The Birth of Chipzilla

Or, the early history of Intel Corporation

JAN 21, 2025

This is the third entry in a multipart series. You may be interested to read al *Shockley Semiconductor* *and about* *Fairchild Semiconductor*.

Robert Noyce resigned from Fairchild Semiconductor on the 25th of June 1968. When Gordon Moore heard that Noyce was leaving, he chose to leav with him. In his resignation, Noyce stated: "*I do not expect to join any comp which is simply a manufacturer of semiconductors. I would rather try to fin some small company which is trying to develop some product or technology which no one has yet done. To stay independent (and small) I might form a n company, after a vacation.*" For Moore's part, he felt that there was tremendous opportunity in starting a new semiconductor company, and h said as much to Noyce on several occasions. It would be natural for anyon feel some trepidation when leaving a job to start a company, but this wasn the case for Moore and Noyce. Moore stated that, even at this early time, t culture in the Valley didn't stigmatize failure; when failure occurred, peopl simply started over again with another attempt. These two men were also quite confident that they knew what it was they were doing. Memory is no unique to any one computing or calculating machine. All such machines n memory and the more the better. Moore figured that if a company came o with a standardized memory product, the market for it would be quite lar large market would mean higher production volumes, which would then n lower cost, and would in turn expand the market even further.

Having moved to San Francisco in 1961, Arthur Rock worked with Thomas Davis Jr to start the Davis & Rock venture capital firm. Rock had been instrumental in funding Fairchild and bringing the various parties togethe and he coined the term *venture capital*. Of course, starting a semiconduct company wasn't cheap. Arthur Rock had kept in touch with the traitorous eight, and when he heard that Moore and Noyce were going to make a nev company, he immediately expressed his willingness to participate. The ent discussion about the matter between Noyce and Rock was a phone call las less than fifteen minutes. Rock described this call: *Bob* [that's Noyce] *just called me on the phone. We'd been friends for a long time. Documents? There was practically nothing. Noyce's reputation was good enough. We put out a page-and-a-half little circular, but I'd raised the money even before people s it*. In the span of about a day and a half in fifteen telephone calls, Rock had managed to raise $2.5 million (around $22.5 million in 2025 dollars) in addi to his own investment of $310,000 (of this, $10,000 was part of the founde investment of $1 per share, while the remainder was of the outside investments at $5 per share). Moore and Noyce contributed $245,000 each The arrangement that Rock made gave the three founders half of the com and the outside investors the other half.

Moore and Noyce initially considered naming their new company Moore Noyce, but they decided against this. While it would humorously sound lik *more noise* when said quickly, noise isn't a word with good connotations in electronics. They settled, instead, on the name NM Electronics, and their company was officially incorporated on the 18th of July in 1968. The same they hired Andrew Grove who'd served as the assistant director of development at Fairchild. On the 20th, they hired Leslie Vadász who'd wor in Fairchild's R&D lab and helped in the development of the silicon gate wi Federico Faggin. The company's name was never intended to remain NM Electronics, but the group couldn't think of anything too great. One of Noy daughters suggested the name Intel as a contraction of integrated electro but that name was taken. Intel's first major purchase was the name of the company at a cost of $15,000, a officially adopted before the end of the mo

Andy Grove, Bob Noyce, Gordon Moore

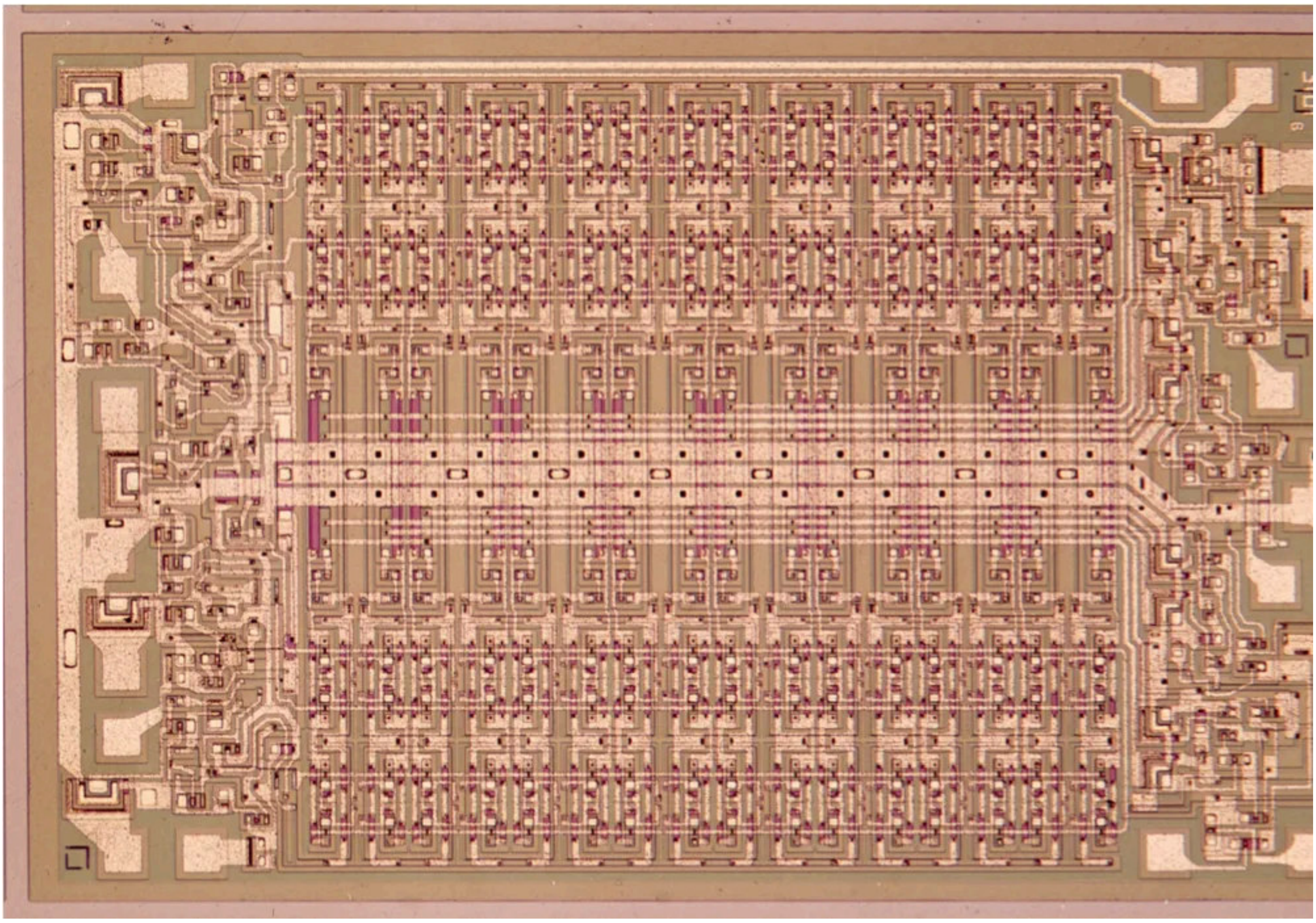
Intel's structure in these early days had Rock as Chairman, Noyce as CEO, Moore as Executive VP, Grove as director of engineering, and Vadász as th director of MOS design.

