AUTOGRAM that was developed as an alternative for high speed documentation of D-size logic diagrams. It was about a 5-inch diameter cathode-ray-tube (CRT) with the drive electronics that was integrated with a Zeiss lens mounted on a [was it Bell & Howell 35MM camera?] recording device. This was advance technology in that it had 3,000 lines per inch on the CRT. The other system was the Ultra-High Precision Display (UPD) that was developed to produce laminate artwork for chassis back panels. I seem to remember that it generated a one-half size image on the face of the CRT for artwork of a 15.75" chassis panel. Leland 'Lee' Granberg was the lead engineer on these projects. I do not remember the resolution of this unit. Both of these projects were instrumental in future evolution of automated design. They proved that software technology and electro-mechanical technology could be combined for highly accurate and high production products.

Robert 'Bob' A. Erickson replaced Red Phillips as Director of Engineering in the late 60s. Paul Welshinger, reporting to Erickson, was the manager of documentation that included Design-Drafting while I was given responsibility for Computer Aided Design. Erickson and Welshinger both believed that CAD had high potential for cost savings and reduced design cycles thus aggressively pushed the discipline. They supported the transfer of the CAD programs from the CP-667 to the Univac-1108.

This transfer was a somewhat traumatic effort. Programs increased in complexity while users increased their demands. Unfortunately, the only Univac-1108 in DSD was controlled by the Division Controller, Al Wald. The Controller functions had priority on the system and Al had very little interest in accommodating the CAD function. It took a number of years to entirely transition to an Engineering controlled Univac-1108 and over time to stand-alone workstations.

With the transition to the Univac-1108, other engineering disciplines were integrated into CAD. These disciplines relied on the Engineering data base of each design to accomplish their specific task. Those disciplines were such as SIM-LOGIC that simulated the logic sequences and timing of modules and LOCATES that automated the test generation of the test sequences [inputs and expected results] for a module.

As the complexity of designs and component modules increased in capability there was a need for designing at a higher level. It was in the late 70s that the move was made to a hardware description language (HDL). This continued into the late 80s when DSD was transitioning as a "systems house". With the advent of Loral, Martin Marietta, Lockheed, Lockheed Martin, there

was more emphasis on systems and CAD was less of a driver in the system. My understanding is that the technology and discipline was "sold" to Cadence Corporation in the late 80s or early 90s.

Background

The introduction of computers to design computers in the electronics industry appears to have been the brainchild of those that understood the potential of "electronic calculating machines". The discipline evolved from some of the early work by Engineering Research Associates (ERA) employees on classified war-time Navy cryptology contracts. The project was referred to as the Communications Supplementary Activity -Washington (CSAW).

Former CSAW supervisors, Howard T. Engstrom and William C. Norris, and the former head of the Naval Computing Machine Laboratory, Ralph. I. Meader, joined with investment banker, John Parker to establish ERA in 1946. Parker was the former head of Northwestern Aeronautical Corporation (NAC), a St. Paul, Minnesota firm that made gliders during World War II. ERA established a small office in Arlington, Virginia, but the majority of ERA's workforce was located in the former NAC facility in St. Paul. This facility was located at 1902 West Minnehaha Avenue in St. Paul, between Fairview and Prior avenues.

Although the rudiments of "mechanized design" may have been practiced earlier by this group of CSAW entrepreneurs, it appears that it was at the "glider factory" where the discipline began to evolve. Those identified with the early applications were renowned engineers such as Seymour R. Cray, R. N. Kisch, et al. In looking back, one could say that they did as did Neil Armstrong when he landed on the moon; "That's one small step for man; one giant leap for mankind." For "uninitiated" engineers and programmers, one could hardly imagine what would evolve over the coming years!

An Early Technical Paper Synopsis

Somewhere in probably the mid-1950s, Cray and Kisch wrote a paper that was presented at an IEEE conference. Burt Horsted, one of the initial Mechanized Design programmers, made us aware of the existence of the paper. He found it in his records what for an engineer can best be described as "somewhat useless information that one might find useful in the future" archives! Good move! A copy of the paper is on file and available at the Charles Babbage Institute (CBI) at the University of Minnesota; Reference #EF518.

Burt's comment was that "this paper should stand as one of the more important early writings of the computer age!!!!' It describes the process of writing Boolean equations to describe the logic; simulation; manual placement of circuits; and generation of wire lists. Until that time everything was done manually on paper, and old writings describe the incredible loss of control of wire lists as logic corrections were made, with resulting wiring updates multiplying and cascading. At that time, taper pins were used and wired by hand.

