CHAPTER

1.5

Tim and Kim

1975 - 1976

In introducing the 6502 microprocessor to the world, Chuck Peddle knew he had something revolutionary. As part of MOS Technology's marketing plan to encourage people to experiment with the 6502, Peddle and his team at MOS Technology would develop two small computer systems, known as development systems. "They worked on them while we were finishing up the processor and getting ready to do the marketing," explains Peddle. Engineers and hobbyists, the idea went, would use them to evaluate the 6502 instruction set and develop their own systems.

The Kit

The first development system offered by MOS was in kit form, which reduced the selling price to only $30. Since the unit was designed primarily to instruct the user on the workings of computer systems in general and the 6502 in particular, MOS Technology contracted Microcomputer Associates of Santa Clara, California to write the unit's internal program. The two founders, Ray Holt and Manny Lemas, taught engineers how to use microprocessors. Peddle relates, "You have to understand how little the world knew of microprocessors in 1974, '75 and '76. There were guys making big money selling classes on microprocessors during that time." Manny Lemas had worked for Peddle during his GE days, while Ray Holt had an impressive background working on the F-14 Tomcat project for the Navy.[1]

The technicians developed the system in a special research area on the second floor of MOS Technology. The lab was a room within a room, with a large sign on the door in capital letters warning NO ADMITANCE. Inside, the team stared intently at oscilloscopes or sat over hot irons soldering components onto circuit boards. Small pieces of circuitry were scattered chaotically across the room. Since the 6502 microprocessor and supporting chipset contained almost everything necessary for a computer, the design was minimal. When assembled, it could be connected to a teletype machine or a computer terminal.

[1] Holt claims he invented the world's first microprocessor for the Navy in November 1969, approximately a year before Intel. Security restrictions by the Navy prevented him from disclosing this until 1999 – by which time most people accepted that Intel was the first.

The biggest job was programming the built-in ROM code for the computer. This consisted of a debugger and monitor program, appropriately called the *Demon*. According to Peddle, Demon was programmed by Manny Lemas and Mike Quarter, who previously developed Peddle's time-sharing system. The programmers used this time-sharing system to develop the code, which they burned into a 6530-004 RRIOT chip. This little powerhouse included RAM, ROM , I/O and timer capabilities.

The system was named simply. Peddle and his team liked acronyms, thus the Terminal Interface Monitor, or TIM was christened. TIM would begin a predilection at MOS Technology and Commodore for assigning friendly three-letter names to their products.

Those ordering the $30 development kit received the grey-ceramic 6530-004 chip and a manual consisting of 14 sheets of 11x17 paper, folded and stapled in the middle. Included in the manual were a suggested schematic, the TIM monitor commands, a few sample programs and a listing of the monitor code. It was up to the user to provide the resistors, transistors, capacitors, wire, and even the 6502 microprocessor.

Though receiving a computer in the form of a kit does not seem particularly user friendly now, hobbyists at the time clamored to build their own computer. Nonetheless, a good portion of the kits failed to operate upon completion. Rather than using a prepared circuit board, many buyers simply wire-wrapped the chips together on a piece of generic perf board or prototyping board, often termed a kludge board. After placing the required components on the board, builders hand wired the chips one pin at a time, resulting in a snarl of fine multicolored wires. Once the chips were in place, the user then had to construct or purchase a separate power supply for the TIM. Finally, the TIM was (as the name suggests) able to interface with a standard ASCII terminal or teletype machine.

As hoped, the do-it-yourself nature of the kits spawned familiarity with the products, and once hobbyists had invested time learning about the chip, they often remained loyal to the 6502. Many hobbyists ended up using their TIM computer as a small development system, since it was ideal for creating small programs. For their part, MOS Technology continued to sell TIM computer kits to diehard hackers, even after the Commodore acquisition. Ultimately, TIM was just a stepping-stone to developing and marketing a fully assembled computer.

KIM-1

MOS Technology developed a second system concurrently with the TIM. This computer was slightly more user friendly – at least by 1975 standards. Rather than a chip and some instructions, this system arrived fully assembled, except for the power supply. It was a true development system.

The inspiration for the new computer came from Don McLaughlin, MOS Technology founder and engineering manager of the project. Peddle recalls, "McLaughlin said, 'Listen, I think this is a product that will help sell the [6502]'. They thought it was a good idea because they were calculator guys." Peddle and a programming manager named Bob Winterhalt agreed with the idea and the three men began the design.

According to MOS Technology employee Al Charpentier, his friend and fellow engineer performed the actual hands-on design work of the system. "That was done by a guy by the name of John May," recalls Charpentier. "He was sort of the primary mover on that project."

At this early stage in microcomputer development, user-friendly personal computers were barely on the horizon. Niceties like a video monitor, keyboard, software, power supply, or an enclosure were not part of most designs. The recently released Altair relied on switches for input and blinking lights for output. Any other interfaces had to be added by the user. By today's standards, it was comically impossible for most people to contemplate using these machines.