Before the company could begin operations, they needed a place to work. Over on Middlefield Road in Mountain View, Union Carbide was vacating a building. They'd really just begun that process, but a conference room was available. Intel rented it. As Intel took over the building, Moore felt the spa was larger than what they really needed, but whether he was right or wro that wouldn't be the case for too long. Official operations of Intel began in August of 1968.

For Intel's first few months, the company had quite a bit of work. They nee to build a manufacturing process, figure out their product line, and hire enough people to get products made and sold. This involved them needin build Fab1 as quickly as possible. The goal was to get things done by the er December, and this meant that they wouldn't be building every tool they needed. At Wescon, they actually bought some equipment right off the sh floor. A few things had to be adapted to meet their needs, but most of thei equipment wasn't made by them. This wasn't solely due to the timing constraints either. The founders of Intel had learned from their prior experiences in this industry. While a single company might be able to innovate in some areas, it wasn't long before competitors replicated that success. Then, those competitors would also be iterating and innovating. A single company had a limited customer base, but the market as a whole was larger and innovations could come from anywhere. They wanted everyone's expertise, so they bought what they could from whomever had the best to... Moore worked closely with Intel's suppliers, and he even made some investments in them personally.

While Moore, Noyce, and Rock felt little fear at Intel, this wasn't true for Grove. At Fairchild, Grove had been strictly R&D. He didn't really see the re... of the company, and he'd been hired by Moore out of graduate school. At I... he had the chance to really see the entire company and its operations. He constantly feared that the company would go bankrupt, but perhaps as a result of that fear, he became quite focused on manufacturing. He wanted company to be able to do the same things every day to make a uniform product successfully, affordably, and reliably. He quickly began handle mu... of the company's operations. The team that was assembled to undertake t... early efforts was phenomenal, and Intel met its goal completing the Fab1 s... by the 31st of December.

Before Fab1 was even completed, Noyce had visited Sharp in Japan. They spoke Tadashi Sasaki with the hope of gaining (at least some of) the comp... business for ICs. Sasaki then asked Rockwell, who did their manufacturing work, if they could give Intel some of their business, and Rockwell said no; they wanted to enforce their contract's exclusivity. Sasaki then invested 4... million yen into his friends Yoshio Kojima's company, Bijikon Kabushiki-ga... (or Busicom), in Nara, Japan which gave him quite a bit of influence there, allowed him to work on a CMOS calculator with Intel. Marcian Edward Ho... (or Ted), Intel employee twelve, was the person initially tasked with this project on the Intel side of things. He worked as both an engineer and the liaison between the two companies.



Intel 3101 SRAM die, image from Intel

In April of 1969, Intel released the 3101 SRAM. The 3101 held 64 bits of data (eight letters of sixteen digits), and sold for $99.50 (about $850 in 2025 dollars). Even at this time, the chip had far too little storage capacity to be useful as main memory (especially with its high price), but it was incredibl fast with an access time of fifty nanoseconds and it dissipated just six milliwatts per bit. With the chip's high speed, low power draw, and small s it was quite useful for processor registers in minicomputers and mainfram The company had been hoping to gain a Honeywell contract with the 3101 That didn't happen, but the chip was moderately successful. This chip was fact, successful enough that Intel's work with Busicom fell on the back bur

Busicom had initially provided Intel with a twelve chip, PMOS, decimal arithmetic design for their calculator hardware, and by June, Masatoshi Sh had refined this to seven chips. He didn't have a full schematic, but it was something to work with. Shima then visited Intel in June with two other

Busicom engineers. When Shima arrived, he was a bit dismayed. Almost no progress had been made, and he discovered that Intel had some serious expertise in hardware and memory design, but they didn't have any seriou expertise in logic design. Stan Mazor began to act as a buffer between Shi and Hoff, and over three months, there were many meetings about the des but almost no progress.

At this time, Intel was just a memory company. They had packaging to accommodate early memories and nothing more. This limited the design o the chips to 4bit allowing the chip to fit in a 16-pin or 18-pin DIP. These restrictions were not initially given to Busicom, but Hoff knew them, and t influenced what he presented. Unknown to Intel, Sasaki had also come up with a four chip design and gave this to Busicom. With both sides now agreeing to a four chip design, it would seem that things could have progressed, but unknown to Busicom, no more progress would be made th year.