The paper is entitled:

A PROGRESS REPORT ON COMPUTER APPLICATIONS IN COMPUTER DESIGN
{Editor's Note by Lowell Benson – *See the October 2009 'Article for the Month' on web site page* http://vipclubmn.org/documents.aspx .}
S. R. Cray and R. N. Kisch
Remington Rand Univac
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The paper as written and presented is "somewhat" detailed with associated formulae, diagrams, and photographs. In some cases, the copy is illegible. With this in mind, it seemed logical to extract and "edit" the document for those less inclined to "electron spin".

These engineers that lead the discipline initially contemplated the reduction and/or the generation of design logic through the use of Boolean algebra or similar methods but considered that problem too complex initially. Instead, consideration was given to the mechanization of several other phases of development work which represent the labor intensive and repetitive effort that goes into the development of a new computing system. These were the methodical processes such as checking design logic [emulation and timing or simulation] and the performance of processes [implementation] of detailed design. This latter was referred to as placement [component] and routing. Over the years, this evolved from wire tabs for backboard planes to the current year [2008] complexity of semiconductor design with associated interconnect and intra-connect.

The particular building block chosen for the design program, "one step for mankind" was quite simplistic by today's standards of circuit complexity. It was a one-microsecond magnetic switch developed at the St. Paul laboratories of Remington Rand Univac. The circuit performed three-level "and-or-not" logic and provided one-bit of temporary storage in each package. It was particularly well adapted to mechanization because of the simplicity of its logical structure and the inherent storage at each logical step.

The initial "mechanized design" processes were the validation of the Boolean equations for clerical and logical errors with programs running on the Univac 1103 with a permanent equation file established on one of the computer's magnetic tapes. A part of the loading operation was a preliminary check of the equations to ascertain, for example, that each symbol in an equation was composed of the proper kind and number of characters. If an equation did not meet the format requirements, it was not entered in the magnetic tape file but instead was punched on paper tape. At the end of this initial loading operation, the designer had a paper tape containing all of the equations having format errors. Corrections were then made, and the revised equations entered and added to the magnetic tape file.

Next, the individual equations were subjected to more complete verification regarding the number and types of inputs and the relative timing of these inputs. Improper equations were again printed out on the monitoring typewriter. Other computer programs were available for changing the equation errors on the master magnetic tape file.

Other computer programs were available to accomplish such tasks as sorting the equations in various ways and preparing printed copies of the equations and other information appearing in the magnetic tape file. These first mechanized procedures were executed to make sure that nothing appeared in the design logic that could not be physically implemented. When a set of several thousand equations was considered, it was obvious that manual verification and checking would require several weeks of effort. With the mechanized methods, this task was usually reduced to several hours for the task.

In a following phase of the program, the designer had the opportunity to simulate the logic of his design in a manner of the actual equipment fabrication. The control panel for the proposed equipment was created on paper by laying out and identifying all of the push buttons and indicator lights which would appear on the actual panel. The push buttons include those used for setting and clearing the stages of arithmetic and control registers, those used for initiating the various sequences of operation, and miscellaneous operating controls. The indicator lights indicated the contents of the register, the state of control elements, etc. The push buttons and lights that appeared on this panel were incorporated into the design by adding special symbols to some of the equations of logic to represent the manual inputs, and by the preparation of some additional equations to express the indication functions. [How many of you still have calluses on your middle three fingers of your hands from setting the registers for program changes?!!!]

The paper tape output, when processed on an electric typewriter, provided essentially a picture of the control panel with each indicator light represented by either a "0" or a "1" depending on whether or not the light is on. Thus the contents of registers could be examined at the end of an operation, and the performance of the "paper" computer evaluated. In that manner, all the operations of the computer being designed could be simulated with various combinations of operands and the complete set of equations verified. When operational errors were detected, sufficient evidence was usually present on the printed control panels to allow the designer to rapidly discover the logical error in the design. Then, one could make the necessary corrections to the equations.

When the design checking process was completed, another formidable operation had to be undertaken. Decisions were to be made regarding the placement of the circuit packages in the standard chassis assemblies, and manufacturing tabulations must be prepared which completely describe the wiring required to interconnect all of the packages. At those times, a standard chassis accommodated up to 180 of the building block packages so that in an equipment using, for example, 2000 packages, 12 assemblies would be required. Indiscriminate or improper assignments of the various magnetic switch packages to the chassis would result in an excessive number of interconnections between chassis, in-tolerable lengths of wire on some of the switch outputs, and possible excessive unbalance of the loads on the clock pulse driver lines. Automatic component placement was employed to optimize these variables.

Wire tabulations were similarly prepared. Several hundred pages of material could be generated in a few hours by the computer, with the freedom from the various types of human errors. The connection points are listed in an order such that subsequent wiring in that order will require a minimum length of wire. The length of wire required is also listed in each case and a color code is assigned. Additional manufacturing and maintenance aids, such as component inventories and cross tabulations for signal tracing, were also quickly obtained.