This new sibling of TIM would share similarities, but differ in a few areas. As with the TIM, this unit would contain a 6502 processor running at one megahertz. However, McLaughlin advanced TIM's basic design slightly, branching out in a unique direction. Instead of reading data from a row of flashing lights, the new computer would contain a six-digit display. Each digit in the display had seven segments, which could display numbers and letters. The primitive display was a step up from tiny lights representing binary digits used on most other systems. McLaughlin also improved on the basic input method for personal computers at the time. Rather than a row of switches for binary input, McLaughlin specified a keypad. John May eventually selected a black keypad with 23-buttons. This was a remarkable improvement over other microcomputers of the time, allowing users to enter code more easily.

Both the keypad and the LED display reside directly on the surface of the printed circuit board (PCB), along with over a hundred precariously exposed components. The lack of a case or a power supply for the new computer clearly indicated MOS Technology was not targeting the machine for the mass market. A careless user could easily damage the machine..

Little TIM provided a paltry 256 bytes of memory, hardly enough to store three lines of characters on an 80-character computer display. TIM's bigger brother would contain a full kilobyte of memory, comprised of eight MOS Technology 6102 memory chips. At the time, 1024 bytes was a generous amount. There was even room for expansion. Two 44-pin edge connectors made data and control signals available to the builder for additional functionality.

Although the two development teams were separate, they shared as much code as possible. To support a teletype machine, John May used the code from the TIM system. The 2-kilobyte program, also named TIM, contained the code to operate a cassette tape unit for storage, drive the alphanumeric display, and accept input from the 23 keys of the keypad. It also contained a monitor program, which allowed users to view memory contents and change code. A tiny bootstrap program would automatically start the monitor on reset. This was the pinnacle of user friendliness in 1975.

The name for this new computer followed the tradition set by TIM. The TIM allowed input from a terminal, hence Terminal Input Monitor. The new system allowed input from a tiny black keyboard, so McLaughlin dubbed it the Keyboard Input Monitor, or KIM. They also added a number after the computer name, a practice later continued by Commodore. It contained one kilobyte of memory, hence KIM-1. [2]

[2] Former MOS Technology engineer Robert Yannes owns the first KIM-1. "I have a very rare thing that I scavenged out of scrap heap at MOS Technology: the original prototype KIM-1, and it still works. It's a little bit different than what went into production," he says.

In the middle of 1975, MOS Technology began selling the KIM-1. Buyers who sent away for their KIM-1 were pleasantly surprised to have a rectangular cardboard box arrive from “MOS Microcomputers”, a short-lived division of MOS Technology. The KIM-1 circuit board arrived sealed in a black static-proof bag, surrounded by thick foam padding with manuals and documentation on top. The documentation included with the KIM-1 went beyond other computers of the day. There were three manuals - a 200-page 6502 programming manual (written by Peddle under duress), a 100-page KIM-1 user manual, and a 150-page hardware manual. The writing was friendly, concise, and detailed. Most importantly, it did not assume the user knew everything about computers already. The KIM-1 user manual promised, “You should be able to achieve initial operation of your KIM-1 module within a few minutes.” Of course, this assumed you had access to a 5 volt, 1.5 ampere power supply. A 12 volt supply was required if the cassette tape was to be used. For those in doubt, the manual contained complete instructions and a parts list for building a power supply. Once the power supply dilemma was solved, the user hit the RS (reset) key to start using the system. This started the TIM monitor program running from ROM, which displayed numbers and accepted input from the keypad. Unlike today’s systems, the KIM-1 contained no on-off switch.

Users then began the exacting process of entering code into the machine in order to make KIM do something. After entering all the data, it was simple to run the program - just set the computer to the address where the program began and hit the GO button. If the program misbehaved, the KIM-1 also had a switch on the keypad labeled SST (single step). This would cause the computer to execute the program one instruction at a time. Users appreciated this important feature, which greatly assisted in debugging.

The built in cassette-tape interface of the KIM-1 proved indispensable for early hobbyists because it allowed them to save and load their work. In contrast, users of the MITS Altair had no way to save programs with their basic system. They would sit in front of their machine, laboriously flipping switches to enter their program into memory. If someone happened to trip on the power cord, the programmer had to start all over again.

The tape-interface alone made many KIM-1 owners fall in love with the computer, and many praised it for its reliability. Tape storage was the perfect medium for a 1-kilobyte computer. Programs loaded and saved rapidly, and dozens of programs fit onto a single cassette. Of course, a cassette recorder was not included with the KIM-1, so it was up to the user to find one. It was also up to the user to connect it to the KIM-1 by interfacing the microphone input and speaker output jacks to the gold-plated IO pins of the KIM-1.

Another advanced feature of the KIM-1 was its ability to connect directly to a Teletype machine or computer terminal through a built-in serial interface. Teletype machines were large electromechanical devices with the ability to enter data through a keyboard, print hard copy, and load and save data via punched paper tape. A noteworthy feature of the KIM-1 was its ability to automatically adjust to the speed of the teletype connected to it. People were amazed to see the tiny KIM-1 operating a massive piece of hardware normally connected to minicomputers or mainframes. This helped to convince skeptics that microcomputers were true computers. As it turned out, however, many people preferred using the LED display and keypad to the noisy, messy, and costly teletype machines.