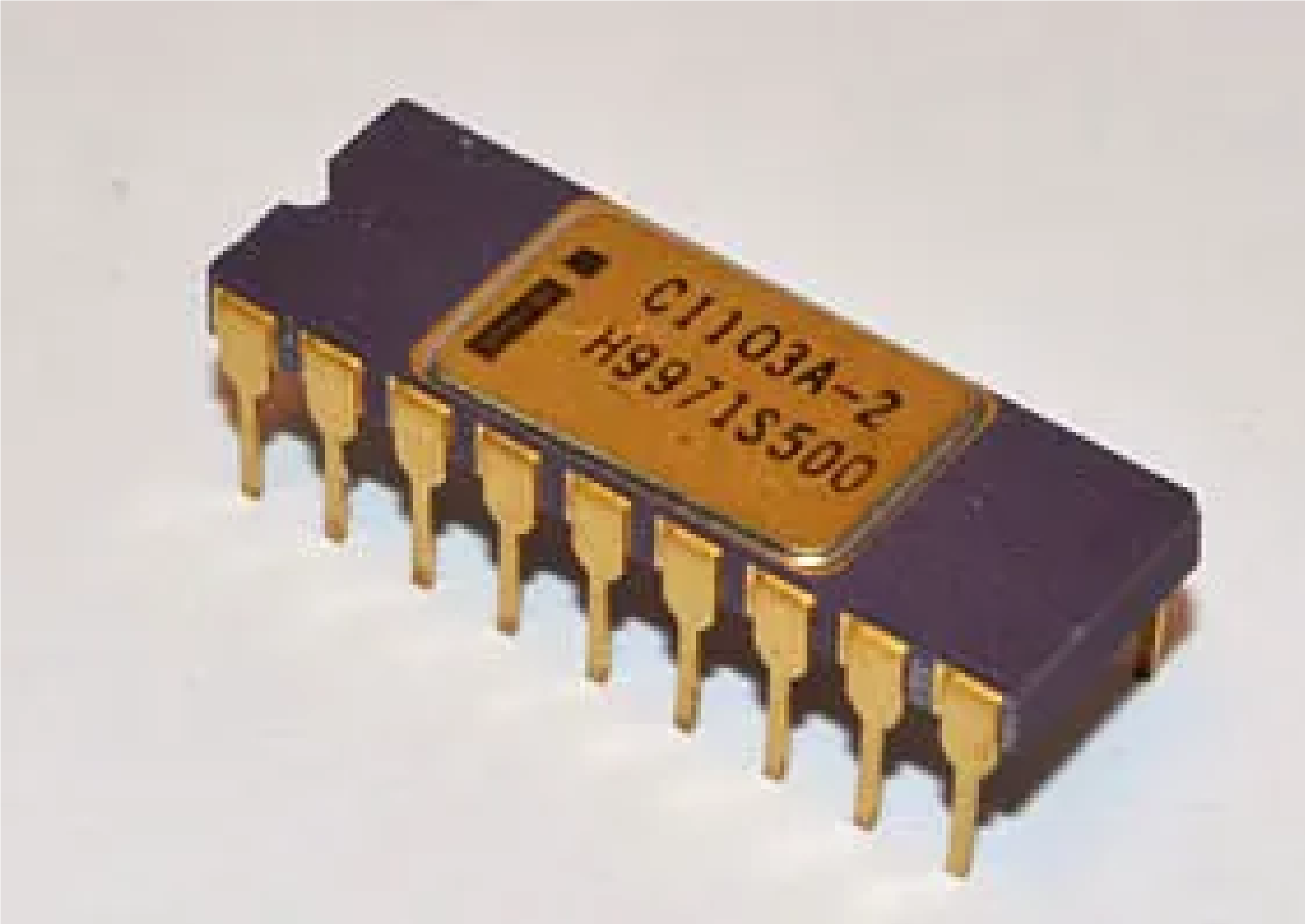
In July of 1969, Intel released the 1101. This was first MOS memory chip. Th 1101 was slower than the 3101, but had a capacity of 256 bits, used silicon gates, and allowed for far higher memory densities than had previously be possible.

In December of 1969, CTC provided Intel the CPU requirements and preliminary designs for a processor they planned to use in their Datapoint 2200 terminal. Intel was then supposed to implement these in LSI. At Intel project became the 1201, but much like the Busicom project, it wasn't given any priority. Intel was a memory company. Frustrated, CTC turned to Texa Instruments who also failed, and CTC eventually built the processor out of discreet components.

For 1969, Intel ended the year with revenues of $565,874 and a loss for the year of $1,912,833 which meant a loss per share of $1.66. While this sounds terrible, the company had set expectations that this would more or less be case.