This method substantially reduced the time and money consuming process of detailed design and physical layout. Because of the great reduction in detailed design time, it was now practical to completely investigate a number of approaches to a system design. Several design approaches could be processed to completion so that component inventories and operating time could be compared for the completed equipments.

How does one communicate with a computer? This was a challenging aspect of the mechanized design process; both from the designer standpoint and that of the programmer. The programmer generated instructions that were loaded on the computer to process the engineer's logic design. The logic designer had the challenge of describing the design in equation form and then inputting the equations into the computer for processing.

The physical processes of communication were of two different modes; 80 column cards and the Flexowriter. The Flexowriter was an electric typewriter with attached paper tape reader and punch as the off-line communication unit. Seven-level, paper tape was the medium for data transfer from printed page to computer and from computer to printed page. [I don't remember if the 80 column cards were used for logic equation input. Somebody help me! Jeez, I'm going back nearly 50 years. Even my memory is getting short!!!]

End of "CRAY/KISCH "MECHANIZED DESIGN IEEE" Paper Synopsis

1957-1958 Time Frame

Burt Horsted writes - Mechanized Design was first applied for classified projects i.e. validating Boolean equations, component placement, logic timing and simulation, wire tabs, etc.

In 1958, Curt J. Bute and Jerry L Neese authored a Mechanized Design paper [Company Proprietary at that time.] It described the "hand process" and the supporting mechanized design process of that time.

{Editor's Note by Lowell Benson – *See the September 2009 'Article for the Month' on web site page* http://vipclubmn.org/documents.aspx.}

1959 Time Frame:

Burt Horsted writes - Most everyone who had worked on the previous computer and program designs had left Remington Rand by 1959 for Control Data Corporation (CDC). My first Mechanized Design (MD) project was a classified design which was follow-on to a previous design, for which an MD system had been written and was running on the Univac 1103. This new design required program revisions to accommodate the increasing design complexities. Of course, all paper tape input and paper tape output had to be punched and printed on a flexowriter. To increase the challenge, there was essentially no documentation. All that I had were the programs for the Univac 1103 written in octal. These had to be interpreted, flowcharted and studied to determine what function they performed and then the changes made. {Editorial Note by Earl Vraa: *Burt, you were ahead of your time. Many call it "reverse engineering" or making an "enhanced Chinese Copy"*.} As I recall, Jerry Neese had working knowledge of the system, and was a great help in making the proper program changes. We worked through the details and it performed well in supporting the design development process. The project people for this project were Curt Bute, Manager; Wayne Olson, lead logic designer; Wally Eidahl; and I believe probably John Alton; plus several others whom regretfully I can't remember. [Joe Kimlinger et al.]

Earl Vraa writes - In the early 60's, Jerry Neese was the manager of what was then renamed "Automated Design". Some of those early "pioneers" were W. Burton 'Burt' Horsted, Milton (Milt) Montgomery, Wayne Leverkuhn, Bruce Klugherz, Bob Lawler, Earl Vraa, and ???

1961 Time Frame

Earl Vraa writes - I came into Remington Rand when Mechanized Design was hosted on the Univac 1103A. Milton Montgomery was the instructor. Let's see, was a "37" a direct jump or a return jump? I've got my old instruction card around here somewhere.

I did not know the application of some of the first programs; "need to know" until I received my classified clearance! But it seemed to evolve from logic equations, to logic simulation, logic diagrams, wiring tabs for the wire wrap machines, automated routing of PC boards, etc. Over a period of time it evolved to include test and eventually hardware description language in the later years.

The programming applications migrated from the Univac 1103A during this period of time to the AN/USQ-17 and then to the 1206 [the later two had the same instruction set; if I remember correctly].

Generally, the design engineers "verbally specified" their requirements to the MD programmers. The program flow [hence: flow charts] was drawn on D-size pads of paper, virtually instruction by instruction. The reason for this was that the programs were written in 36-bit octal instructions for the Univac 1103 and later the Univac 1103A. The computer had 4,096 words of memory that somewhat restricted the size of the programs. [My first program was "three memory modules" long.] How else is it described? The program was modular such that it performed part of the process and then loaded a "new program module [subroutine]" over the top of the existing memory except for what would now be referred to as "boot strap memory". That part of the program would perform additional processes and then do the same thing over again. One had to make sure that "boot-strap memory" was not over-written.

I still remember the first time loading and running my first program. It ran "without an error"! Of course it didn't do anything because the program control was structured with Return Jumps (RJs) to subroutines. I had a stream of RJs and the Instruction Set had the capability to set or clear a bit to "ignore" the RJ function. I had the "bit" set or cleared and the program "run to completion"! [But, it was fast! emv]. Of course we had the "massive magnetic drum"; massive in size, it had 32,768 36-bit words of memory for data storage that was the storage medium during the program process before writing a magnetic file for storage.