The KIM-1 debuted during Wescon in Chuck Peddle's hotel suite, along with the 6502 and other development systems. Users received the small computer enthusiastically. Al Charpentier recalls, "They sold a lot of those. It was sort of the first fully packaged microcomputer that you could take out of the box, throw a power supply on, and do something with. It was hell, but it educated people on the processor."

Engineer Robert Yannes recalls KIM-1 engineer John May showing the machine at his college. "I had a lot of familiarity with the KIM-1," says Yannes. "The guy who designed that was actually a friend of Al Charpentier's, and he was a Villanova graduate too. He had brought it to Villanova University when it first came out and I had gone to that presentation. They had KIM-1's at Villanova too, so I ended up playing with them."

"The KIM-1 had one characteristic that everybody always commented on," says Peddle. "It was a packaged, complete, plug-it-in-and-start-using-it product. You could sit down and learn to program using my manuals."

Early Competition

In December 1975, the coveted inside front cover of BYTE magazine contained a two-page advertisement for 'the world's lowest cost computer system'. Though it contained a 6502 microprocessor, it was not the KIM-1. It was the Jolt computer, sold by Microcomputer Associates either as a kit for $249 or fully assembled and tested for $348. Jolt, named after Rod Holt who helped develop the TIM and KIM-1 code, was technically similar to the TIM computer. Although Jolt competed with the KIM-1, Peddle did not object. "Manny just said, 'We want to do this board of our own', and I said 'great'", explains Peddle. "I was looking for anything that would help customers design with the [6502] product. We gave these guys the license." Nonetheless, Jolt did not have lasting popularity with the hobbyist market. Jolt's most notable achievement lies in its use as the platform for the Atari 2600 VCS prototype system.

The Jolt advertisement in Byte did much to influence MOS Technology. A few months later, in the April 1976 issue of BYTE Magazine, a new product announcement appeared for the KIM-1 titled, 'What's New, KIM-o-sabee?' There was also an advertisement from MOS Technology itself. The low-key ad, stating the features in KIM-1 in point form, included a clip-out order form for a $245 KIM-1 microcomputer system. Anyone who understood computers recognized the potential immediately.

The advertisement in BYTE caught the attention of the hobbyist market. A month later, BYTE ran a feature article titled, 'A Date with KIM'. Byte contributor Richard Simpson gushed about the low price and quality of the feature-packed KIM-1. He accurately identified it as the ideal system for anyone who did not want to assemble a kit. The KIM-1 subsequently became a favorite of BYTE and other popular homebrew publications, such as Dr. Dobbs Journal, Kilobaud, and Interface Age. Articles and projects appeared in these magazines well into 1979.

Advertisement for KIM-1 in BYTE Magazine.

MOS Technology released the KIM-1 in 1975, the same year as the Altair 8800 computer. The Altair has come to be known as the first computer system in North America to herald the new microcomputer revolution. The differences between the KIM-1 and the Altair computer illustrate a split in design philosophy within the computer world. The KIM-1 was a single-board computer, with all components mounted on a single printed-circuit board. It had room for expansion, but there were no slots to insert adapter cards. This design philosophy reduced production costs and thus gave the KIM-1 a major pricing advantage over the Altair. Commodore computers would follow this tradition of containing everything on a single board, with specialized user ports for peripherals. The Altair 8800 used an Intel 8080 chip, which retailed for $360, but Ed Roberts was able to negotiate the price down to $75 each in bulk. Still, he needed to sell his computers for $439 in kit form, and $621 assembled to make a profit. MOS Technology was able to profitably sell KIM-1 systems for $245.

Though it was not a true personal computer, MOS Technology soon discovered the KIM-1 had a large market. “That was one of the things that took MOS by surprise,” recalls Bob Yannes. “Throughout the early days of computers, one of the most successful computers introduced in that timeframe was the KIM-1.

“They had developed the KIM-1 as a sort of sales tool for the 6502 processor. They would say, ‘Here’s a development system for you, you can design your own computer system and develop your software on the KIM-1 and help understand the hardware architecture and so forth.’ And people would use them and say, ‘Why do we want to design our own computer? We have one right here and it’s only [$245], which is cheaper than we can build it for.’ They would just buy KIM-1’s and bury them in their products.”

Hobbyists began enthusiastically calling and writing for the kit. Though the goal had been to drum up interest in the 6502 chip, it soon became apparent that microcomputers would also be a valuable source of revenue for the company. According to Kilobaud magazine, MOS Technology sold over seven thousand KIM-1 computers by June 1977. At $245 each, revenue was in the millions, which helped MOS pull through a tough financial period. “They sold a lot,” says Charpentier. “By God, they sold thousands of them - ten thousand or something like that. It was a big number of processors back then.” There was an obvious demand for computers.

The appeal of the KIM-1 was not lost on Chuck Peddle. “It was a complete package, and there are a lot of people who bought it just for that reason and learned something, and then said ‘Okay, that’s all I can do.’ But we were seeing those people and talking to them and getting feedback.”

The Seeds of the Software Industry

While the early microcomputer industry focused on hardware, very few people focused on software, with the notable exception of Bill Gates. As a result, there was a conspicuous absence of quality microcomputer software. Byte magazine noted this in December 1975, describing the situation as a “software vacuum”.

