Computer History Museum

Special Interest Group on Semiconductors

RE: Systems-on-Chips – The end game in the semiconductor revolution

The real story behind the explosive impact that semiconductors have had on our world lies in the industry's 40-year pursuit of Moore's law. Shrink the features...lower the cost ...speed up the chip – a (nearly) unending tale of increased functionality on a single chip. Lowering the size and cost of a chip is not only about economics, however. When a complete system can be implemented on one chip, the size reductions often possible in the resulting product can itself cause a revolution.

The goal of the SOC working group is to identify a handful (~5) SOCs which revolutionized the systems they enabled, and tell their story. Not only the story of the chip, but the story of how that chip came to be, the people involved, the challenges overcome, and the impact on our society.

Of course, what constitutes a system covers a wide range of complexities. There are very simple systems (like wristwatches), and very complex systems (like supercomputers or cell phones). We'd like to examine this evolution of SOC's, from simple to complex, over approximately the last 30 years (1975 – 2005), and tell the stories of those systems and their creators.

In addition to the few we focus on, we also want to collect and organize information describing as many other significant SOCs as practical and appropriate. Only the top handful may make it to exhibit form, but it is also important to note that the CHM has the charter to gather and catalog information and artifacts useful for future research by others. In some cases, we may only note where the information or artifacts reside, rather than collecting for the CHM itself.

As a starting point for our work, I offer the following suggestions as examples of products incorporating SOCs which might make our list. This is only a starting point, as I would hope that others can grow and refine the list such that it is maximally representative of the impact that SOCs have had.

Product/Application	Approx. Date	Designer/Mfg.
• Digital watch/consumer	1975	Intel/TI/Timex
• Auto Engine Control/auto	?	Intel? Others?
• Toys – Speak n' Spell/toy-ent.	?	TI
• Hearing aid/pacemaker/medical	?	
• Cell phone/consumer		TI/Nokia/Ericsson
• iPOD/entertainment	2005	Apple computer

TO: David Laws

FROM: Doug Fairbairn

SUBJ: SOC Status/Digital Watch

DATE: Sept. 20, 2006

I've made some good progress in mapping out the history of the digital watch industry, and specifically in pin-pointing what I believe to be the seminal events in moving to a single chip solution for wristwatches.

As we have discussed, the Pulsar from Hamilton has captured most of the headlines in that it was the first all electronic watch, or "wrist computer". The attached article claims that the first prototypes contained "44 tiny integrated circuits interconnected by 4,000 hair-fine wires." It further stated that RCA reduced this to a single IC for the mass produced version, which did not appear until two years later (1972). I think the claim of a single chip is overstated, however.

The two people you helped get me get in contact with, Dan Davis and Peter Stoll, both seemed to have played significant roles in the development in two single-chip watch modules.

Dan seems to have played a major role in contracting for the development of the first single-chip LED watch from a small company in Plano, TX – not TI!

Peter Stoll was hired by Intel in 1974. His first project was to design a single chip LCD watch chip as a replacement for a two-chip solution. He accomplished this later in the same year.

I have captured some of the major milestones in the chart on the next page.

On the following pages are a couple of examples of the developments in the digital watch business and which gives some perspective on how fast the digital watch business evolved.

Watch Time article:

http://www.watchtime.com/archive/wt_2004_02/WT_2004_02_134.pdf

A Brief History of the Electronic Watch

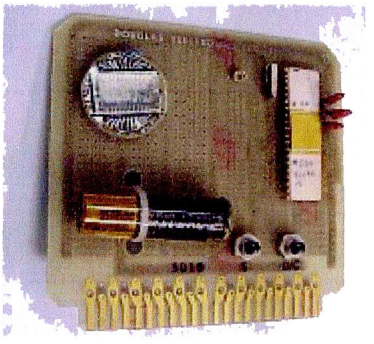
Name/Event	Who?	Date	Source/Comments
First electronic watch	Hamilton	1957	Battery operated in stead of winding. Used traditional Balance wheel for time *Source: BBC: The History of the Digital Watch*
Accutron	Bulova	1960	Vibrating element (powered by battery) instead of flywheel; Also first use of transistors. Used by NASA went to moon. *Source: BBC*
Quartz wristwatch technology	Swiss Research CEH	1967	Refined quartz to make it fit in wristwatch and to make more accurate than Accutron. Swiss industry thought quartz was fad and continued to refine mechanical oscillator. *Source: BBC*
First quartz wristwatch	Seiko 35SQ Astron Watch - $1,250.	Dec. 1969	Clunky and unreliable. Recalled after only 100 watches were made. Techniques were refined and quartz became the standard for the future. *Source: BBC; Wikipedia; oldpulsars.com*
First digital display - LED	Hamilton Pulsar	1972	First announced in 1970, but took two years to get to production. Announced 4/4/1972 in full page WSJ ad. Cost $2,100. in 18 carat gold case. Required that you push a button to see display. Appeared in 2001: A Space Odyssey, Johnny Carson show (5/5/1970), etc. *Source: BBC*
First plastic digital watch - $20 (LED)	Texas Instruments	1975	Price competition forced many out of the business. *Source: BBC*
First LCD watch?	Seiko 06LC	1973	LCD technology developed in 1972. *Source: BBC; Wikipedia*
			An alternate to the above is a report that Microma was selling an LCD watch in 1972 – at the time Intel bought them. (Peter Stoll and other reports)

The impact of integration:

- From a flashy, high end product sold primarily through Tiffany's to a few hundred customers:

Year:	1972
Price:	$2,100
Reliability:	Very low
Market size:	Hundreds of units

- To a high-volume product sold at your local discount store:



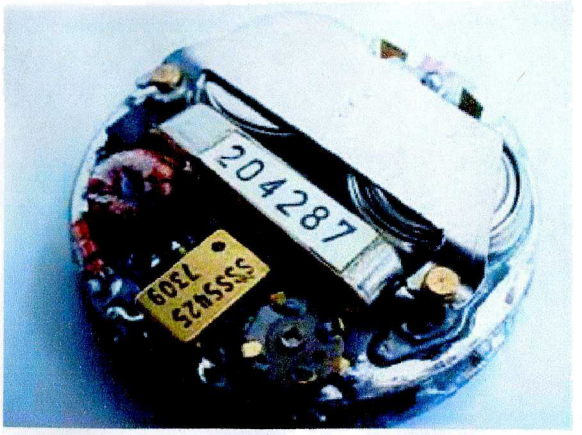
Peter Stoll's one-chip watch

The $20 TI watch

Year:	1976
Price:	$20
Reliability:	Very high
Market size:	Tens of millions of units

Peter Stoll believes he developed the first single-chip LCD watch chip in 1974.

