

Plated Wire Dialogues

INTRODUCTION

Occasionally an inquiry comes into a VIP Club email box, linked from our website. Some answers are simple, i.e. one and done. Other query answers require the knowledge of multiple people thus are distributed to various people seeking their recollections. Such a distribution results in a flurry of email messages – everyone involved may not be copied on every message. Over two weeks’ time there were 22+ topical messages – copied hereunder in chronological order.

This ‘topical’ paper was stimulated by a message from Ian Eperson, first email of Part 2 below. Part 1 is listed herein because the content is relevant to the topic. This paper’s INTRODUCTION and CONCLUSION are written by Lowell Benson, retiring Legacy committee co-chair and VIP Club webmaster 2006-2018. Note that a few of the messages touch on transitions from plated wire to semi-conductor memories.

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¹ Click on an item for a quick scroll thereto.

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Paper edited with Microsoft Word, 26 January 2020.

DIALOGUES

Part 1

April 17, 2018 7:23 AM - LABenson to Paul Dickson, Cc: Ron Q. Smith

Paul: I just read "Remington Rand UNIVAC 1110 - The 1110 was one of the very few computers to use plated wire memory, which was faster than core." on web page <http://www.computerhistory.org/revolution/memory-storage/8/264>.

I know that plated wire memory was used in the AN/UYK-11 Minuteman computers and in the commercial 9200 & 9300 systems. Had not read nor heard of the 1110 use before. Can you confirm or do you know someone who could confirm the UNIVAC 1110 use of plated wire memory?

April 17, 2018 7:49 AM - Ron Smith to Lowell and Paul

Yes, the 1110 used plated-wire memory for what was called "primary memory."

When the 1110 was begun, UNIVAC was expecting a major improvement in manufacturing costs for plated-wire memory. The 1110 was the first 1100 system designed to permit up to 16 million 36-bit words of memory. Early in the design of the 1110, they realized that plated-wire memory was going to remain extremely expensive. As a result, they modified the 1110 to have two levels of directly addressable memory. Primary memory would be plated wire but was limited to 262KW. Secondary memory was bulk core memory which could be up to 1MW in size. While the architecture permitted 16MW total, that size wasn't actually designed into the 1110.

The original idea was that the plated-wire memory would be used as a software-managed cache for the bulk storage of secondary memory. The original plans called for a special "block transfer" box that software could use to quickly move data and instructions between primary and secondary memory. Part way into the design of that, they realized that it would as expensive as an instruction processor and not noticeably faster. So, they instead designed for up to 6 IPs. When we got the 1110 to start testing, it became obvious that it took too much time to move data between memories – and the secondary memory was directly addressable anyway.

So, the software tried to keep only the most frequently used stuff in primary and leave the rest in secondary. Usually that meant keeping instruction banks in primary and data banks in bulk core. In the later release called the 1100/40 primary memory remained plated wire, but secondary memory became semiconductors.

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April 17, 2018 9:11 AM – Paul to Ron and Lowell

Ron had already responded but thought I would throw this out for reference.

A Wikipedia page does a good job of explaining the various systems and their memory types.

One of the 1110's I worked on in 1972-3 (FTD, Wright Patterson AFB) had {Univac type} 7005 core memory as the extended storage and of course plated wire as the primary storage. This was a pricey configuration as the T7005 core memory had a very high cost compared to the slower T7013 extended memory.

These systems all transitioned to their semiconductor memory versions

- 1106 (slowed down 1108 became the 1100/10
- 1108 became the 1100/20
- 1110 became the 1100/40

April 17, 2018 9:14 AM – Paul to Ron and Lowell

As a side note I have a coffee cup celebrating the 1000th model 3011 processor shipped. The 1106, 1108, 1100/10 and 1100/20 all used the same processor complex; they got their money out of that one. *Paul*

Part 2

January 2, 2020 14:04 – Ian Eperson to membership at vipclubmn.org

I wonder if the VIP club is still in touch with the plated wire veterans - Larry Bolton, Clinton Crosby, James Howe...As a fellow veteran (though on the other side of the Atlantic) I was wondering if Univac only ever used non-destructive read wire.