1964 Time Frame:

Burt Horsted writes - About this time, we rewrote the Automated Design system for commercial designs that supported the development and manufacture of the Univac 1107, the Univac 494, the Univac IOC [IOC is I/O Controller], and I think the Univac 418. These were very successful and gained many enthusiastic supporters on the commercial side of the Univac computer business. Eventually the "Bull line-printer was interfaced to the Univac 1103A and we had a high-speed printer at last! I remember writing the "generate wire tabs" program; a real challenge. With these systems came wire-wrap, using a staggered grid. I became deeply involved in this and wrote the wire-wrap router program and made many trips with Manufacturing engineers to Gardner Denver who designed and manufactured the wire-wrap machines. One could say that this was some of the initial "Numerical Control" (NC) programs. Later came the Univac 1004 from Philadelphia, which had two panels wired together [one staggered, one square.] This project eventually led to my going to Utica for a couple years, returning in 1965.

Earl Vraa writes - Logic diagrams were printed on the Cal-Comp 35 drum plotter. Needless to say, the designs were forcing the mechanized design discipline. "D-size" logic diagrams were printed in three sections on the Cal-Comp and then taped together for a complete "D" size page. [Or were we using a smaller Cal-Comp plotter to start and then migrated to the Cal-Comp 35 that printed an entire D-size drawing?]. My memory seems to recall that it took either 45 minutes for each logic diagram; or was it for each page?

A challenge for the "three-page" logic diagram was the effort to do automated placement of the symbols so as to not have a symbol on the "tape-line" between two pages. The time to generate a set of logic diagrams was not acceptable but it was faster than a "manual layout job".

In the spring of 1964, I went to an automated design (AD) conference in the New Orleans where I met a fellow AD'er from IBM. We talked about the logic design generation drawing printing time. Over a couple of "glasses of sarsaparilla" we thought, "Wouldn't it be great if we could generate D-size logic diagrams on a CRT and then take a picture?" I came back to St. Paul and talked to Lee Granberg about it. "No problem", said Lee!!! "All we gotta do is fine grind the phosphor and deposit it in the tube. And then we find the optics with a camera (35MM) to record the screen image." This was a small CRT with a beam that could be controlled to move point to point on the display. A 35mm camera was mounted in front of it. With the shutter remaining open, the beam was moved around the screen to draw a picture. When the drawing was done the camera would advance to the next frame. {Editor's Note - *Lee, can you elaborate on this and do you have any pictures from this era of the "AUTOGRAM"?*}

The generation of logic diagrams went from 35 minutes to, I believe, about 15 seconds plus the film developing and copy time. James Andrews was instrumental over a period of years in refining the processes, procedures, and software for the application of the AUTOGRAM for support of projects. {Editor's Note - *Jim Andrews should be able to elaborate on this and his support of the, was it the 1107/1106 project, when you were turning around a complete set (>2000 pages) of logic diagrams every night. And, if I remember that you received a cost savings award for the effort? Did it come with any financial compensation from Plant 8? Good Job!*}

Another challenge was that of automating the artwork for printed circuit boards (PCBs). Based on the success of the AUTOGRAM, Lee Granberg, et al., designed and built the High Precision Display (HPD). We thought it was "railroad steam engine", at least it somewhat looked like one and was nearly as large! No, just joking. {Editor's note - *Lee, can you help again? Any pictures?*} I know it was somewhat of a "challenge" to program and correct the beam deflection [what's the term I searching for?] as we needed straight line artwork. The system was initially used for the "x" project that had a large array of Printed Circuit Board panels.

It was sometime in this time period that we found the AD was being sabotaged by some employees that thought it would eliminate their job! A few personnel changes were made in the suspect areas and we were back on the road again!

In the late 60s, interactive displays were evolving. Univac Commercial was entering the market and produced the Univac 1557/1558 that appeared to be a fit for interactive logic design. It was a bit ahead of its time and was memory restricted [plus cost]. We did some feasibility work but gave it up as the display technology was evolving rapidly with the changes in basic electronic technology. One might say that we were seeing the results of President Kennedy's challenge of "landing a man on the moon." Circuit miniaturization with resultant increased circuit speeds "and lower costs" drove the system development rapidly. There was always "something faster and better!"

Jim Andrews writes - Program and data cards continued as the computer input norm. Alternative input for data and programs was the Flexowriter that produced a 7-bit paper tape. Programs were converted to the Univac CP-667, a Navy computer of which only 3 were built. Many Univac 1206 computer programs converted at this time were the wire-wrap system. Enhanced programs were such as a program for a catastrophe filing system that packed up and stacked master files for the wire-wrap machine on to magnetic tape (at 200BPI) for storage in a fireproof vault in case of a disaster.

The 1969 time frame was that of the first work for a Univac customer. The design and development of a translator system (LAMPS) was installed for the Buckbee Mears Company in St. Paul for their Univac 418 computer. It expanded the use of their Gerber photo plotter for producing TV masks. The effort included writing an Operators manual, a language manual, and teaching an introductory course to the customer.

