Return to "Visible Storage"

***** Please note: This website (comp-hist) was completed before I found out about Wikipedia in 2002.**
Since then I have added material occasionally.
Items are certainly not complete, and may be inaccurate.
Your information, comments, corrections, etc. are eagerly requested.
Send e-mail to Ed Thelen. Please include the URL under discussion. Thank you ***

WISC
(Wisconsin Integrally Synchronized Computer)

Manufacturer	University of Wisconsin
Identification,ID	WISC
Date of first manufacture	start January 1951, complete about 1955
Number produced	1
Estimated price or cost	-
location in museum	-
donor	Gene Amdahl

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Photo - 63 K Bytes

Placard - by Ron Mak

WISC

WISC (Wisconsin Integrally Synchronized Computer) was Gene Amdahl’s first computer design, which he did while completing his Ph.D. in theoretical physics at the University of Wisconsin. The machine was built at the university during 1951-1954, and then it was used to train electrical engineering students in the new field of computing. WISC used paper tape and a teletypewriter. Its memory was a rotating magnetic drum, and the machine operated either at human “single-step” speed or at the speed of the drum. Dr. Amdahl went on to become a top designer at IBM. He later founded Amdahl Corporation, Trilogy Systems, Andor Systems, and Commercial Data Servers.

Developed at:	University of Wisconsin	Memory technology:	magnetic drum storage
First introduced:	1954	Memory size:	1024 55-bit words
CPU technology:	vacuum tubes	Cycle time:	60 operations/second (drum speed)

Sources: http://www.digitalcentury.com/encyclo/update/amdahl.html <
Interview of Gene Amdahl by the Computer Museum History Center staff, April 2000

Architecture

From From WISC to TRILOGY, lecture by Gene Amdahl, 1 hour, 1983

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Drum memory
    32 tracks
    32 words/track

arithmetic was serial, recirculating registers
1 full rotation of drum for each floating point operation
   60 revolutions/second
   bit time was 10 us

each word 50 bits long
   40 bits of fraction
    8 bits of exponent
    2 bits sign, fraction and exponent
5 more bit times for switching

much overlap
drum was from Engineering Research Associates
    one contact was Bill Norris, who later founded CDC

machine completed in 1954,
  remained in operation at university until 1959,
  when last person who could maintain it retired.
Machine given to that person, who used it in consulting business.
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Special features

2 "static" registers, 4 registers recirculating on the drum [this saved vacuum tubes]

Historical Notes

Entries

- From WISC to TRILOGY, lecture by Gene Amdahl, 1 hour, 1983
- Notes recorded at Computer History Museum from **Gene Amdahl**, the designer, April 2000
- Information drawn from the "working life" of the WISC. by Charled McClure
- More on the team that constructed WISC by Andy Lewis

Notes recorded at Computer History Museum from Gene Amdahl, the designer, April 2000

" This machine was designed in the summer of 1950. It as was written in a thesis by June of 1951. The thesis was sent from the University to other places to be evaluated. It was accepted as of September of 1951 and published at the

University by February of 1952. The machine was actually started to be built in January of 1951. It was completed about 4 years later, but I had already left to work at IBM by June of 1952, but I did all the initial planning and including making some of the first pluggable units by hand. I have one of those at home.

It was built at the Electrical Engineering Department and was used as a training project to train electrical engineers in this, then new, field of computing.

Q - How many people helped you build this?
A - I have no idea, There were two that worked with me for 8 1/2 months.

Q - So the paper tape came in here?
A - Yes, and there was a teletypewriter here.

Q - How fast could you go?
A - You could go at human speed with the Single Step Switch, or at the speed of the drum.

Q - Where is the drum?
A - Back in there, down at the bottom. I specified this drum, and ordered it from Engineering Research Associates.

Q - What was it's capacity
1024 55 bit words. And 4 recirculating recirculating registers, some 55 bits long, some 44 bits long, depending if you were dealing with the fraction or the exponent.

Q - what kind of logic aids?
A - At that time I was not proficient in Boolian Algebra, so it was all manual, with pencil and paper.

Q - So the debugging must have been extraordinally difficult.
A - I don't know, I was not there. (much laughter)

Q - Why did you leave before the computer was finished?
A - Well, I had an offer I couldn't refuse.