Regards, *Ian Eperson* (ex-Plessey Memories - Towcester, England)

January 3rd at 6:14 PM - G. Devlaminck responded to Mr. Eperson,

Below is the contact information for the three fellows you asked about. I'm not sure what you meant by being a "fellow veteran." Does that mean military or former Univac employee. If a former employee or associate you could join the VIP club for \$7 per year or \$18 {sic - for 3} years. Then you would get the club directory which lists all the names of the members who said "yes" to be included in club directory.

- Clint Crosby: clintoncrosby@unique-software.com
- Larry Bolton: lnr.bltn@comcast.net
- James Howe: james.a.howe@comcast.net

Ghislain Devlaminck Membership Administrator

{Editor's note: This answers Mr. Eperson's first question}

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January 4, 2020 @ 7:41 AM Lowell to some Legacy committee people, et al.

Larry, Clint, Jim: The following message came into the VIP Club's membership@vipclubmn.org mail box on January 2nd: {copies to Legacy Committee members; Keith Myhre, John Westergren, Harvey Taipale, Paul Dickson, Jim Andrews, and Steve Koltes}

"From ian.eperson@dedf.co.uk

I wonder if the VIP club is still in touch with the plated wire veterans - Larry Bolton, Clinton Crosby, James Howe...As a fellow veteran (though on the other side of the Atlantic) I was wondering if Univac only ever used non-destructive read wire. Regards, *Ian Eperson*"

My immediate assumption is that Mr. Eperson obtained your names from our website - <http://vipclubmn.org/Memory.html#PlatedWire>. A second assumption is that Ian read our linked articles, including the 2015 http://vipclubmn.org/Articles/Wired_Up.pdf.

The answer to the first question is: "Yes, we are still in touch."

Does anyone have an answer to his 2nd question: "I was wondering if Univac only ever used non-destructive read-wire?" There is a partial answer in the footnotes of page 6 of the referenced [Wired_Up.pdf](#) paper. I vaguely recall that I'd read or heard someone comment that a 1100 series machine had used plated wire - Dang!! wish that I'd written that down. {Ed note: I had, had to search to find the messages of Part 1 of this paper.}

Can any of you added anything about where we used this technology? Would appreciate a response yet this month as I clean out my 'Legacy' to do list.

It is questions like Mr. Eperson's that lead the Legacy Committee to more parts of 'Telling Our Story.'

January 4, 2020 @ 9:21 AM – Paul to Lowell and Cc'd people

It was used in the initial 1110 systems and the 9000 series on the commercial side. *Paul*

January 4, 2020 @ 10:22 AM – Larry Bolton to Lowell and Cc'd people.

Defense side used it in the Minuteman Weapon System Computer (WSC). These computers were used, one each, in the LCF (launch control facility) and the LF (launch facility). See 18-bit AN/UYK-11 on the VIP site. One manned LCF handled 10 unmanned LFs. One missile per LF. *Larry Bolton*

January 4, 2020 at 12:03 PM – Ian to Jim Howe, et al.

Ghislain Devlaminck at the VIP club was kind enough to provide your email address (along with those of Larry and Clint). I wonder if you can help.

I was part of the team at Plessey Memories (Towcester, England) in the early 1970s producing plated wire. We had two plating lines: one, a production line, for destructive read wire and a second line intended for non-destructive read wire. Unfortunately, the NDR line was killed by the 1103 DRAM before it got started so we only manufactured, in any volume, destructive read wire.