But when it came to software, the KIM-1 had an advantage over other microcomputers. The single board design resulted in a homogenous population of computers, which guaranteed programs would work from one system to the next. The simple operating system put all KIM-1 users on equal footing, so programmers knew their programs would run on all standard KIM-1 computers. Distributing the programs was also easy due to the standard tape-interface. Soon, programmers began copying and distributing their code on low cost audio tapes.

MOS Technology sold one of the earliest KIM-1 software packages at a time when no one knew what might appeal to users. One obvious application was number crunching. The 6502, like all chips at the time, could not perform many mathematical functions – it could add and subtract numbers; all other operations were iterations of these two functions and had to be coded by the developer. MOS Technology developed a program called KIMATH, which effectively transformed the KIM-1 into a full-function calculator. KIMATH also added the capability to handle decimal numbers with high precision. As usual, the MOS Technology documentation included with the software was outstanding, complete with a manual and assembler source code.

Another early favorite of development was music. Since the KIM-1 did not contain a native sound device, users connected a small piezoelectric speaker to a few pins on the IO port. Other hackers found a way to play music by recording beeps to the cassette tape. Once they recorded the music, they ejected the tape and played it back in an audio cassette player.

The seventies was the age of hardware hacking (hacking is used here in its original positive sense – describing experimentation in the pure spirit of inquiry), and hardware projects proved popular among KIM-1 users. One gifted 12-year-old hacker, Tod Loofbourrow, created a 70 pound, six foot tall robot using the KIM-1. Hayden Publishing approached Loofbourrow to write a book about his robot, which he subsequently wrote on yellow-lined paper. He titled his book, *How to Build a Computer Controlled Robot*, and it went on to become a successful publication.[3]

The calculator-like KIM display would seem to be a poor candidate for playing games, but games were among the most popular programs for the KIM-1. Most game adaptations were simple pen and paper mind-challenges, which ranged from the well known (Tic-Tac-Toe, Hangman, Mastermind, Maze) to the obscure (Hunt the Wumpus, NIM, Shooting Stars).

Programmers had to design their games for the minimal KIM-1 display which meant that they often had to rely on the imagination of the player. In Maze, the player could only see the walls directly surrounding the small blinking avatar. Hunt the Wumpus required the player to use a pencil and paper for working out a strategy. With such concessions, most mind games were easily adapted.

Gambling and card games were also especially well suited to the limited display. Programmers learning their craft created Blackjack, Craps, Bandit (Slot Machines), and a horseracing game.

Surprisingly, programmers even tried action games. These primitive games went by such names as Duel, Farmer Brown, Ping-Pong, and Asteroid. Duel was notable as being one of the earliest two-player games on a microcomputer. It was a simple but fun reflex game where each player watched the display and tried to hit their button first when a character appeared.

No one attempted to sell any of this early software. Programmers shared their games, copied them to tape, and widely distributed them to whoever wanted a copy. They saw games as a way to learn about programming while creating something fun. Most of these early games lived on in more advanced computers years later.

One of the earliest KIM-1 users enjoying these primitive games was Chris Crawford. Crawford delighted in the choices these games allowed and eventually programmed his first computer game using a KIM-1. Years later, Crawford developed famous games for Atari and became influential in game design theory.

Another early programmer who would gain recognition in the industry was Jim Butterfield. For Butterfield, using a KIM-1 was an adventure in exploration. His goal was to uncover the hidden secrets of the KIM-1 and pass that knowledge on to other users. Jim has the rare ability to understand complex subjects and describe them in simple terms. One of the biggest barriers to learning about microcomputers in those days was the problem of communicating knowledge since the average hacker seemed to be speaking a different language. Butterfield allowed those on the outside to enter the world of programming in comfort.

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[3] Loofbourrow used the revenues from his book to found a Fortune 500 company called *Foundation Technologies.*

At gatherings with other KIM-1 users in his native city of Toronto, Butterfield presented his new finds to an attentive audience seeking to unlock the mysteries of the computer. One of his most popular programs was a game. The Apollo moon missions had always been closely associated with computers and the vivid pictures were still in Jim's mind in the mid-seventies. This inspired him to write Lunar Lander, a simulation of landing on the moon. The game started with the user at the controls of a lunar module 4500 feet above the moon's surface, and slowly descending. Players used the number keys to control the throttle. To add a sense of urgency, there were only 500 units of fuel to expend. If a player set the throttle too high, the rocket soon used all its fuel and crashed into the surface..

Rather than try to represent the scenario graphically, Jim chose to display the altitude, fuel, and rate of decent as numbers. Anyone playing would have to imagine himself huddled in a capsule with only the instrument readings to guide him. Four glowing red LED digits displayed the altitude and the right two digits represented the rate of descent.