And over here was the power panel, and the power supply was largely under there, and some over there I guess.

Q - What was it used for?
A - It was used as a training tool, first for construction of it, then debugging. Then it was a computing tool until the last man that could maintain it retired. He asked the University if he could have it and use it in a consulting business. They agreed since they knew that it would not be useful to them with no one to mantain it. So they gave it to him. He knocked out part of a wall of his basement so he could get it in there. He used it for about three years then became too senile to consult. When he died, he had it in his will that he wanted to give the computer to me.

Q - How did the bullet holes get there?

A - When he was senile, his son wanted to do target practice in the basement. He set his targets up above there, and if you look at that pattern you see generally you see that you pull the trigger, you pull down and to the right if you are right handed. You can tell that he wasn't much of a marksman. You can see that it did some damage inside, but not much.

Q - How many registers did it have?
A - It had an instruction register which was static, [in tubes, not drum] and it had a exponent which was static, but all other registers were all active, - recirculators on the drum. An this was, I think, the first fully overlapped computer. There were four instructions in the course of being executed at any one time, you are reading an instruction in while you did the arithmetic in instruction in n-1, and while you where getting the operands for instruction n-2, and looking for instruction n-3.

But it wasn't a fast machine, it could do 60 operations a second, that was the speed of the drum.

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from Charles W. McClure, April 2007
I offer the following information drawn from the "working life" of the WISC.

To establish my "bona fides", I am the "CWMc" who prepared the WISC programming example included as Appendix G in the WISC Users Manual. By education I was (and remain in retirement) an electrical engineer but my interest has been in developing the programming and inter-device communication protocols which permit a number of electronic devices (computers and more specialized units) to work together towards the solution of a problem. I was a graduate student working on the WISC under the direction of Prof. Charles H. Davidson from 1959 through 1962. As will become apparent below I consider this period to be the apex of the contributions of this piece of equipment to the students and faculty of the Wisconsin School of Engineering and to Engineering Education in general.

Without diminishing Dr. Amdahl's design foresight by one iota, I proffer that Prof. Davidson was the driving force that brought the WISC to fruition. For more than thirty years "Charlie" led the digital computing interests in the Wisconsin Department of Electrical Engineering and he advanced engineering education through his teaching prowess. Charlie was the author of the WISC Users Manual and developed innovative techniques to bring sophisticated computing to the engineering "masses." He believes thousands of engineering students passing of the University were introduced to computing through his formal classes and educational access to machines in the Engineering Computing Laboratory.

In keeping with good graduate student traditions, my personal contributions to the WISC legacy were first in the programming arena (maintaining the library of subroutines mentioned in Appendix D of the WISCUM) and then in making some modifications to the actual machine. I added some hardware capabilities to the machine by extending the implementation of Amdahl's design in a compatible manner; the CLE instruction modified the original EXT instruction; a set of breakpoint switches was added to the console.

My most significant effort was the creation of "PAT" (which stood for Pseudo Assembler Translator) as my MS thesis. PAT was a system -- a collection of routines and procedures -- which allowed third year engineering undergraduates to make use of the computer without having to master the intricacies of hexadecimal logic and subroutine calling sequences. For example, students were told about only decimal memory addresses and a TRAnsfer instruction was inserted into each address ending in hex 'a'. At that time (1960) the prevailing wisdom was that a person should not utilize a computer as merely a tool until and unless they understood the inherent limitations of the logic design -- accuracy (round-off in floating point calculations), efficiency considerations, and monitoring for hardware malfunctions. PAT allowed students to make use of the computer through a couple of three hours labs in the same way they were already using a slide rule (even though few could explain the nuances of log-log scales and keeping track of the decimal point -- and essentially none ever saw a circular slide rule!). The students and faculty were sufficiently interested in this new tool that a commercial computer was soon acquired and the WISC was supplanted for undergraduate use.

The WISC had a few attributes which should be mentioned before all memory of that era is lost:

1. A tone generator was connected to the instruction decoder and fed a speaker on top of the main frame. After a few hours of listening to the "music of the beast" it was possible for humans to deduce what the machine was doing; it was possible for a person to recognize that an iteration was not converging or that the machine had reached the final steps of producing output. Some users had special routines solely to produce musical passages as the program transitioned from one step to another.