I have offered to update the plated wire page on the technikum29 website (<https://www.technikum29.de/en/devices/plated-wire-storage>) and was wondering if Univac only ever produced NDR wire (You may be interested that they have a working Univac 9200.) Regards

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January 4, 2020 at 12:21 – Larry Bolton to Ian, et al

Sorry, I cannot answer this question. I am not familiar with the difference. I thought ours was NDR. James or Clint would have to answer that question. Larry Bolton

January 4, 2020 at 12:27 – Larry Bolton to Lowell and Paul D.

FYI. I see you are not in the communication loop. I'm not sure who should be coordinating VIP responses.

January 4, 2020 at 12:53 PM – Larry Bolton to some VIP Club members

Is someone going to provide Paul's and my response and any others to Ian? Do we have a policy of who coordinates responses to outside questions or comments?

January 4, 2020 at 2:31 PM – Paul Dickson to some VIP Club members

- Picture from Henry Ford Museum: <https://www.thehenryford.org/collections-and-research/digital-collections/artifact/450091>
- Information currently on tehnikum29: <http://www.technikum29.de/en/devices/plated-wire-storage>
- From Computer History .org: <https://www.computerhistory.org/revolution/memory-storage/8/264>
- This item does state it was nonvolatile/nondestructive read:
<https://encyclopedia.thefreedictionary.com/plated+wire+memory> Paul

January 4th at 4:53 PM – Paul Dickson to Dick Petschauer and Tom Soller, Cc Lowell.

Hi Dick and Tom: Any idea of the scope of plated wire memory use on our products. I know it was used on the 1110, 9200, 9300 and 9400. Paul

January 6th at 3:52 PM – Richard Petschauer to Paul and Tom, Cc Lowell

I believe the first and only 1100 was the 1110 and used it after the 9000 series. It had a larger memory than the 9000 series computers and strained the plated wire production in Bristol Tennessee. Since the 1110 had a much larger revenue than the 9400 (in production at Utica) it had priority. The 9400 system was missing delivery dates because of memory shortages. Paul Spillane located in Bluebell, the director of all commercial manufacturing, directed Bert Boshea VP procurement and Glenn Turner, on Spillane's Staff, to look for an outside memory source for the 9400.

Glenn was the director of all memory development at Plant 1 in the 1960's. I reported to him as manager of the thin film memory department. Glenn asked me to join the group and help pick a vendor. We visited three companies on both coasts over three days. On Friday, the last day, in a phone call to Spillane, I recommended we select Intel who already manufactured the memory chips and had just started a plug-compatible memory system group. They could put their full staff on the project. On the following Monday Spillane had the field service people install a 9400 system at Intel to assist with technical information and provide help. In a month Intel delivered a full-size prototype for testing. After several changes, it was approved. Per my recommendation the maximum memory size was doubled, a new system was announced (the 9480?). Marketing was happy and final shipments exceeded the original 9400 business plan.

Established in 1980 Later the 1110 plated wire memory was also replaced with semiconductor memory but designed and manufactured at Roseville. Its size was also doubled, again by my recommendation and against that of my boss at that time, Art Schneider. Because of the high speed of the wire memory, we had to use the more expensive bipolar chips, rather than the CMOS types. I think the chip supplier was Fairchild. Later they did a "chip shrink", a common practice to get more chips per wafer and reduce chip cost. A few months later random transient single bit errors appeared in the field. The low access time of the memory did not allow time for error detection and correction. We developed a temporary test to screen out the weaker chips in inventory.

A few months later it was determined that small trace amounts of radioactive rare earth particles in the chip's ceramic package could with time emit an alpha particle that could strike a single memory cell (basically a cross coupled transistor flip flop) and sometimes change its state.

The solution was to have the manufacturer add a coating to the chip which would absorb the alpha particle. Component Engineering soon added Alpha sources to be used in chip testing and vendor qualification.

Later I may send some technical info on plated wire as a memory element. I am not familiar with the 9000 series memory wire systems.