Lunar Lander might seem primitive by today's standards, but back in 1975 board games were the most popular games available. Snakes and Ladders, Monopoly, and Checkers were the pinnacle of gaming, so something like Lunar Lander was futuristic by comparison. Lunar Lander was a hit at conventions and gatherings, where it fascinated hobbyists. Part of the appeal was the adventure element. Individual landings could last five minutes or more, so players could become deeply engaged in a single game. For a grueling stretch while the lander descended, a player would intently study the rate of decent versus the altitude, and occasionally glimpse the fuel gauge. After four minutes, the lander would be close to the surface, and tension began to mount. If everything went just right, the player was rewarded with a SAFE message. More often, fuel ran out and the module went crashing into the lunar surface as the dreaded DEAD message flashed onto the screen.[4]

Jim Butterfield also created a small utility called Hypertape, which had an impact on the KIM-1 user community. Butterfield was having lunch with a friend who also owned a KIM-1, and mentioned that the unusual circuitry of the KIM-1's cassette tape input would make it possible to enhance the speed of tape reading. "You don't need all those 1's and 0's written on the tape," he said. The friend, Julien Dubé, asked how that could be accomplished and Jim outlined his approach. The next day, Julien reported a speedup of three times. Feeling that this was a challenge, Jim looked more closely at the code, and found extra ways to accelerate the format. The final version of the program allowed data to be written six times faster. A full one-kilobyte program now only took 20 seconds to load with the standard KIM-1 system, as opposed to the regular two minutes.

[4] Lunar Lander would later spawn a mini-genre of games around the lunar landing concept such as Lunar Lander (with graphics), Thrust, and Space Taxi.

In July 1976, the first issue of *Kim-1 User Notes* appeared, with Eric Rehnke as editor and contributions from Butterfield. Jim eventually amassed enough information to release a book. He teamed up with Rehnke and Stan Ockers to self publish a 176-page opus called *The First Book of KIM*. This was one of the pioneering works in what would later become a lucrative computer-publishing business. Several key areas of the KIM-1 were explained which could not be found elsewhere, such as programming the LED display to output custom characters and using the timers built into the 6530 chips. The book was also a software treasure trove, containing carefully commented listings for the most popular KIM-1 programs. The book gained a reputation as being indispensable for KIM-1 users and programmers.

One of the contributors to The First Book of KIM was Peter Jennings (not to be confused with the news anchor), another Toronto resident. Jennings had just graduated university and he was anxious to purchase his own computer system. Cost was a major factor in his decision because of outstanding student loans. He knew from articles in magazines that the Altair used an 8080 chip and the KIM-1 used a 6502 chip. Jennings wanted to test drive his new computer before buying, but microcomputer users were hard to find. “We take for granted how easy it is to track down people with common interests these days with Google,” says Jennings. “The only group of computer enthusiasts in Toronto at the time was 100% 8080.”

To weigh the merits of each chip, Jennings, who worked for a company called *Comshare* and had access to a Xerox Sigma IX time-sharing computer, developed a set of emulators modeling the 8080 and 6502 chips. When Jennings finished his comparison, it was no contest. He wanted to program the 6502.

In May 1976, Jennings made a small journey to the *Midwest Regional Computer Conference* in Cleveland, Ohio, just four hours from Toronto. There he paid $245 for his KIM-1 and happily drove back across the border to begin a much longer journey.

Peter Jennings contributed a simple game to The First Book of Kim, but he wanted to try something more challenging. He chose the game of kings, chess. Chess programs are notorious for using large amounts of memory. The program must create copies of the chessboard and then evaluate each board. Most sane people scoffed at the idea of creating a chess-playing program in one kilobyte of memory. To put one-kilobyte of memory in perspective, imagine a display of 40 characters by 25 lines - 1000 characters on a single screen. That is just about one-kilobyte. Jennings' task was like setting a table for 12 people on a stool. If he had thought about it a little more, he probably never would have started. “Most computer programmers thought it was impossible,” remarks Jennings.

In order for the computer to move a chess piece, it must be able to identify all legal chess moves at any given time. This is a tall order with just one kilobyte of memory, considering there are six different chess pieces that all make unique moves. Furthermore, some moves are illegal when the king is under attack. Jennings' program had to test all these conditions. If Jennings’ game merely made a random legal move, it would have been sufficiently impressive. Peter wanted more. He wanted the computer to think and scheme.

Not only was memory space against him, but his tools were absurdly primitive. Programming the game would be difficult even with a powerful computer connected to a keyboard and video display but Jennings had only the KIM-1 to develop his masterpiece - a small calculator keypad and six-digit display, connected to a teletype machine for hard copy. Still, he used what was available to him, even including extra functions. “Peter found room for diagnostics,” marvels Jim Butterfield. “For example, the display would flicker with data during the strategy part of the run, and he could read what it was up to – ‘It's checking Queen mobility now...’”

For months, Jennings toiled away at his impossible task. Sometimes he was a willing insomniac, gloriously coding until sunrise with (and sometimes against) his KIM-1. Those who looked in on him thought he was performing deep calculations with a large calculator, oblivious that he was actually teaching a computer to think about chess. Six months later, Jennings prevailed in his battle against the kilobyte. Microchess used 1118 of the available 1152 bytes of memory in the KIM-1. “It was quite a squeeze,” says Butterfield. “He even made use of the small RAM areas within the 6530 chips. I found it an amazing accomplishment.” It is easy to be impressed by large projects, but more difficult to appreciate something small. Jennings program was smaller than any piece of software written today, yet the compactness and efficiency made it impressive. His accomplishment must rank as one of the most incredible programming feats of all time.