2. It should be emphasized that paper tape was the input and output medium; the input tape was created using a Friden Flexowriter (which was entirely separate from the machine) and the readable output was printed by feeding the output tape through this same device. There was no Teletypewriter associated with the WISC during its tenure at the University.

3. The Engineering Research Associates magnetic drum was the heart of the WISC and was mounted under the main frame. The bearings supporting the drum and its attached motor tended to leak lubricating oil into the drum housing and the oil would gradually collect in the bottom of the [horizontally positioned] drum. Therefore occasionally the accumulated oil had to be drained from the drum but no drain plug had been provided; it was necessary to unscrew the bottom-most read/write head. Reinstalling the head was no picnic since it was only a few inches from the floor, goopy oil would continue to leak until the head was fully seated, the threads were delicate and could have been easily damaged, and if the head was

advanced too far it would come in contact with the surface ostoricalf the drum -- thus quickly grinding away the magnetic coating on the drum. The final adjustment was done with an oscilloscope monitoring the signal from the head as the drum spun a few thousandths of an inch away from the head mechanism; close meant a strong signal -- too close meant squealing sounds and no signal.

4. The reliability and stability of vacuum tubes required some careful maintenance procedures. One of the permanently stored subroutines was a quick test of the basic functions. Good programming practice demanded that programs include back-up procedures and exercise this internal test at a frequency determined by the importance of the programming output. Start-up each day involved powering up up some 1000 tubes and this warmup took a half-hour or more. During this period the internal test was run repeatedly until consistent results were achieved; then a more complex program (a Runga-Kutta solution to the differential equations of a bouncing ball was a favorite) would demonstrate whether the machine could be trusted. The WISC power supplies had a provision for varying the delivered voltages so aging tubes might be coaxed into failing while running diagnostics rather than during useful execution. The logic modules required selected tubes whose characteristics were well matched; keeping a stock of spare modules was a job assigned to undergraduate students paid on an hourly basis.

5. A thousand vacuum tubes generate a lot of heat. A [noisy] air conditioning unit kept the room bearable during Wisconsin summers. During winters we opened the windows to reduce the demands on the air conditioning equipment but it was often the case that the AC was running while the windows were open on a cool autumn day. The final check of the evening was to shut the windows when the mainframe was turned off. Temperature control became more of an issue when another computer (an IBM 1620) was installed in the same room.

I hope these reminiscences can somehow be added to the historical record of the WISC. I would suggest that Charlie Davidson could provide much in the way of context. I believe his PhD thesis was one of the first ever devoted to programming as an intellectual activity.

I will make it a point to visit the Computer History Museum if ever I am in the area.

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More on the team that constructed WISC by Andy Lewis

I have an undated news release which I believe is from 1955 from the University of Wisconsin News Service that provides some more background on the team of six people who completed the construction of WISC in 1955.

I stumbled into this as I was doing some minor research on A.V. Vernon Miller who was president of the state's first Electric Cooperative in Richland County. He had a son named John B. Miller who was on this team which finished construction of the computer. This news article notes that construction began four years previously (1951), with Gen Amdahl, graduate student from Flandreau, S.D., Charles Davidson, graduate student from Washington D.C., working under the supervision of Prof. H.A. Peterson chairman of the UW electrical engineering staff.

The article notes that Amdahl left in ~1953 and that the final construction was completed by graduate students J.L. Asmuth, D.S. Noble, A.K. Scidmore, and staff members Charles H. Davidson, Instructor J.B. Miller, and Prof. V.C. Rideout. I only have a hard copy of this news release and could FAX it to you or scan and email it to you?

Andy

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This Specimen

- e-mail is from Paul Pierce to inforoots atsign computerhistory dot org - February 2, 2005
- WISC at Amdahl by Joseph Massucco - March 27, 2022

This e-mail is from Paul Pierce to inforoots atsign computerhistory dot org - February 2, 2005

About the WISC, history and restoration-

Some of the history of the WISC, as I remember my father telling me; some of this also came from Gene Amdahl. My father Dick Pierce and I both studied Electrical Engineering at Wisconsin, and my father also briefly owned the WISC.

Gene Amdahl was the designer (or perhaps architect) of the WISC, which was the first pipelined machine. However, he left before it was built. I don't know if he even did any of the circuit design. It was built by Professor Charlie Davidson and his students. If any documentation remains (apart from the published technical reports) it might be in his papers.