January 6th at 4:18 PM – Richard Petschauer to Paul and Tom, Cc Lowell

More info on plated wire: See my paper on 1100/2200 technology attached, or VIP link <http://vipclubmn.org/Articles/HISTORY1100series.pdf>. Pages 16 and 17 cover plated wire. As explained herein; it did use non-destructive readout (NDRO). The original core memory had to be switched to a "0" to read it out. An output voltage indicated a "1" was stored so it had to be restored after reading. This was DRO or destructive read out for core memories. Dick Petschauer

January 7th at 7:12 AM – Lowell to Dick, Tom, and Paul with Cc: some VIP Club people.

Dick, et al': Thanks for this information about plated wire memory as used in the 1110. I'd like to add this technical info as a paragraph to <http://vipclubmn.org/Memory.html#PlatedWire>. If you have more information about plated wire as a memory element - that too could be added to this section of the Legacy Anthology.

I would also add a reference to page 16 of your paper "History and Evolution of 1100/2200 Mainframe Technology". That paper is already available on our website, see the 1990 entry of <http://vipclubmn.org/OurStories.html#Books>. Perhaps that pdf should have been an Article for the month! {Editor's note: I made it the February 2020 article.}

You mention Glen Turner, he wrote an article for our Legacy Anthology, <http://vipclubmn.org/couplers.html#Doppler>. And your work on thin film is also on the memory page - <http://vipclubmn.org/Memory.html#ThinFilm>.

An aside from plated wire: One of these years we'll complete the story of our Legacy - interesting details keep arising as the world finds our website. And, no one person knows everything. I think that when a couple of us met with Dr. Norberg at CBI in Jan 2006 - we set a goal of 200 career summaries because Dr. Norberg said that that would tell the story. Today with 180 career summaries in the People chapters and story pieces by another 2-300 people, the story still has missing pieces.

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January 9th at 11:30 AM – Dick to Lowell w/Cc to Tom and Paul

Also, I saw a place holder in one of the VIP sections on memory a place for semiconductor memory technology to be added. In my History paper following the part on plated wire, pages 18 to 20 cover information for first mainframe use for both bipolar and MOS chip technologies. Dick

January 14th at 9:30 AM – Ian to Larry Bolton w/Cc to several VIP club members

Larry” Thanks for forwarding the email but I'm not sure if it answers my query. {Editor’s note: Bolton and Dickson January 4th emails at 9:21 and 10:22 AM, page 4 above.}.

In the early 1970s Plessey were successfully making destructive read plated wire – i.e. requiring each read operation to be followed by a write to re-establish the original (0/1) state.

They (We) were attempting to get to production quantities of non-destructive read wire but found it difficult to achieve the consistency needed for large scale commercial manufacture of memory modules. It would seem that the team at Univac were more successful in producing non-destructive read wire.

I was wondering if you were successful from the start or if, like Plessey, there was an initial period during which Univac were producing destructive read plated wire. I was going to recognize that (in plated wire production) the Yanks were a step ahead of the Brits – but thought I should double check before awarding this accolade.

Apologies but you seem to have become the US point of contact on this. Regards – Ian

January 14th at 11:40 AM – Lowell to Ian and Larry, Cc to some Club members

Good Morning Ian: As the former webmaster and as the retiring co-chair of our Legacy committee - my wont over the last decade has been to collect inputs from several people before responding to technologists from other organizations. After your initial inquiry, I've received some 'plated wire' feedback from a couple of people who had worked in the commercial side of the UNIVAC house versus the defense side that used plated wire in the Minute Man AN/UJK-11 computer. As a volunteer (as all retirees are), have not put together a composite of all the tidbits that people have provided. I even found one item in my 'pending' list from 2018 {"Dang!! wish that I'd written that down"}.

I plan to do a combined answer in the next couple of days, then get it back to you and update <http://vipclubmn.org/Memory.html#PlatedWire> from whence you got the names of Messrs. Bolton, Crosby, and Howe. Cheers! Lowell Benson, BEE, U of MN 1966 [Editor’s note: This paper its references, and conclusion have the answer.]-

Predict the future; then plan and work to make it happen!