“Jennings had accomplished something that, if asked, I might have dismissed as impossible to do in that small computer,” says Butterfield.

Engineer Robert Yannes credits some of Jennings success to the 6502 itself: “The 6502 was a very efficient processor for its day.”

In many ways, Jennings achievement was lonely. Everyone can appreciate a baseball knocked over the outfield fence, but it was a rare person who could understand this achievement. But Jim Butterfield and the cadre of programmers around him knew what it meant. “Peter demonstrated his program at a small gathering of KIM-1 users in my home,” recalls Butterfield. “I had set up a chessboard marked with the coordinates to match the KIM's display code. I had privately wondered if Peter was perhaps taking on more than was possible, and was amazed to see it virtually complete. It went well.” A friend of Butterfield's volunteered to do battle with Microchess, the first test against a human other than Jennings. The KIM-1 handily beat the human. Jennings felt elated.

Microchess was cognitively under-funded with only 1 kilobyte of RAM and predictably it could not compete with skilled chess players. “Competent chess players told me that it didn't play a strong game,” says Butterfield. “This put me in mind of Samuel Johnson's quip, ‘If you see a dog walking on his hind legs, it's not so much that he does it well, as that he does it at all.’” To Jennings, the reward was knowing that he had accomplished his goal withing the limits he had set for himself..

Word of Jennings accomplishment spread quickly through the burgeoning software community.. Chuck Peddle learned of the program and offered Jennings $1000 for all rights to the program, but Jennings declined. He planned to make much more than $1000.

Software publishers were nonexistent in 1976. According to Chris Crawford, “There were no software publishers or anything like that in the microcomputer world. If you wrote a program, you duplicated some cassettes, typed up and photocopied a manual, and stuffed the whole thing into a Ziploc bag, and then sold it to whomever would take it.”

Jennings created an enterprise called Micro-Ware Limited to distribute and sell his programs. He sold the first copy of Microchess on December 18, 1976 for ten dollars, which included documentation and a printed listing. He was the first person to sell a game for the personal computer market. For an extra dollar, he included a paper-tape machine-readable printout of the code, and for three dollars more he included a cassette. In time, Micro-Ware took on software from other programmers like Ken Anderson. After a while, he merged Micro-Ware with another company he started with Dan Fylstra. The Massachusetts-based company became *Personal Software,* (later to become famous for marketing VisiCalc). “Our getting together was to implement the publishing model where we would do the marketing and authors would receive a royalty for their work,” recalls Jennings.

Jennings mounted his KIM-1 in a brown leather briefcase, which he also used to lug around his chessboard and pieces. At trade shows, he demonstrated his game in the Personal Software booth. Demonstrations began with him setting up the pieces on a chessboard and then starting his program. A spectator would move a piece and Jennings entered the move into the KIM-1, then hit GO. Even at one million instructions per second, the 6502 took up to three minutes to move at the highest skill level. To users of the day, the longer it took, the more impressive it seemed. It was like the difference between a line of dominos five inches long and a huge, multi-branching domino trail. After a tense, exciting wait, the KIM-1 selected a prudent move, often causing intense conversation by chess playing spectators.

Microchess made a splash in magazines like BYTE, where they hailed it as a small miracle. The microcomputer had conquered chess, a game that has awed people for centuries. It should not have been possible, yet there it was. Users in 1976 who were wondering what to do with microcomputers had their answer. Suddenly, ordinary people could see that a computer was much more than a calculator - it was a thinking machine. Computer chess sparked public interest and articles on Microchess appeared in numerous newspapers, magazines, and even a book titled *Chess and Computers* by David Levy.

Jennings even received a phone call from reclusive Grand Master Bobby Fischer, who wanted to play a game against the KIM-1. Jennings knew his one-kilobyte program would be no match for Fischer, but he agreed. After Fischer handily beat the program, he thanked Jennings and told him it was fun. “Fischer was very interested in computer chess and called me many times over the following months to discuss developments in Microchess and other computer chess programs,” recalls Jennings.

Jennings biggest ally in marketing Microchess was undoubtedly Commodore. At trade shows, an employee named Rick Simpson demonstrated the KIM-1 using Microchess. Afterwards he directed interested customers to Jennings. Ever the astute businessman, Jennings asked Simpson if he could insert a printed advertisement for Microchess with the KIM-1. Simpson consulted with management, and they agreed to insert the gold flyers in every KIM-1 box they shipped.

For a while, Jennings forgot about the deal. After all, it was just another form of advertising along with his advertisements in magazines. During the day, he continued working at Comshare. In the evening, he filled orders for Microchess. One day he arrived home from work to find two large canvas bags from Canada Post on his front doorstep. Jennings assumed his letter carrier left his bags and would soon pick them up.

As it grew darker outside, the letter carrier failed to materialize. Jennings became increasingly concerned. It felt wrong to touch the bags, but eventually he decided to bring them inside the house for safekeeping. In the morning, he could call the post office and have them picked up. As the evening wore on, Jennings couldn't ignore the bags sitting in his living room. He became bolder and decided to have a peek. To his surprise, his own address was written on the first few envelopes. He dug deeper and soon realized both canvass bags were packed with letters, all addressed to Micro-Ware. He dumped the letters on the floor and began opening them. Each one contained a check for a copy of Microchess. “There is something uniquely satisfying about receiving money for something you have created yourself,” Jennings later said. One out of every three KIM-1 buyers ordered Microchess on cassette. It was time for Jennings to quit his job at Comshare.