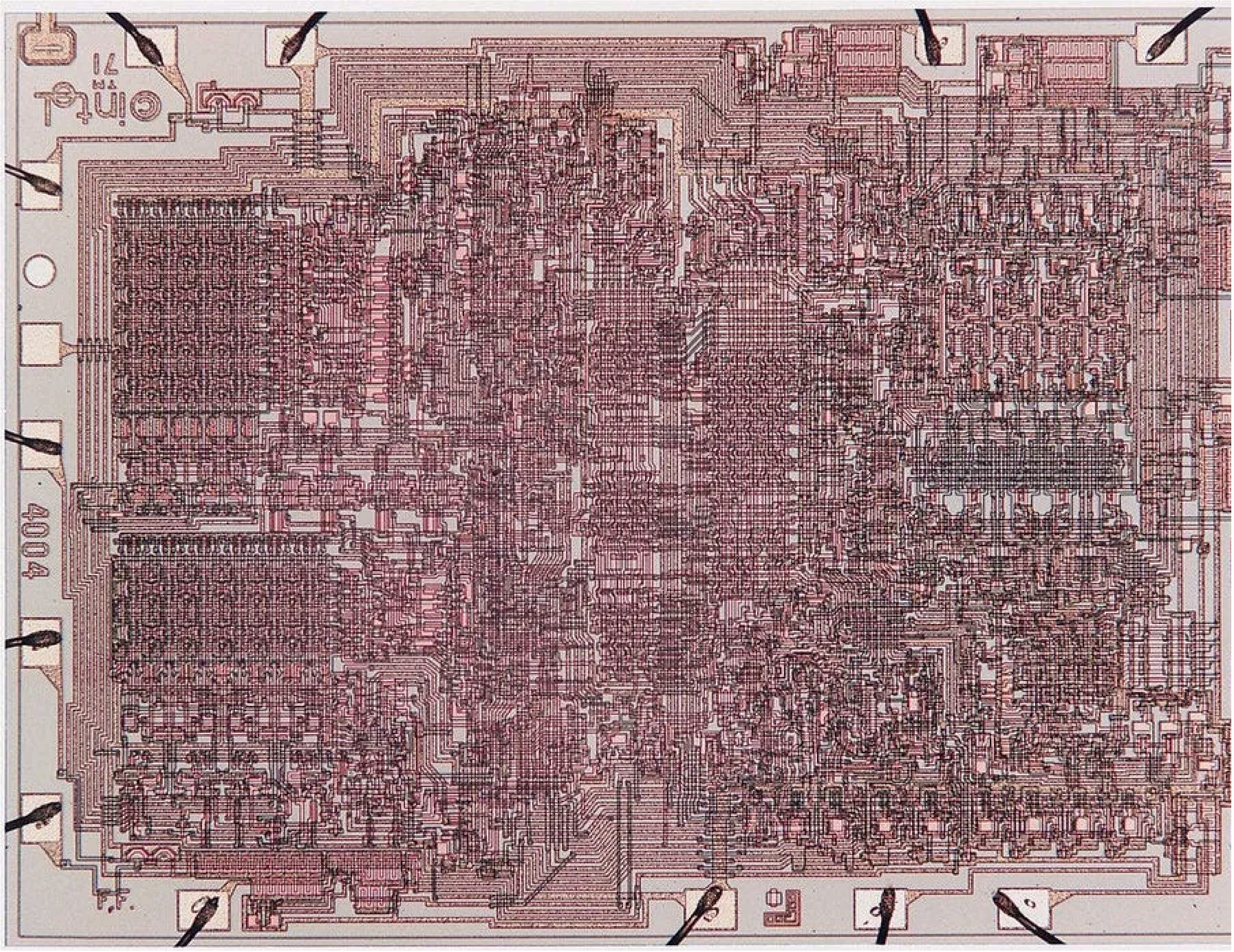
Back on the Busicom project, Hoff eventually brought a proposal chip desi to Shima that would use a general purpose 4bit CPU with binary logic, a R chip, and a RAM chip. Shima then added a 10bit static shift register for use with the printer and keyboard interface of the calculator. They improved t instruction set, the bus, and by December of 1969, Shima was able to write functional specification. The agreement for Intel to build the chips was officially entered into on the 6th of February in 1970.

In April of 1970, Federico Faggin joined Intel after having left Fairchild. He'd previously worked with Vadász at Fairchild, and his skills, especially his ha developed silicon gate technology, were well known to the executives at In Their company was essentially based upon Faggin's work. Given both Fagg background and Intel's needs, his request to work on chip design was immediately accepted. Faggin now had just six months to produce working silicon from a specification, and he didn't have anyone to help him in the endeavor. Shima returned to Intel just a few days later and was rather unhappy to discover that effectively zero further work had been done on t calculator chips. Faggin started working 12 to 16 hours each day. This was particularly hard for him given he had a month old daughter at home and a loving wife. During this time, his wife went to Italy with her sister as he couldn't be around to help. I am sure that Faggin somewhat enjoyed the w but the hours, the pace, the separation from his family, and the deadline w probably dreadful. Adding to this, when Faggin reviewed the specification, thought it to be a poor design. There was much that he wished to change, he didn't have the time. More over, when he asked questions, he was told t this was his project and he simply needed to figure it out. He verified that architecture was free of errors, but otherwise didn't change it. He had too much to do. There was still logic design to be done, circuit design, layout, cutting, masking, initial fabrication, testing, fixing any problems found in testing, and then the tasks related to production.



Intel 1103 DRAM

In October of 1970, Intel changed the industry forever with the introductic 1103. This was the world's first commercially available DRAM IC and it had capacity of 1 kilobit in an 18-pin DIP. The 1103 was used heavily throughout industry showing up in the HP 9800 series, the PDP-11, and many more systems. Less than two years after introduction, the 1103 became the best selling memory IC in the world for its time.