Also, the PC Laminate Router System on the CP-667 was enhanced during this period. The Ultra-Precision Display (UPD) continued to be controlled by the Univac CP 1206 to reformat the PC Laminate Router output to drive an Ultra-Precision Display which created artwork to make PC boards from.

John Travalent writes - Automated test started with the development of a ternary, parallel fault simulator for the NIKE-X computer in the 1966 timeframe. As I remember the NIKE-X computer was a 32-bit machine made from SSI and MSI logic and the simulator was programmed in and ran on the NIKE-X computer itself. The fault simulator was used just on the high speed multiply logic of the computer. The test vectors were generated by hand and the simulator outputs were verified by grounding logic circuits in the computer.

In the 1969 timeframe, we went big time and used a UNIVAC 1108 for software development and started developing a general purpose logic simulator based on the simulation techniques used for the fault simulator. I believe this was the beginning of the Sim-Logic program.

Earl Vraa writes - Development continued on the CP-667 computer for some time and then migrated to the 1108 in late 1960s time frame. This was when AD moved out of the "black" and was to be applied to support the design process of military computers.

Jim Andrews writes - The Logic Diagram Software was converted to run on the Univac 1108 to automatically layout of logic drawings with output a Cal-Comp plotter. A previously designed ANUSQ-17 program for AUTOGRAM logic diagrams. We developed S/W generated character set for AUTOGRAM display to significantly improve quality of its output with a goal of producing Class A drawings.

Enhancing the CP-667 PC Laminate Routing System to reduced plotting time by over 50% and we developed a program to show results of PCB routing with output on a high speed printer.

Earl Vraa writes - A major documentation challenge of the time was that DoD required "Class A" logic diagrams to document computer designs. The AUTOGRAM did not meet that requirement and the Cal-Comp Plotter was too slow [and marginal to specifications]. An

alternative replacement was sought that had a high though-put rate and one that could meet stringent DoD Documentation Specifications. An automated drafting Internal Research and Development funded study researched technology and industry for the alternative documentation device.

The recommendation was that of the Xynetics-1000 plotter. It looked good for a price of $70,000 [1971 dollars] but as we found out after delivery, didn't work on Mylar! The Xynetics-1000 plotter was designed with the Mylar on the platen with the electro-magnetic motor "riding" on an air cushion so that it would not contact the wet ink laid down on the Mylar. Unfortunately, the thickness of the Mylar, the weight (momentum of the head), and the air cushion caused the electro-magnetic motor to go out of tolerance. Xynetics went back to "the drawing board" and designed the Xynetics-1100. The Xynetics-1100 was designed with the electro-magnetic motor controlled on the platen above the plotting surface. This solved the accuracy problem and the first Zynetics-1100 was used for many, many years. The plotter had an accuracy of 0.001 inch on Mylar and could ink a D-size logic drawing in a matter of minutes. It had a multi-pen capability and could ink colored diagrams. The effectiveness of the unit resulted in the purchase of another unit later as production increased. These units provided service for various Engineering and support functions until the early 1990s.

John Travalent writes - In 1970, the test and simulation group of the NIKE-X program was moved into the computer aided design group of Defense Systems Division. We had moved the fault simulator to the 1108 and were doing "stuck at one" and "stuck at zero" fault simulation for PC cards while Keith Oliver [mentioned below] was doing physical fault insertion for the overall system using the MIDAS system. Commercial Univac had a automatic test generation program (ATG) for PC cards called LOCATES which was written in Fortran and which we were using in Defense for developing PC card tests and fault catalogs. But it did one fault at a time, was slow, and we couldn't get timely support when we needed it. So we decided to put an ATG front end on the parallel, fault simulator and the result was the INDICATES program which became a Univac standard ATG program in both commercial and defense. With upgrades to keep pace with bigger and bigger MSI and LSI chips, INDICATES was used for over 10 years. But it was written in 1108 assembly language and with the advent of 3rd party simulation and ATG software appearing on high powered workstations from vendors such as Mentor Graphics, it faded into the sunset.

Jim Andrews and Earl Vraa write - During this timeframe, the control program for the AUTOGRAM display system was converted to a Univac 1004 computer with a Univac-6C magnetic tape unit. DSD also supported Univac Roseville Automated Design and converted the output of their Logic Diagram Program to the AUTOGRAM. Over 18,000 logic drawings were generated with this system during development of the Univac 1110 commercial computer and saved an estimated $286,000 [1971 dollars].

The AUTOGRAM had served its purpose and it was time to consider a replacement. We generated the specifications for the Univac 1617 Computer Output Microfilm (COM) system to replace the AUTOGRAM Display System for logic diagrams.