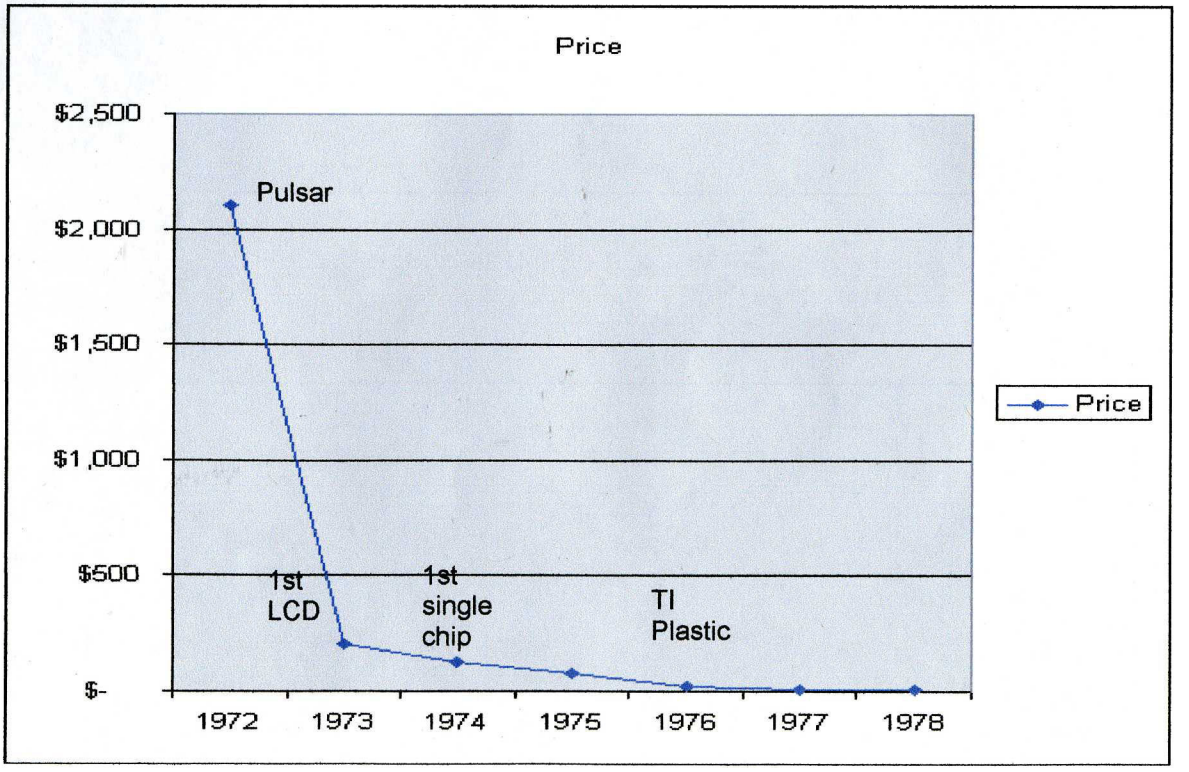
The following Microma watch autopsy seems to show a two-chip watch watch from ~1973.



Peter's chip replaced the two chip solution with a much lower cost part that also eliminated a number of external discrete components. I don't yet have a picture of that solution.

Digital Watch Prices

	1972	1973	1974	1975	1976	1977	1978
Price	$ 2,100	$ 200	$ 125	$ 80	$ 20	$ 10	$ 8

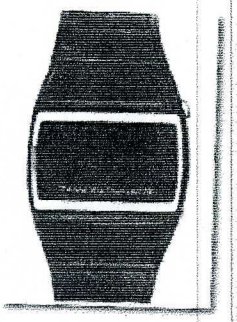


1972

Microma Watch Business

Intel entered the timekeeping business in 1972, acquiring digital watchmaker Microma. Digital watches were then regarded as high-tech marvels, selling for about $200. When competition drove prices closer to $19.95, Intel realized it could apply its technology expertise better elsewhere.

The $20 Watch



At the Chicago Consumer Electronics Show in January 1976, Texas Instruments shocked its competition by introducing the first $20 watch line. The lowest price for a digital electronic watch fifteen months before had been $125 and even a few months before, $49.95. The $20 watch got its start in TI's IDEA program. To encourage innovation, TI provided 41 million annually as grants to employees with ideas for improving products or processes.

The TI watches were the vanguard of an outpouring of low-priced watches made by U.S. semiconductor companies, who were competing against traditional watch firms like Timex and a host of smaller upstart assemblers. By the following year many of these companies, including Gruen, Benrus, Litronix, and Microma, were out of the watch market altogether.

By May of 1977 TI had cut its price on its model 503 sports watch to $9.95, making it the first electronic watch sold for under $10. By fall of 1978, TI, Fairchild, and Timex were the last companies assembling watches in the United States. And by 1980, TI was out of the watch business completely, largely due to competition from even cheaper foreign watches.