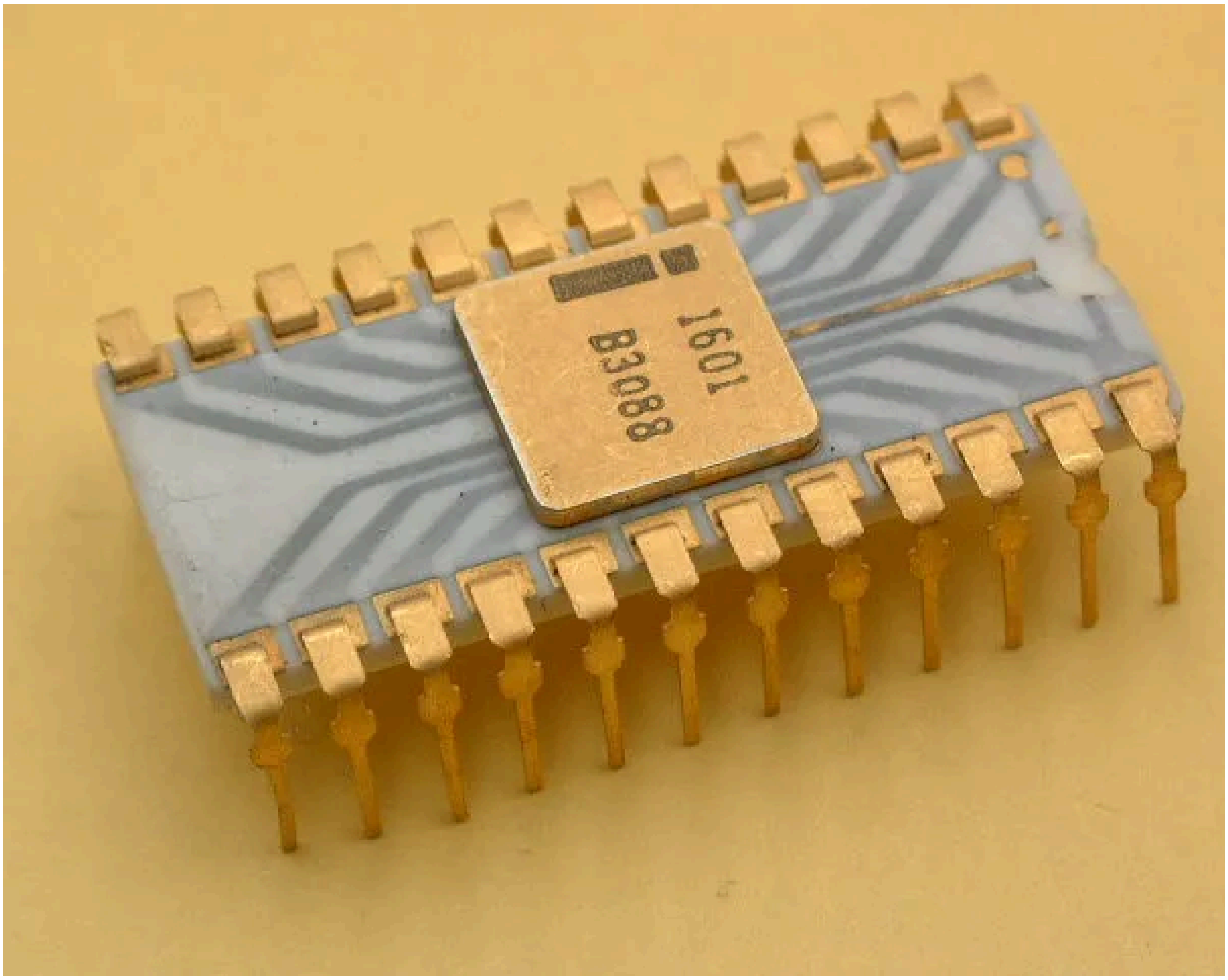


The Intel 4004, if you look at the bottom left, you'll see F.F. for Federico Faggin

In December of 1970, the Busicom chips came back for testing. None of th
worked. Faggin began checking them with a microscope, and he realized t
one of the masks hadn't been applied. He noted this, and requested anoth
run of chips be made. Those came back three weeks later. In January of 19
Federico Faggin completed testing of the first single-chip microprocessor
ever made. It was his second self-designed computer, but this one was bu
with multiple technologies he had pioneered. He was just 29 years old. Th
four chips he created were the 4001, 4002, 4003, and the 4004. The 4001 w
a ROM of 256 bytes with a built-in 4bit I/O port. The 4002 was a RAM chi
40 bytes, which would, in this case, hold 80 4bit words. The 4003 was a 10
shift register, and in the system for which this chip was designed, it would
handle the keyboard and printer. The Intel 4004 was a 4bit microprocesso

that ran at 750kHz. It was built of 2300 transistors on a 10 micron process packaged in a 16-pin DIP. It used 8bit instructions, had 4bit data words, an 12bit addressing. This rather unusual arrangement meant that the 4004 cc address 4120 bits of RAM which would mean 1280 4bit characters. It could address 32768 bits of ROM which would mean 4096 8bit words. The 4004 46 instructions and 16 registers.