Commodore soon realized the value of Microchess. At the time, electronic games were becoming popular in households. Several companies released handheld games such as *Simon* (Milton Bradley), *Merlin* (Parker Brothers), and later *Speak & Spell* (Texas Instruments). Each of these electronic games would go on to huge success, especially when *E.T. the Extra Terrestrial* featured Speak & Spell in 1982. Commodore wanted a piece of the electronic games market, so they contacted Jennings about creating their own handheld game.

“We did a thing called CHESSmate based around Jennings work,” says Peddle. Internally, CHESSmate was very similar to an ordinary Kim-1 computer, with a sibling of the 6502 microprocessor, the 6504, substituted. Commodore hired Jolt maker Microcomputer Associates to construct the CHESSmate prototype. “Of course, it didn’t work very well,” adds Peddle.

At the time the CHESSmate was developed there was only one other electronic chess game, the Fidelity *Chess Challenger*. The contract with Commodore called for Jennings’ game to beat the Chess Challenger in tournament play. “One of the funniest moments was my lawyer going over the contract,” recalls Jennings. “He read the clause which required that my program beat the Chess Challenger and pondered it over for a while. He just couldn't wrap his mind around the concept of the two machines playing against each other and one winning. ‘What do you mean?’ he kept asking. It’s hard to put yourself back to the seventies when most people had no contact with computers and had no concept of machines that played games against people or other computers.”

Commodore engineers added more ROM memory to the game, and Jennings improved his Microchess code by adding 32 opening moves. He even provided eight different play levels to the game so novices could enjoy the game. CHESSmate was able to hold up Jennings' end of the contract by consistently beating the rival Chess Challenger.

Commodore CHESSmate with manual and chessboard coordinate stickers.

In 1978, Jennings traveled to Pasadena where Bobby Fischer was in hiding from the world. He spent several days demonstrating the prototype CHESSmate software running on an expanded KIM-1. Fischer played many games and handily beat the program each time, but he had a strange fascination with the alien strategy devised by a machine.

Fischer even challenged Jennings to a game, an offer that caught Jennings off guard. “It was a surreal experience being challenged by the reigning world champion to a friendly game at a time when very few people even knew where Bobby was and nobody had seen or played him in years,” says Jennings. Though Fischer predictably won, Jennings believes he gave Fischer a respectable challenge.

A consummate businessman, Jennings offered a royalty to Fischer in return for calling the electronic game the “Bobby”. At the time, the strongest commercial game available was the “Boris” named after Boris Spassky, who Bobby Fischer had defeated in Iceland for the title of World Champion. Even though the CHESSmate would play competitively against the Boris computer it could not defeat it every time. Fischer declined and “Bobby” became CHESSmate.

An application that causes users to purchase a computer is called a *killer app*. Games were rapidly fulfilling this role for the KIM-1 and other early microcomputers, and Microchess was one of the biggest sellers. Over the next ten years, Peter Jennings sold several million copies of Microchess to owners of home computers. With the help of the KIM-1, Jennings helped pioneer the computer games industry.

The KIM Modular System

After the Commodore acquisition, the KIM-1 officially became the first computer marketed under the Commodore name, along with the TIM kit. All KIM-1 computers now included the Commodore “chicken-head” logo etched into the printed circuit board.

John May had originally designed the KIM-1 with expansion in mind, as evidenced by the system bus and I/O lines made available to the user on the card edge connectors.. With the surprise success of the KIM-1, others soon decided to create hardware expansions for the KIM system. One entrepreneur who spotted the potential was another former GE employee, Larry Hittle.

Peddle recalls Hittle's contribution to the GE computer program. "He was involved with that whole program," says Peddle. "He put GE in the communications business. He was the guy that put together the communications system for the original Dartmouth machine."

Like many ex-GE employees, he was an entrepreneur. "He got the idea of starting his own CRT [Cathode Ray Tube] company, a company called Courier Systems. So he spun a company out of GE. He started Courier and did all the things wrong that all the other entrepreneurs were doing. Venture capitalists stole him blind, and he finally dropped out of that company to start his own little assembly company."

Hittle formed a company in the Denver area called *Monolithic Systems*. As it turns out, one of the first devices manufactured by Hittle's company was an accessory for the KIM-1. "He was heavily involved [with Commodore] for a while," says Peddle. With the surprise success of the KIM-1, Hittle decided to design and manufacture his own line of KIM-1 expansion products.

Additional memory was the most desired commodity. Hittle developed two different memory expansion boards, the KIM-2 and KIM-3, with four and eight kilobytes of RAM respectively.