When the Engineering school was through with the WISC, they sold it through university surplus. Dr. John McNall, an astronomy professor and a good friend of my father, wanted the machine but could not bid on it because of university rules. So my father bid on it for him, and they loaded it up in my uncle Peter's 1951 pickup and hauled it out to Middleton, just west of Madison. Dr. McNall set it up in a downtown storefront and let high school kids run programs on it. Later he moved it into storage in his basement, it was there that it acquired the bullet holes. I believe they were strays from outside.

After Dr. McNall died from cancer, the WISC seems to have gone back to the University, or maybe Dr. Amdahl bought it from his widow. In any case I was there when the Engineering school presented Dr. Amdahl with an honor and he acquired the WISC. He took it to California and displayed it in the lobby of Trilogy. A friend and I visited him there some time in the mid 1980's, this was the first time I remember seeing the WISC in person. Ultimately Dr. Amdahl was persuaded to present the WISC to the Computer History Museum.

There is a photo of the WISC in Wieks (3rd edition) that shows it standing in one of the labs in the old Electrical Engineering building (I had lots of classes there.) In the center you can clearly see that it has a Flexowriter console typewriter, not a Teletype. Since the Flexowriter has a parallel interface there is no need for a "UART" in the WISC, and much of the logic is probably shared between the Flexowriter and the paper tape reader and punch. To be authentic, the WISC should be displayed with a Flexowriter instead of the Model 15 Teletype. Unlike teletypes, Flexowriters seem to have come with many different interface arrangements. It might be very difficult to find one that matched electrically. But a lot of them look the same, so for display its not so hard. I have a bunch if you need one.

Probably all the frames of the WISC have survived, and there should be a module tester along with it too. However, its likely some cables have been lost, and more important, its very likely all the technical documentation is gone. As a university project its likely that the technical documentation was never very clear or complete. Restoring the WISC would be a very difficult project. The first thing, and very much worth doing in any case, would be to do some serious research to find any and all documentation.

Paul Pierce

Here is something else I found:

Memorial to Harold Peterson, chairman of the department at the time the WISC was built- http://www.secfac.wisc.edu/senate/20020506/1643(mem_res).pdf

and the relevant excerpt:

... He was instrumental in the development of computer technology in the Department of Electrical Engineering. He encouraged Professor Rideout in developing instruction and research in analog computers. Two Ph.D. students in physics, Dr. Gene Amdahl and Dr. Charles Davidson, came to Peterson in 1950 with the idea of building a digital computer. Professor Peterson encouraged them, provided space and a home in the department, and assisted in finding financing for the development of the Wisconsin Integrally Synchronized Computer (WISC), the first digital computer built in Wisconsin. Numerous electrical engineering graduate students did the research for their MS and Ph.D. degrees on the WISC project, and many went on to key positions in the computer industry.

WISC at Amdahl by Joseph Massucco - March 27, 2022 - writer @ jmassucco . com

I worked at Amdahl during early 80's. I remember that just after Gene Amdahl had acquired the WISC he brought it to Amdahl Headquarters in Sunnyvale, where I saw it. I'm not sure how long it was there. I believe it was originally supposed to be housed there permanently, but at some point I heard it had been moved elsewhere (This may have been when Gene became disillusioned by Fugitsu's interference - and veiled threats about supply problems). Sometime later (when I was working for Tandem Computers) Trillogy moved into the building next door in Cupertino.

Hope this helps,

- Joe -
Joseph Massucco
(206) 384-6528

Interesting Web Sites

- Gene Amdahl - wikipedia
- WISC - Gene Amdahl's PhD Thesis (off-site, scanned by Todd Bezenek who reminds us of the University of Wisconsin Libraries policy on copyrights.)
- www.bitsavers.org has more than the following on-line - Users Manual for the WISC and Dr. Amdhals thesis - thanks to Ron Kneusel

Other information

- Amdahl's Law - Amdahl's law provides a simple rule of thumb for bounding possible speedups when executing a job in a multiple processor environment. The law assumes that a single job is executed, that the amount of parallel work in a job does not scale with the number of processors and that processors not utilized due to limitations of parallelism in the job, are left idle.
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If you have comments or suggestions, Send e-mail to Ed Thelen

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Go to Visual Storage page

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