Then came the U-300 Univac Display, "the predecessor to today's PC" although it was just a monitor that was interfaced to the Univac 1107/1108. A time of tribulation! We were trying to force Automated Design into the future but the hardware was lacking. We were operating on the Controller's [Al Wald] computer system which meant that we "did not have any priority". **You know the Golden Rule. "He who has the <u>gold</u>, rules."**

Development continued on the CP-667 computer for some time and then migrated to the 1108 in late 1970s timeframe. This was when AD moved out of the "black" and was to be applied to support the design process of military computers.

Jim Andrews writes with info/edited by Earl Vraa - The early 1970s was a period of transition of the CAD programs to the Univac 1108. There were continued major improvements to the Logic Diagram System, PCB schematics and assembly drawings, a PERT chart program, and a Viewgraph program which was a forerunner to Microsoft's PowerPoint. This program was used to produce technical illustrations for many years.

Electronic data transfer was now possible and we developed remote processing techniques to transfer magnetic tape data over phone lines to a remote 9300 computer eliminate the physical transfer of magnetic tapes between facilities.

Other developments included the development of a "zigzag routing" algorithm for the PCB Laminate Router System to maintain specified clearance between pins for the S3A program printed circuit boards, a system to check the manual routing of a PC board before it was fabricated, comparing an interconnect deck or net list against the routing done on an Applicon display, and a continuity program to handle ceramic PC board technology with blind holes that reduced a several week error prone manual job to less than an hour.

There were other activities that included a Cal-Comp compatible plotter library for the new COM unit and a special version of the Logic Diagram System to support the Salt Lake City Commercial facility. It was during this period that Jim Andrews received the Sperry Excellence Award for producing Univac 1110 logic schematics.

He was also lead supervisor to produce a next generation Logic Diagram System for use by DSD on the Univac 1110 and the National Security Agency (NSA) on their Honeywell 6000.   NSA CAD

Earl Vraa writes - In the 1973 timeframe, the Computer Output Microfilm (COM) was designed and built as an alternative to the AUTOGRAM to produce logic diagrams. We thought that it had commercial application and "pitched" it to Commercial Management and Marketing in both Roseville and Philadelphia. Not too many years later, Cal-Comp Corporation came out later with what looked like a "Chinese copy". Jim Andrews' old Professional Staff Data Sheet shows that the COM was developed in the 1973 timeframe and in 1975, the CAMIDS (Computer Aided Microfilm Documentation System) automated documentation system was developed using the embedded 1616 computer and the COM as the output device.

Following this, word processing software, Computer Aided (CAMIDS?) software [the forerunner to Sword] for doing word processing on the COM unit was available. We developed the DODO program which automatically created top down hierarchy charts using high speed plotters, printers, or COM, and the BISON [what is the acronym "BISON"?] program which produced Input, Step Output diagrams to document software efforts. Later, in 1979 we installed DODO and BISON at Univac in Switzerland and interfaced the programs to a Benson plotter.

And one day in the early to mid 70s, someone walked in and said "Vraa, you are the only AD guy with the "required" clearance. Our old customer had a PC panel, not "board", short out and it was a mite "unusable". An understatement! It looked like someone had shot it up close with a 12-gauge shotgun. I was "relocated" back to Plant 2, Bldg 4 in isolation with a set of classified magnetic tapes to reproduce the artwork for the damaged panel. That was nearly enough to drive one to imbibe. I remember one especially challenging program - the program had virtually no documentation. "Stan Halper, I have not forgotten you"!! The end result was that the artwork was generated after taking me about a month. I later heard that Plant 8 had never been so peaceful! Should have been in Bldg 4 listening to Vraa talking to himself! And probably his "spiritual advisor"!

1975/76 Time Frame:

Dr. Kenneth J Thurber wrote "Large Scale Computer Architecture - Parallel and Associative Processors". The AUTOGRAM was one of the first of a family of "Computer Output Microfilm (COM)" typesetting systems developed. Dr. Thurber came to the Department and inquired as to the availability and potential for its use to typeset his book. The AUTOGRAM produced the typeset film from which the book was published in 1976. [Earl Vraa has an autographed copy of the book].