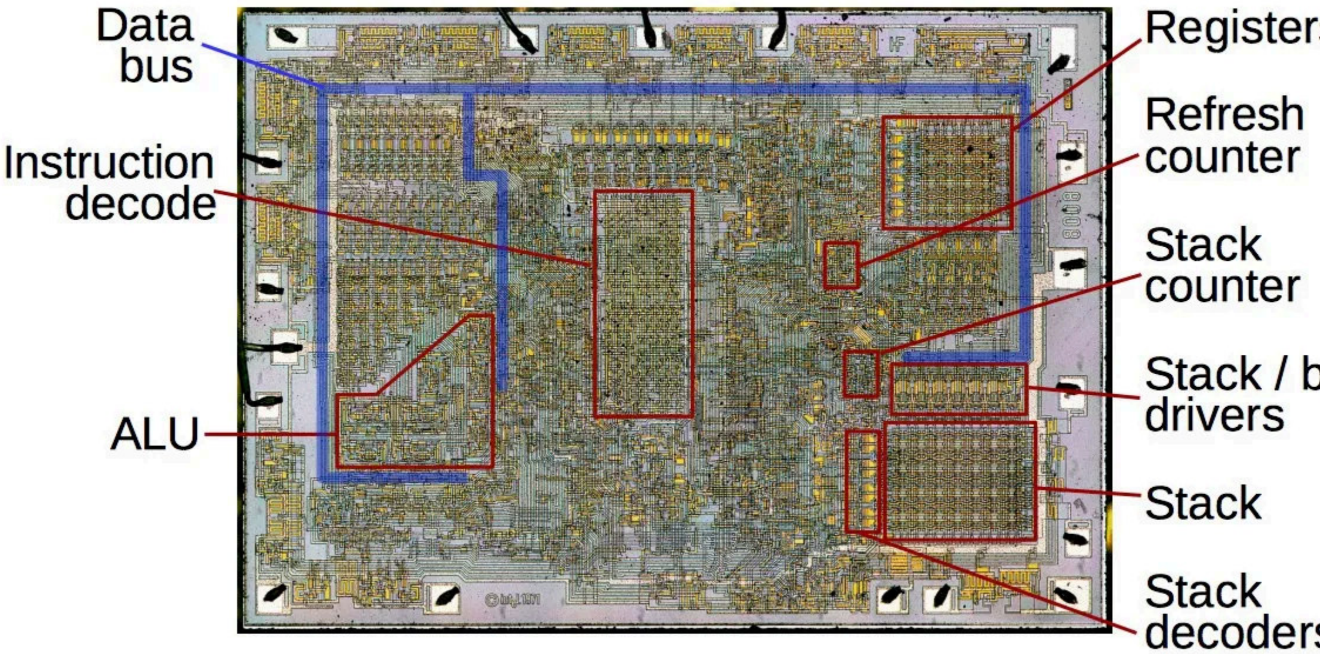
Intel's revenues for 1970 were $3,932,517 but the company posted another (though far smaller) of $969,915 which meant a loss of $0.69 per share.



Intel 1601 PROM

1971 was a big year. The Intel employee head count hit 460, the 4004 becar available, the 1103 was selling well, and the company released the 1601 in January. The 1601 was the first commercially available PROM built on Pchannel silicon gate MOS. The company also began selling fully assembled circuit boards populated with memory chips for mainframes and minicomputers. Intel completed the build out a new headquarters of 78,0(square feet in Santa Clara providing them about three times the space the had previously. This, naturally, allowed them to dramatically increase production. Unlike the previous location, the Santa Clara location had chemical and solvent disposal systems in place from day one preventing tl from later becoming a superfund site. In September, Intel released the firs EPROM, the 1701. This was an improvement over the 1601 in that it could b reprogrammed. The package had a black plastic cover over the chip. With cover removed, shining ultra violet light on the chip would erase it and all it to be programmed again. All of these factors combined allowed Intel to j its first profit at $1,015,080 on revenues of $9,411,821. Share holders saw $0 earned on each share.

The release of the Intel 4004 caught the attention of Daniel Alroy who'd ju started the [Q1 Corporation]() with the dream of building a microcomputer. T 4004 was proof to him that his idea was possible, but the 4004 wasn't sufficient for his tasks. As his previous employer had funded CTC at his suggestion, he knew that Intel had worked on an 8bit CPU, and he met wit Noyce to urge him to produce that CPU. He pledged to be the first buyer, l Noyce said that CTC would need to release the Datapoint 2200 CPU desig Intel. Alroy then spoke with CTC President, Phil Ray. Ray agreed.



Intel 8008 die shot with descriptions, image and descriptions from Ken Sheriff at righto.com

Of course, Intel now had Faggin. Immediately after wrapping up the 4004, was tasked with bringing this new 8bit design into the world, and essentia all of the problems from the 4004 project were present. The design wasn't great, he had very little time, and he had very little staff. The 1201 became Intel 8008 which was made available commercially in April of 1972. The 80 was an 8 bit CPU with a 14 bit address width. It was manufactured on a 10 micron process and built of 3500 transistors. It was packaged in an 18-pin which resulted in 30 TTL chips being required to interface memory and I/ This packaging was dictated by Grove and Vadász despite protest against and meant that the chip did not perform as well as it could have otherwise The 8008 could achieve around 29,000 operations per second. True to his word, Alroy bought a bunch of 8008s and delivered the world's first compl pre-assembled, commercially produced, microcomputer system to the Lit Division of Litton Industries on Long Island on the 11th of December in 197