January 14th at 2:18 PM – Larry Bolton to Ian, Cc some Club members

Sorry, I cannot answer your question. The research and development of the plated wire memory technology was done prior to the implementation into the Minuteman Weapons System Computer. The computer design was done in St. Paul, MN. It appears the development of the plated wire technology was done in Bristol, TN or elsewhere. I don't think anyone in St. Paul had any involvement in its research and development. All members of the VIP Club are former St. Paul employees. We are users of the technology, not the developers.

Established in 1980 The wire we used was used in NDRO memory for Minuteman. I suspect the same is true for the commercial computers developed in Roseville, MN. I doubt if Clint or Jim know of any points of contact that could answer your questions on research and development of the plated wire technology. The paper that Clint, Jim, and I wrote was written to document what existed as we used it. I know this does not answer your question. I hope your search can link to others that can provide answers. Others copied on this response can add to or correct any statements I have made. Larry Bolton

PS: I assume your initial contact was based on your finding and reading the original paper that Clint, Jim, and I wrote and as posted on the VIPClubMN.org web site. There was also a subsequent addendum posted a few years later.

January 15th at 10:11 AM – Ian to Lowell w/Cc to other Club members

Lowell: Thanks for your efforts on this. My apologies if my query appeared to be more formal than I had intended. I was simply wishing to update the Wikipedia and technikum29 web pages on plated wire based on my experience working on its production at Plessey Memories.

Looking at Clint, Larry and Jim's 2008 note for the VIP Club on the facilities at Univac it was clear that their work on plated wire was much more extensive and long lasting than that in the UK. I was anticipating that it was also considerably more technically advanced - particularly with respect of destructive vs non-destructive read wire production.

I simply wished to make sure that any changes to the web pages were accurate and not biased by my own, somewhat limited, experience with plated wire production in the UK where large scale plated wire production ended in the early 1970s as ICL (the UK's mainframe computer manufacturer) switched to semiconductor memories – initially second sourced Intel 1K DRAMs (1103) provided by Microsystems International Limited. I was concerned that my updates might be misleading as my experience is limited to the early years of plated wire's production. Regards *Ian*

January 15th at 11: 52 AM – Ian to Larry w/Cc to Lowell

Thanks for the information. I hadn't appreciated that, for Univac, the plated wire process development and main production were separated by 1000 miles. At Plessey they were in adjacent rooms. I guess that it is also easier to sum up the UK experience as we were only producing significant quantities of wire for around 5 years (1969 through 1973).

I admit to, perhaps, not being the most objective observer. Plated wire was my first “real” job and I was full of enthusiasm for this fantastic new technology that was going to replace the slow, old fashioned, core stores. Unfortunately, it wasn't long before the 1K DRAM came along, ICL decided to make the switch to semiconductors and several members of the Plessey team, including myself, were laid off. (Since then I have had a somewhat skeptical view of the various headlines along the lines of “this new technology is going to put you all out of work”.)

Yes, I did see Harry Goldbacher's 2015 note for the VIP club – Univac's production was clearly on a different scale to that at Plessey where a single room contained the wire drawing machine, our production (destructive read) and development (non-destructive read) plating lines.

Lowell is pulling together the collective Univac experience (thanks Lowell) – I will be interested to see the overall picture from your side of the Atlantic. Regards – *Ian*

Established in 1980

January 15th at 12:09 PM – Keith Myhre to Ian and Lowell w/Cc to some Club members
Ian, The last sentence of the technikum29 web page (<http://www.technikum29.de/en/devices/plated-wire-storage>) states: "Other hand our UNIVAC 9200 is still running with the original wire-memory, probably the last remaining functional magnetic wire store in the world!"