At the heart of Hittle's expansion system was a motherboard, called the KIM-4. The foot-squared KIM-4 motherboard mated with the KIM-1 expansion connector, essentially creating an elongated circuit board. It contained six expansion slots, much like the slots on an Altair computer. Each slot contained 44-pin connectors. This allowed users to connect video cards, sound cards, memory cards, keyboard adapters, or anything else the computer world dreamed up. If six slots in the KIM were not enough, Hittle designed the board with a BUS expansion connector so users could attach several KIM-4 motherboards to each other.

Hittle also created two accessory cards for his motherboard. The first was the KIM-5 resident assembler and editor, which was provided essential software tools in ROM. He also created the KIM-6 prototyping board, useful for hardware designers creating their own electronics for the KIM.

In partnership with Hittle, Commodore sold and marketed all the KIM expansion products, releasing a color brochure of the entire line of products. The KIM-1, which began life as a demonstrator, was becoming a true computer system.

Other third-party developers also produced KIM-1 hardware products. Don Lancaster, famous for his groundbreaking early writings in BYTE magazine on digital logic and video interfaces, designed and sold a version of his TV Typewriter that allowed the KIM-1 to connect to a television or video monitor. He marketed the device through his company, Synergetics.

Many homebrew projects were created by hackers to extend the capability of the KIM-1. Peter Jennings expanded his Kim system to 8 kilobytes RAM. More importantly, he added two 8-inch floppy disk drives which required that he also create his own disk operating system in order to use them. He also created the Micro-ADE development system, a popular KIM-1 utility for cassette or disk based development. The resulting system was so powerful Jennings used it to develop later versions of Microchess for the Commodore PET and Apple II

Jennings also attached his KIM-1 system to a primitive modem so he could operate his computer remotely. This feature came in handy when Jennings flew to Santa Clara to deliver his CHESSmate code. While in the offices of Microcomputer Associates, Jennings realized his code required some minor changes. Using a terminal equipped with a paper tape punch, Jennings called his KIM-1 system in Toronto, made the required changes to the source code, re-assembled the code, then punched out a new paper tape to be burned into ROM. It was an impressive demonstration from what looked like a simple computer.

Another third-party manufacturer, *Forethought Products* of Oregon, created an expansion motherboard for the KIM-1 called the KIMSI.. The KIMSI had eight S-100 bus expansion connectors, allowing peripherals made for the popular Altair 8800 bus to interface with the KIM-1.[5]

The KIM-1's on-board serial interface allowed users to connect their computers to terminals, and some even connected them to electric typewriters for use as a printer. With its expansion capabilities, the KIM-1 system was able to replicate the basic abilities of minicomputers.

The KIM-1 system had great features for the price but it was still lacking in one area - it had no case. As a writer to Byte magazine noted, “I just can't see myself sitting there with a naked board gathering dust and me dropping ashes all over it while I sweat out a program.” To remedy this problem, Commodore created an optional plastic enclosure which looked very much like a mammoth calculator case.

In 1976, Peddle interested a third high-profile source for the 6502. “After we were bought by Commodore, we were approached by Rockwell to buy rights to the product,” recalls Peddle. “Rockwell came along and gave us a bunch of prestige.” With a third, stable source for the 6502, hardware makers were more likely to use the 6502 in their products.

Rockwell wanted to sell a clone of the KIM-1, but Commodore was reluctant to license clones. Instead, Rockwell released a “KIM-like” board called the AIM-65. The 6502 system was similar to the KIM-1, but contained a 20-digit LED display and a tiny thermal printer mounted directly on the motherboard. It also included a full-sized keyboard, which attached to the board by a ribbon cable. They sold the system for under $500.

Synertek also became a second source for the 6502 microprocessor and wanted to clone the KIM-1. They released the VIM, but fearing confusion with the cleaning product, they soon renamed it SYM; their system contained a more extensive operating system and more memory than the KIM-1. Overseas, a Dutch company named Elektor developed a European KIM-1 clone, called the Elektor-Junior. In Germany, a series of systems called the ALPHA were developed.

Commodore actively marketed the KIM-1 system against their competition, with advertisements appearing in 1978 asking, “Honestly: How many reasons do you need to make sure your next microprocessor is the original, genuine KIM?” The advertisements appeared in magazines like Kilobaud, but curiously, all Commodore advertisements in BYTE magazine ended and would not reappear for almost a decade.

[5] The KIMSI was also compatible with the Apple I computer.

The KIM-1 was produced by Commodore until about 1981, and has since become known as the first single-board computer (a computer with all components attached to a single circuit board). As Charpentier recalls, “Really the biggest success on the 6502 program was the old KIM-1 board.”

Estimates for the number of KIM-1 computers sold are difficult to find. “They sold a couple of hundred thousand, I think,” says Yannes. “Commodore sold lots,” says Peddle. “We were selling thousands per month - big numbers.” Did it get over a hundred thousand? “It might have gotten that high. It was certainly higher than ten thousand.”

A sad thing happens to old computers like the KIM-1. The next generation of computers soon rolls in with the latest features, and users become bored and a little disgusted at their obsolete machinery. Many discard them as obsolete relics, only to realize years later how much they cherished the machine. As a result, there are not many KIM-1's left in the world.

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To read the entire Commodore story, order “On the Edge: the Spectacular Rise and Fall of Commodore” ISBN 0973864907. This hardcover book is available for only $29.95 at www.commodorebook.com.