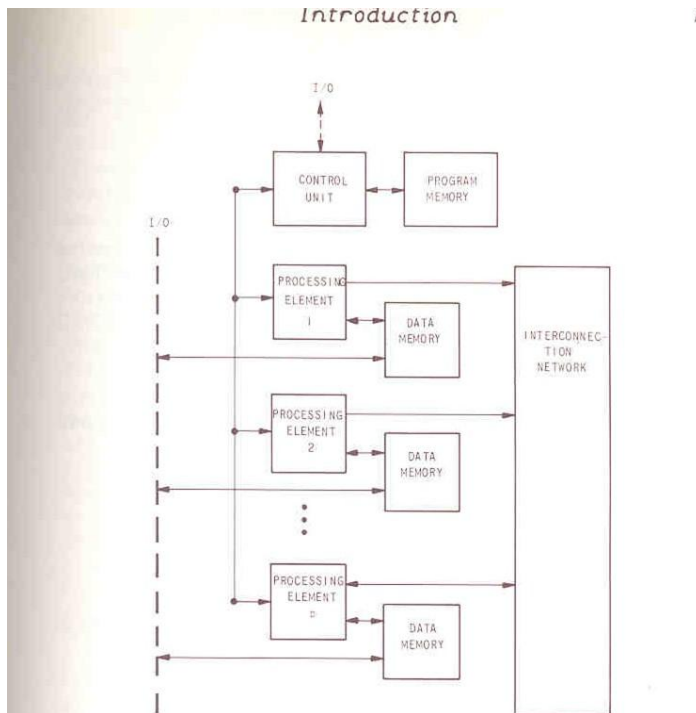Introduction   /
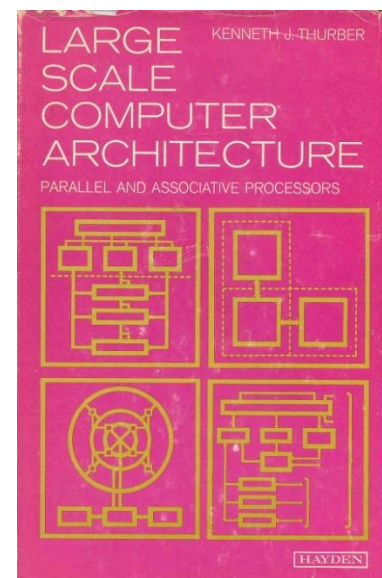
Figure 1.2 Block Diagram of a Parallel Processor

processing elements must operate concurrently. They operate in parallel, i.e., synchronously. A processing element is said to be *active* if, and only if, its data from the data stream is being processed. If the processing element is not operating on the data stream it is considered *inactive*. After each control instruction is received by the processing elements, a processing element can either perform the current instruction or omit it (based on previous states and/or data values), but it cannot do something else. If desired, the processor could operate as a stand alone unit. A parallel processor is normally interfaced to a general purpose computer through the control unit. The general purpose computer is usually known as the *host* and commands the overall array of processing elements. The control unit supervises and directs the detailed execution of programs.

(continued from front flap)

About the author...

Kenneth J. Thurber is currently with the Product Development Group of the Sperry Univac Defense Systems Division where he is responsible for the architecture of new Univac military products. He is also a member of the Computer Science Department of the University of Minnesota where he teaches courses on advanced computer architecture.

> I have a copy of the "requirements specification" developed by Erickson and Vraa! Unique!

In 1976, we proposed to get capital for an "engineering" computer center. Bob Erickson and I generated a system specification at Eddy Webster's over lunch. Got the picture? This was on 6 January 1976. We first had to get approval of the Controller, Al Wald. Boy, did I ever get a "new one made"! I wrote the specification with all the financial requirements that Bob and I took into Al. The meeting lasted all of thirty seconds! It was the beginning of the year and I had used 1975 for the year date. Al's comment was something to the effect "#^*!&>, why should I believe your numbers, you can't even get the date right"! Tightwad! He didn't want engineering to have its own computer. What did we do? One thing was to get one of his minions "transferred" to Salt Lake City as a result of an "episode" at the St. Paul Radisson! Ah, memories!

The mid to late 70s increased the use of computer terminals and a course was developed for employee "Use of Computer On-line Terminals". This was taught for many years to numerous engineers, design drafting, and other employees.

Jim Andrews and others wrote demonstration program to display the attributes of a large storage fixed head disk for military applications, applications for the Tektronix-4014 to plot a continuity test tape (TEKGERBER) and to plot individual nets that were found in error by a Continuity Test (Teknet), the NETTERHELPER program that analyzed Emitter Coupled Logic layout and routing rules, the AUTOVG program to automatically generate voltage and ground plane connection artwork, and interfaced OPTIMA with our plotters so that the ZKSD project could generate milestone charts.

A Tektronix 4014 graphics display was purchased and interfaced with the Univac 1110 system for interface such that any existing graphics applications could use it. Also, a Laminate Back-panel Routing System was developed.

 Dr John Esch writes - In January 1978, I returned from Univac Roseville to the Defense Systems Division to lead the new Software Engineering Department. Until that time, DSD had a number of independent tools to help software developers. The philosophy of the new department was to bring uniformity to the software development process. The process was to provide developers with tools so helpful that staff would want to use them and that, through their use, would bring some degree of standardization to the development process.