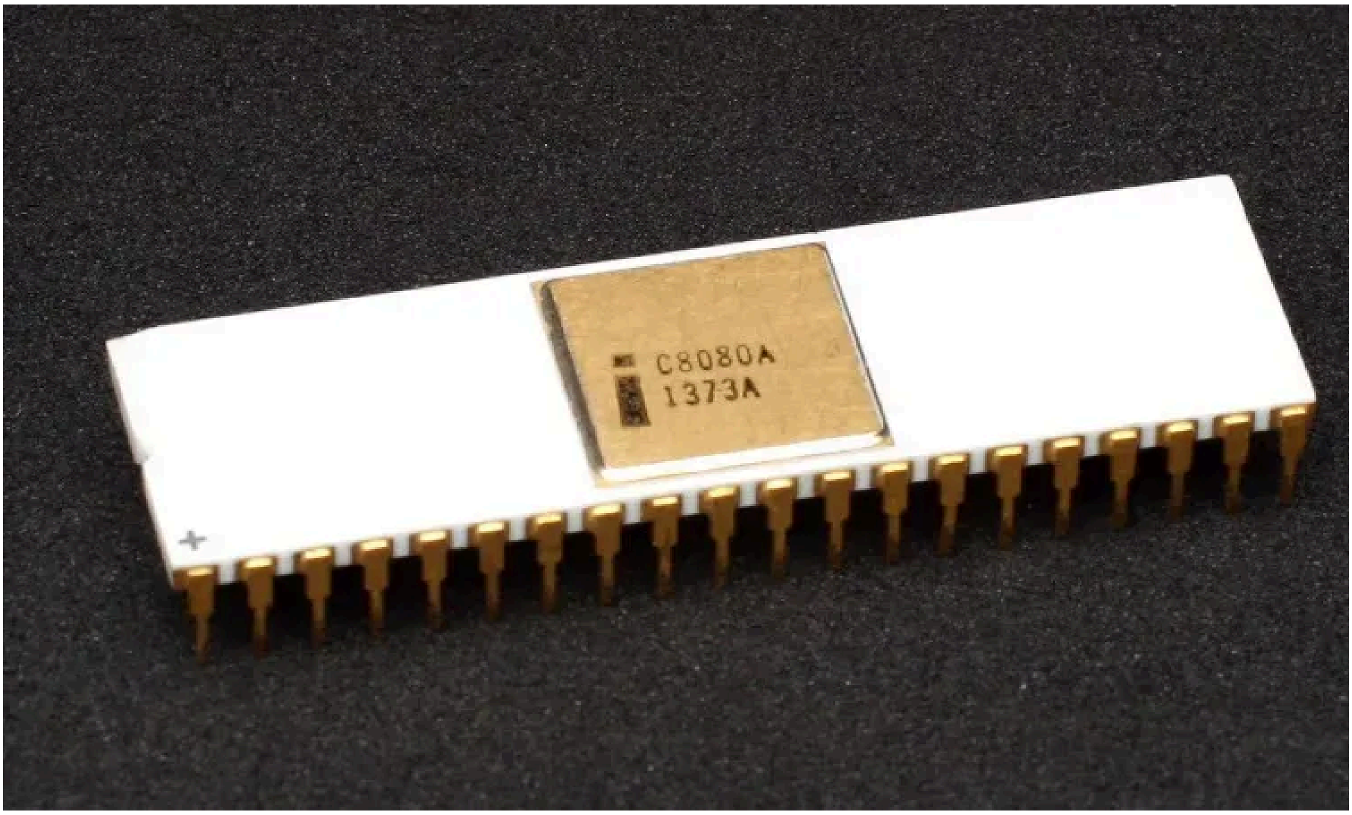
The Microma watch

1972 was a huge year. The release of the 8008 brought microcomputers to world, the memory business was booming, and Intel began expanding to Livermore with Fab3, and to Penang, Malaysia with a site dedicated initiall assembly, but later growing to handle test, design, development, sales, services, and marketing for the region. Intel acquired Microma on the 14th July in 1972 for $15 million. Microma was a local Mountain View company t built digital watches with LCD displays. Over the next six years, this acquisition would prove to have been a mistake, one that Moore called *my million mistake*, and saw him wearing an Intel-Microma watch for many ye to remind him of his error. While it may indeed have been a mistake, Intel some amazing engineering with the Microma. In particular, Intel made the first SOC, the 5810, in 1974 for use in a Microma watch. It included all of th timing functions and the LCD controller, and it was built with CMOS. Desp this pioneering work, in September of 1977, Intel announced that it would l selling Microma. The company went to ASUAG. Intel closed 1972 with 1002 employees, $22,970,729 in revenues and $3,083,600 in profit which provid $1.11 per share.

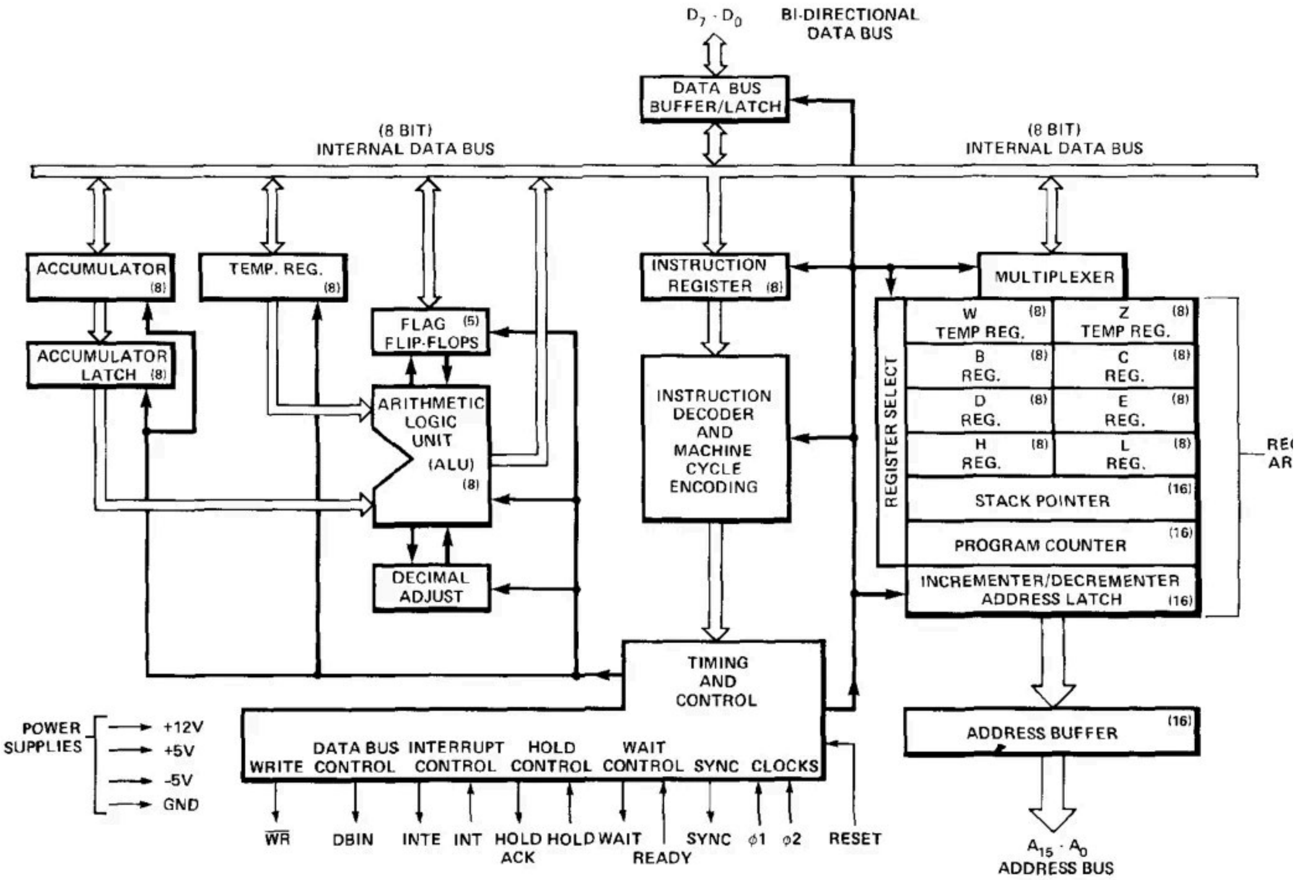
In June of 1973, Intel introduced the Intellec 4 and the Intellec 8 microcomputers at the National Computer Conference in the New York Coliseum. These were sold to software and hardware developers in limite numbers. For the Intellec 8, the price started at $2395. These machines ha resident monitors in ROM and they had a PL/M compiler (also a new product). The Intellec series supported a teletype at 110 baud, paper tape, glass teletypes at 1200 baud. The Intellec 4 shipped with 1K RAM and coul support up to 4K instruction RAM. Data memory was just 320 4bit words, could be expanded to 2560 words. The 8, on the other hand, shipped with RAM and could support up to 16K. These machines were offered either as boards or as fully assembled rack-mountable units with front panel and p supply. The fully assembled systems weighed in at 31 pounds.