To the best of my knowledge, the Minuteman III Weapon System Controllers (AN/UYK-11), first installed in 1971, are still in operational use. They have been running 24/7/365 since then (49 years).

The following is an excerpt from Page 7 of a VIP Club online document dated March 2017 (<http://vipclubmn.org/Articles/ProgramMgmt1974.pdf>): "Marth, Don {Don is a VIP Club member living in Lonsdale, MN.}

In 1974 I was Deputy Director for the Minuteman III Weapon System Controller responsible for overall coordination and management of the program. The Weapon System Controller was a two-drawer radiation hardened computer employing a plated wire memory. So reliable was this computer (components were burned in) that they are still in use today in Minutemen silos as the targeting and guidance computer. I can't recall many other names except for Dale Maus to whom I reported."

It appears that the technikum29 web page could use an update. *Keith Myhre*

January 15th at 12:52 PM – Larry to Lowell and Keith w/Cc to some Club members
I find it hard to believe the Minuteman III is still in use. Some time ago, when I looked up the Minuteman System, it appeared that several updates have occurred. The processing power of the III is old technology and newer processors are more powerful and faster. Also, the plated wire memory has probably developed corrosion spots on the wire leading to bad bits and the master clock/oscillator has probably drifted out of spec. I thought clock accuracy was critical in determining accuracy of targeting coordinates. The main advantage of the old bipolar semiconductor technology and plated wire was its relative radiation hardness. If it is really still in use after 40 years, I am impressed. If there have been failures. I wonder where they got spares unless they have downsized and scavenged from unused units. Larry Bolton

CONCLUSIONS

The answer to Ian's first question, i.e. Are we still in touch with Bolton, Crosby, and Howe? Sort of, only Larry Bolton has responded to the various email messages – neither Clint nor Jim have responded.

The answer to Ian's second question, i.e. I was wondering if Univac only ever used non-destructive read wire. I Lowell, have read through all the messages and references and conclude that Univac/Sperry only used Non-Destructive Read Out plated wire – no info indicating that we manufactured any Destructive Read Out plated wire.

{Editor's note: The second paragraph of <http://vipclubmn.org/cp18bit.html#UYK-11> is a note from Wes Peters written January 2009 implies that a Minute Man computer was still in operation then. I've searched my files and can't find contact information for him to get an update. Lowell}

Established in 1980 Follow-up Tidbits:

A Legacy tidbit: the curator at the Ford Museum is Matt Anderson, former curator at the Minnesota History Museum in St. Paul where the original ERA Drum Memory prototype is archived.

2nd tidbit: In October 1970 we installed two 1830Bs, two 1840 mag tape units, and a 9200 card/tape system in Hengelo, Holland as a software development for the German Navy's Fast Patrol Boat system. As an installation and maintenance engineer, I had to trouble shoot a 9200-system memory problem. Swapping a two data register cards isolated the problem; it took three days to obtain a spare card and the system was back on line. *LABenson*

3rd tidbit: I reread our original paper. It states the plated wire development was done in Philadelphia. There were multiple production platers in Bristol, TN. One or two were dedicated to the Minuteman wires. I'm not sure if commercial and Minuteman used the same wires. When production in Bristol was stopped, I think one plater was moved to St. Paul to continue Minuteman production. I was told that some research memories were placed on top of a building in NYC to see if there was a concern about ambient atmosphere leading to corrosion. Apparently passed. It appears Minuteman used a half turn word line. Did commercial use the same? Would there be a difference in the wire properties commercial used versus Minuteman? *Larry Bolton*

REFERENCES

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- <http://vipclubmn.org/Articles/PlatedWireAddendum.pdf>
- Article http://vipclubmn.org/Articles/Wired_Up.pdf
- See 18-bit AN/UJK-11: <http://vipclubmn.org/cp18bit.html#UJK-11>
- A German technical site: <https://www.technikum29.de/en/devices/plated-wire-storage>)
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