The net result of the department's efforts were a combination software design language and supporting tool set. The language was described in PX12605, "A Software Design Language Specification." Its abstract reads:

> "This document presents initial specifications for a software design language. The purpose of the language is to permit formal descriptions and automated support of software design. The elements of the design language are described [design objects, properties, relationships] and syntax for the language is specified. An example of the use of the design language is included, together with a sample report to be generated."

By the early 1980's the department had successfully migrated and integrated a number of previously existing tools to comply and support the software design language. A position paper for the DoD Workshop on The Environment For Ada "Some User Interface Expectations" described the results and its potential application to software development and the Ada programming language. In particular, its states:

> "Sperry Univac DSD has been evolving toward a software design system since the mid 1970's. A feature of this system is a Software Design Language which is a concrete example of a descriptive language. The current system is depicted in the figure below. The Structured Narrative Organizer Outputs Processor (SNOOP) solicits commands as indicated and produces the requested output from the design language statements input to it. The Design Object Drawing Outputter (DODO) program produces graphics for a hierarchy chart showing which functions call other functions. The Build Inputs Steps

Output Network (BISON) program produces graphics for an input-process-output diagram. FLOWCHARTS produces graphics for a flowchart diagram. And CAMIDS combines text and graphics to produce input for a variety of hard copy devices."

We didn't know it at the time but, as usual, the division was way ahead of the industry. It took about another twenty years for the Unified Modeling Language (UML) with its standardized graphic languages that Sperry was already using back in the 1980s.

Time marched on and one day in the early 80s I was called by my boss, Robert A 'Bob' Erickson to give a presentation to some program development types from TRW and Motorola. They were headed for Control Data Corporation (CDC) to review their AD to team for the Very High Speed Integrated Circuit (VHSIC) program. Somehow Bob made contact with the TRW/Motorola program directors and convinced them to come to Sperry DSD instead. I "pitched" them on the capabilities of DSD CAD and they never went to CDC! That was the beginning of AD expanding into the integrated circuit support. Probably the beginnings of the Hardware Design Language (HDL) use in DSD. I have the paper that Larry D Anderson and I wrote in the mid-80s on HDL related to the VHSIC program; "A System Through Hardware Design Methodology". {Editor's Note by Lowell Benson – *See the August 2009 'Article for the Month' on web site page* http://vipclubmn.org/documents.aspx .}

Looks like VHSIC ran from mid 1980 to mid 1984. CAD was our entry into this game but we expanded our presence with some computer architecture concepts [binary tree maintenance bus?]. Building on our internal CAD work in automated layout, test and simulation and with the advent of the Ada programming language, ideas and prototypes for VHSIC CAD kept popping out - mixed level simulators (MIXSIM), automated layout for irregular sized objects (SLATE), and a Hierarchical System Language (HSL) based on Ada concepts to describe both the structure and behavior of hardware. DoD became so enamored with HSL that they established a VHSIC phase 3 contract for development of an HDL. We were involved with some of the initial development but eventually, due in part I believe to internal politics, full scale development went to a competitor.

The 1980s
1981 –
Started promoting Computer Aided Manufacturing activities.
We created Gate Array checking software so that chips built for AN/UYK-43 and AN/UYK44 computers would work the first time they were manufactured.
1982 -
Developed CAD software to aid designing gate arrays and semi-Custom Integrated Circuit Chips.

MFG automation improved with implementing driving a numerically controlled drill with a UTS-20 terminal with diskette instead of paper tape.

1983-

Supervised 12 CAD programmers supporting all projects in house looking at ways to improve the artwork generation and verification process for IC chips, PC cards, and laminated multi-layer back panels.

1984 -

The MRS Task Force led an effort to convince management to capitalize $1.2M to install a second Univac-1100/83 system for Engineering design automation. We augmented this with 400 terminals during the following two years.

{Editor's Note - *I'll quit here for now.   I'm "brain dead". Do I deserve a "B&B" (brandy & beer)? I know there are many things missing and some dates incorrect. AD began as a brainchild of someone, became an orphan for awhile but for <u>the dedication of the employees,</u> and then broke out to provide support for many designs. Earl*}

References:

- A Progress Report on Computer Applications in Computer Design; S. R. Cray and R. N. Kisch, Remington Rand Univac, Division of Sperry Rand Corporation [CBI Records: ERA-Rand-Sperry; CBI # 176, Box 12, Folder #5]
- Mechanized Design, Curt J Bute and Jerry L Neese; Remington Rand Univac, Division of Sperry Rand Corporation [A copy will be submitted to CBI for their records/emv]
- Computer-Aided Design – What is <u>Really</u> Worthwhile? Earl M Vraa, Defense Systems Division, Sperry Univac, St. Paul, MN [A copy will be submitted to CBI for their records/emv]
- A System Through Hardware Design Methodology, Larry D Anderson and Earl M Vraa, Defense Systems Division, Sperry Univac, St. Paul, MN [A copy will be submitted to CBI for their records/emv]