Shortly after the release of the 8008, Federico Faggin began pushing for a general purpose processor that wouldn't have the same limitations as the 8008. Intel had developed a new N-channel MOS process for 4K DRAM, ar this is what Faggin wanted to use. He also wanted a new bus architecture, new interrupt structure, more instructions, and a 40-pin DIP; all while keeping the chip source-code compatible with the 8008. He wanted the instruction cycle time to be 2 microseconds which would put the product within the realm occupied by minicomputers. Approval took time but onc had it, Faggin hired Masatoshi Shima to help with logic design and firmwa

Throughout 1973, the company introduced various memory chips, support chips for memories and processors, and even an LCD driver. Revenues for year were $65,593,000 and profit was $9,214,000 or $2.12 per share.



The Intel 8080



Intel 8080, functional block diagram

The improved CPU that Faggin had been working on saw life in April of 197 the Intel 8080. The first 8080 CPUs were built of 4500 transistors (later models bumped that to 6000) on a 6 micron process, and they came in a 4 pin DIP. The 8080 could operate at 2MHz to 3.125MHz. Every instruction t the 8008 had, had an equivalent on the 8080, and the 8080 thereby maintained source compatibility with the 8008. While the 8080 had an 8b data bus, it did have a 16bit address bus and a few 16bit operations. Maxim RAM support for the 8080 was 64K, and the chip could achieve 290,000 operations per second. The Intel 8080 was *the* breakthrough microproces This humble little processor powered the S100 bus machines, many of the early microcomputers, gave rise to CP/M, Altair BASIC, and so many more products and innovations that paved the way for the industry today. A maj part of its success was the need for fewer support chips which helped low the cost. Of the 8080, Faggin stated: "*The* 4004 *and* 8008 *suggested it, but t* 8080 *made it real*."

Despite the launch of one of the most important technological products ir history of the computing industry, 1974 wasn't the best year for Intel or th broader US economy. The US entered a particularly brutal recession as a result of the collapse of the Bretton Woods system, the war in Vietnam, th 1973 oil crisis, and a market crash. The company's profits did climb, but thi was largely due to the first half of the year. On the 5th of April, the first quarter's results were out and the company was far exceeding the first quarter of the prior year; $6.6 million versus $893,000. In the second two quarters of the year, demand fell while Intel's supply had risen with its expansions. This forced a layoff of about 30% of Intel's total workforce. Fo Federico Faggin, watching coworkers lose their jobs, fighting tooth and na develop products that became highly successful, and never receiving prop acknowledgement for his achievements and contributions were all just to much. He voluntarily left Intel on the 31st of October in 1974. On the 1st of November, he started [Zilog](#).

Despite a rough second half of the year, Intel still faced little danger. All of their debts had been paid, they owned their facilities with no mortgages, t owned all of their production equipment, and they required no equity financing having nearly $2 million in cash. In December of 1974, the compa announced that Gordon Moore would become president and CEO, Robert Noyce would become chairman of the board, Arthur Rock would become v chairman, Ed Gelbach would become senior vice president and general manager of the components division, Jack Carsten the vice president of marketing, Gene Flath the vice president of manufacturing, Les Vadász the vice president of engineering, and finally, Andrew Grove would become executive vice president. The company had grown and the restructuring w necessary, and it positioned Intel quite well for the changes and challenge yet to come.

I now have readers from many of the companies whose history I cover, an many of you were present for time periods I cover. A few of you are mentioned by name in my articles. All corrections to the record are welco feel free to leave a comment.

Discussion about this post

Comments Restacks

Write a comment...